Technical Committee on Electrical Safety in the Workplace
Second Draft Meeting for NFPA 70E
Crowne Plaza Kansas City, Kansas City, MO
August 23 – 25, 2022
Agenda

08-22-01	Call to Order & Welcome
08-22-02	Introduction of Committee Members (Attachment A)
08-22-03	Approval of Previous Meeting Minutes (Attachment B)
08-22-04	Chairs Remarks
08-22-05	Staff Presentation
08-22-06	Task Group Reports and Review of Public Comments (Attachment C)
08-22-07	Old Business
08-22-08	New Business
08-22-09	Adjournment

Attachment A: Technical Committee Roster

Address List No Phone

08/11/2022
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Electrical Safety in the Workplace
National Electrical Code®

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Attachment B: Previous Meeting Minutes

NFPA 70E Electrical Safety in the Workplace Technical Committee First Draft

Meeting

Minutes

1. Dates and location of meeting:
   August 2-6, 2021
   Virtual Meeting

2. Names of TC members and guest in attendance
   See following page

3. NFPA staff presentation on First Draft meeting, process and timeline.

4. Minutes of previous meeting accepted.

5. Number of Public Inputs acted on: 357

6. Number of First Revisions created: 167

7. Task groups will be assigned following receipt of public comments to recommend actions for the second draft meeting.

8. No old business

9. No new business

NFPA 70E First Draft Attendance (August 2-6, 2021)					
	Monday	**Tuesday**	**Wednesday**	**Thursday**	**Friday**
Chair					
Louis A. Barrios					
Principles					
Paul Barnhart					
Steven C. Chybowski					
Daryld Ray Crow					
Thomas B. Dyson					
Ernest J. Gallo					
Bobby Gray					
William R. Harris					
Palmer L. Hickman					
Mark R. Hilbert					
Kevin J. Lippert					
Terrance L. McKinch					
Mark McNellis					
Charles R. Miller					
Daleep C. Mohla					
James K. Niemira					
Thomas D. Norwood					
David A. Pace					
James G. Stallcup					
Samuel B. Stonerock					
John M. Tobias					
Sean P. Welsh					
Rodney J. West					
Jason Wolf					
Alternates					
Lawrence S. Ayer					
Bill Alderton					
Adam Ashton					
Dawn M. Carney					
Jeffrey Paul Conkwright					
Karl M. Cunningham					
Paul Dobrowsky					
James T. Dollard, Jr.					
Heath Garrison					
Eric Glaude					
Donald Charles Hacke					
Martin Nagel					
Larry D. Perkins					
Jim Phillips					
Roy K. Sparks, III					
James W. Stallcup, Jr.					
Gregory J. Steinman					
Ron Widup					
Carolyn Black					
Mike Doherty					
Member Emeritus					
David M. Wallis					
Guests					
Al Havens					
Al Winfield					
Dean Austin					
Bob Huck					
Bob Jackson					
Shannon Bick					
Daniel Roberts					

Dennis Kennedy					
Derek Vigstol					
Donna Cox					
Cory Hannahs					
Eric Hohengasser					
Bryan Holland					
Kyle Bowden					
Lloyd Gordon					
Amanda Newsome					
Rachel Burgaris					
Terry Becker					
Virginia Balitski					
Tom Domitrovich					
Max Issacs					
Don Hook					
Don Ganiere					
Jasone Armas					
Michael Johnston					
Brendan McLellan					
Michael McCabe					
Ryan Jackson					
Bhanu Srilla					
Bill Cantor					
Jeffery Sargent					
Jerry Gringas					
Nicholas Galloway					
Jack Lyons					
Tom Ryan					

Attachment C: Public Comment Report

Public Comment No. 137-NFPA 70E-2022 [Global Input]

The term “electric” should be added in front of “shock” throughout the standard. Presently the term “shock” and “electric shock” is used inconsistently. The correct term is “electric shock” and making this change will help ensure the appropriate term is used throughout all of NFPA standards dealing with electrical requirements and sometimes other requirements that are not electrical. Other standards can use the term “shock” for a different issue.

Statement of Problem and Substantiation for Public Comment

The term “electric” should be added in front of “shock” throughout the standard. Presently the term “shock” and “electric shock” is used inconsistently. The correct term is “electric shock” and making this change will help ensure the appropriate term is used throughout all of NFPA standards dealing with electrical requirements and sometimes other requirements that are not electrical. Other standards can use the term “shock” for a different issue.

Related Item

- fr 140

Submitter Information Verification

Submitter Full Name: Paul Dobrowsky
Organization: Innovative Technology Services
Street Address:
City:
State:
Zip:
Submittal Date: Tue May 31 13:45:12 EDT 2022
Committee: EEW-AAA

Public Comment No. 144-NFPA 70E-2022 [Global Input]

The Correlating Committee directs that reconsideration be given to the action which added this informative annex as its abbreviated content may not correlate with NFPA70B and/or be inconsistent or incomplete where not used within the context of the information contained in NFPA 70B. This also conflicts with the guidance provided in the informational note to 200.1.

Additional Proposed Changes

File Name	Description	Approved
CN_1.pdf	70E_CN1_PC144	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 1 appeared in the First Draft Report on First Revision No. 147.

The Correlating Committee directs that reconsideration be given to the action which added this informative annex as its abbreviated content may not correlate with NFPA 70B and/or be inconsistent or incomplete where not used within the context of the information contained in NFPA 70B. This also conflicts with the guidance provided in the informational note to 200.1.

Related Item

- First Revision No. 147

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC
Organization: NEC Correlating Committee
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jun 02 13:07:52 EDT 2022
Committee: EEW-AAA

Correlating Committee Note No. 1-NFPA 70E-2022 [Global Input]

Submitter Information Verification

Committee: NEC-AAC

Submittal Date: Thu Jan 20 10:23:03 EST 2022

Committee Statement

Committee Statement: The Correlating Committee directs that reconsideration be given to the action which added this informative annex as its abbreviated content may not correlate with NFPA 70B and/or be inconsistent or incomplete where not used within the context of the information contained in NFPA 70B. This also conflicts with the guidance provided in the informational note to 200.1.

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

Ballot Results

✔ **This item has passed ballot**

12 Eligible Voters
1 Not Returned
11 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.
Gallo, Ernest J.
Hickman, Palmer L.
Holub, Richard A.
Hunter, Dean C.
Kendall, David H.
Kovacik, John R.
Manche, Alan
Porter, Christine T.
Schultheis, Timothy James
Williams, David A.

Public Comment No. 145-NFPA 70E-2022 [Global Input]

The Correlating Committee directs that the technical committee review the use of the term protectors throughout the document for clarity and consistency and review the negative ballot comment with regards to the terminology change.

Additional Proposed Changes

File Name	Description	Approved
CN_2.pdf	70E_CN2_PC145	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 2 appeared in the First Draft Report on First Revisions No. 63.

The Correlating Committee directs that the technical committee review the use of the term protectors throughout the document for clarity and consistency and review the negative ballot comment with regards to the terminology change.

Related Item

• First Revision No. 63

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC
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City:
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Zip:
Submittal Date: Thu Jun 02 13:13:45 EDT 2022
Committee: EEW-AAA

Correlating Committee Note No. 2-NFPA 70E-2022 [Global Input]

Submitter Information Verification

Committee: NEC-AAC

Submittal Date: Thu Jan 20 10:24:20 EST 2022

Committee Statement

Committee Statement: The Correlating Committee directs that the technical committee review the use of the term protectors throughout the document for clarity and consistency and review the negative ballot comment with regards to the terminology change.

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

Ballot Results

✔ **This item has passed ballot**

12 Eligible Voters
1 Not Returned
11 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.
Gallo, Ernest J.
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Holub, Richard A.
Hunter, Dean C.
Kendall, David H.
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Porter, Christine T.
Schultheis, Timothy James
Williams, David A.

Public Comment No. 146-NFPA 70E-2022 [Global Input]

The Correlating Committee directs the technical committee to review all the definitions in Article 100 for compliance with the 2020 NEC Style Manual.

Additional Proposed Changes

File Name	Description	Approved
CN_28.pdf	70E_CN28_PC146	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 28 appeared in the First Draft Report on First Revisions No. 137.

The Correlating Committee directs the technical committee to review all the definitions in Article 100 for compliance with the 2020 NEC Style Manual.

Related Item

- First Revision No. 137

Submitter Information Verification

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Correlating Committee Note No. 28-NFPA 70E-2022 [Global Input]

Submitter Information Verification

Committee: NEC-AAC

Submittal Date: Thu Jan 20 12:14:11 EST 2022

Committee Statement

Committee Statement: The Correlating Committee directs the technical committee to review all the definitions in Article 100 for compliance with the 2020 NEC Style Manual.

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

Ballot Results

✔ **This item has passed ballot**

12 Eligible Voters
1 Not Returned
11 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

McDaniel, Roger D.

Affirmative All

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Kendall, David H.
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Porter, Christine T.
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Williams, David A.

Public Comment No. 50-NFPA 70E-2022 [Global Input]

(1) Modify the definition of Electrical Hazard by deleting thee word "electric" in front of the word "shock" and add a new Informational Note No.2.

Electrical Hazard.

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

Informational Note 1: Class 2 power supplies, listed low voltage lighting systems, and similar sources are examples of circuits or systems that are not considered an electrical hazard.

Informational Note 2: As used in this standard, the word "shock" refers to current flow through the body which is an electric shock.

(2) Throughout the NFPA 70E Standard (globally), delete the word "electric" where it appears as a descriptor in front of the word "shock".

Type your content here ...

Statement of Problem and Substantiation for Public Comment

There are a number of public inputs to add the word "electric" in front of the word "shock" throughout the standard. A careful review of these public inputs reveals that there is little to no substantiation. The only substantiation to add the word "electric" in front of the word "shock" throughout the standard, is that the existing definition of "Electrical Hazard" uses the descriptor "electric" in front of the word "shock". The user of this standard understands what the word "shock" means. There is no real or perceived benefit in adding the word "electric" in front of the word "shock" throughout the standard. It is user friendly to simply delete "electric" in the definition of "Electrical Hazard", add the IN and correlate globally. The other types of shock are distributive, cardiogenic, hypovolemic, and obstructive. None of which apply to NFPA 70E.

Related Item

- PI 22

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Public Comment No. 155-NFPA 70E-2022 [Section No. 90.3]

90.3 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.

Additional Proposed Changes

File Name	Description	Approved
CN_42.pdf	70E_CN42_PC155	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 42 appeared in the First Draft Report on First Revisions No. 36.

The Correlating Committee notes that the revised title of 90.3 does not align well with 90.3(A) and (B) and directs the technical committee to consider a title that is a better description of the provisions contained in this section.

Related Item

- First Revision No. 36

Submitter Information Verification

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Submittal Date:	Thu Jun 02 13:34:40 EDT 2022
Committee:	EEW-AAA

Correlating Committee Note No. 42-NFPA 70E-2022 [Section No. 90.2]

Submitter Information Verification

Committee: NEC-AAC

Submittal Date: Fri Jan 21 09:58:48 EST 2022

Committee Statement

Committee Statement: The Correlating Committee notes that the revised title of 90.3 does not align well with 90.3(A) and (B) and directs the technical committee to consider a title that is a better description of the provisions contained in this section.

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

Ballot Results

This item has passed ballot

12 Eligible Voters
1 Not Returned
11 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.
Gallo, Ernest J.
Hickman, Palmer L.
Holub, Richard A.
Hunter, Dean C.
Kendall, David H.
Kovacik, John R.
Manche, Alan
Porter, Christine T.
Schultheis, Timothy James
Williams, David A.

Public Comment No. 47-NFPA 70E-2022 [Section No. 90.3(A)]

(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

(3) Installations used by the communications utility, such as office buildings, warehouses, garages, machine shops, and recreational buildings that are not an integral part of communications equipment associated with the infrastructure network.

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.

Statement of Problem and Substantiation for Public Comment

Communications utility companies have identical office buildings, warehouses, garages, machine shops, recreational building, business office and similar structures that are not an integral part of the communications equipment as used by electric utilities. However, they don't have the same 'covered' requirements for such non-utility locations as specified by electric utility companies. Therefore, the workers who maintain, repair or install new electrical equipment into these buildings and structures that contain electrical infrastructure and distribution systems needed to power these "non-communications loads" should be covered by NFPA 70E.

Related Item

• PI

Submitter Information Verification

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State:
Zip:
Submittal Date: Wed May 18 18:18:43 EDT 2022
Committee:

Public Comment No. 46-NFPA 70E-2022 [Section No. 90.3(B)]

(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:

(5) Consist of service drops or service laterals, and associated metering, or

(6) 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

(7) 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

(8) 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.

Informational Note: For those installations and locations listed as not covered by 90.2(B), consideration should be given to voluntarily adopt electrical safety replated work practices contained in this standard for tasks, electrical equipment and distribution systems that are commonly found in installations and locations that are covered pursuant to 90.2(A). This action will proactively enhance worker safety by incorporating proven principles and practices.

Statement of Problem and Substantiation for Public Comment

While many electric power generation plants who are officially “not covered” per 90.2(B), especially within the nuclear industry, have voluntarily adopted NFPA 70E either partially or wholly into their electrical safety program there are others who have not. This informational note would encourage some to voluntarily adopt proven principles found in 70E without making compliance compulsory or mandatory. This will help encourage those who are “riding the fence” to possibly start incorporating some principles into their programs.

Related Item

• PI

Submitter Information Verification

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Submittal Date:	Wed May 18 17:50:04 EDT 2022
Committee:	

Public Comment No. 131-NFPA 70E-2022 [Section No. 90.5(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. Unless the standard reference includes a date, the reference is to be considered as the latest edition of the 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.

Statement of Problem and Substantiation for Public Comment

Add a sentence to 90.5(C) stating that if reference dates are not included the latest edition is intended. Explanatory references are not for mandatory application, for information only. Considerable time is spent every cycle updating reference dates without a good reason. There is an expectation that the committee knows what is in the edition referenced but that does not always seem to be true. Public Inputs were submitted by NEMA and UL, and accepted for the 2023 NEC.

Related Item

- fr 37

Submitter Information Verification

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Committee: EEW-AAA

Public Comment No. 15-NFPA 70E-2022 [Article 100]

Article 100 Definitions

Scope. This article contains only those definitions essential to the proper application of this standard. It is not intended to include commonly defined general terms or commonly defined technical terms from related codes and standards. In general, only those terms that are used in two or more articles are defined in Article 100. Other definitions are included in the article in which they are used but may be referenced in Article 100. The definitions in this article shall apply wherever the terms are used throughout this standard.

Accessible (as applied to equipment).

Admitting close approach; not guarded by locked doors, elevation, or other effective means. [**70:**100]

Approved.

Acceptable to the authority having jurisdiction.

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)

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

Arc Flash Suit.

A complete arc-rated clothing and equipment system that covers the entire body, except for the hands and feet.

> Informational Note: An arc flash suit may include pants or overalls, a jacket or a coverall, and a beekeeper-type hood fitted with a face shield.

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: 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: 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.

Assured Equipment Grounding Conductor Program (AEGCP). An alternative method for GFCI protection of temporary circuits that are greater than 125-volt, 15, 20, or 30 amperes or for equipment, which by design, is not compatible with GFCI protection.

Informational Note: For further information regarding the specifics of an assured equipment grounding conductor program, see NFPA 70 article 590.6(B)(2).

Attachment Plug (Plug Cap) (Plug).

A device that, by insertion in a receptacle, establishes a connection between the conductors of the attached flexible cord and the conductors connected permanently to the receptacle. [**70:**100]

Authority Having Jurisdiction (AHJ).

An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

Informational Note: The phrase "authority having jurisdiction," or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

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)

Automatic.

Performing a function without the necessity of human intervention.

Balaclava.

An arc-rated head-protective fabric that protects the neck and head except for a small portion of the facial area.

Informational Note: Some balaclava designs protect the neck and head area except for the eyes while others leave the eyes and nose area unprotected.

Barricade.

A physical obstruction such as tapes, cones, or A-frame-type wood or metal structures intended to provide a warning and to limit access.

Barrier.

A physical obstruction that is intended to prevent contact with equipment or energized electrical conductors and circuit parts.

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)

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.

Battery Room.

A room specifically intended for the installation of batteries that have no other protective enclosure. (320)

Bonded (Bonding).

Connected to establish electrical continuity and conductivity. [**70:**100]

Bonding Conductor or Jumper.

A reliable conductor to ensure the required electrical conductivity between metal parts required to be electrically connected. [**70:**100]

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.

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.

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.

Building.

A structure that stands alone or that is cut off from adjoining structures by fire walls with all openings therein protected by approved fire doors. [**70:**100]

Cabinet.

An enclosure that is designed for either surface mounting or flush mounting and is provided with a frame, mat, or trim in which a swinging door or doors are or can be hung. [**70:**100]

Cell.

The basic electrochemical unit, characterized by an anode and a cathode used to receive, store, and deliver electrical energy. (320)

Charge Transfer.

Improper discharging of capacitor networks that results in transferring charge from one capacitor to another instead of fully discharging the stored energy. (360)

Circuit Breaker.

A device designed to open and close a circuit by nonautomatic means and to open the circuit automatically on a predetermined overcurrent without damage to itself when properly applied within its rating. [**70:**100]

Informational Note: The automatic opening means can be integral, direct acting with the circuit breaker, or remote from the circuit breaker.

Competent Person.

A person who meets all the requirements of *qualified person*, 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)

Conductive.

Suitable for carrying electric current.

Conductor, Bare. (Bare Conductor)

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

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]

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]

Controller.

A device or group of devices that serves to govern, in some predetermined manner, the electric power delivered to the apparatus to which it is connected. [**70:**100]

Current-Limiting Overcurrent Protective Device.

A device that, when interrupting currents in its current-limiting range, reduces the current flowing in the faulted circuit to a magnitude substantially less than that obtainable in the same circuit if the device were replaced with a solid conductor having comparable impedance.

Cutout.

An assembly of a fuse support with either a fuseholder, fuse carrier, or disconnecting blade. The fuseholder or fuse carrier may include a conducting element (fuse link), or may act as the disconnecting blade by the inclusion of a nonfusible member.

De-energized.

Free from any electrical connection to a source of potential difference and from electrical charge; not having a potential different from that of the earth.

Device.

A unit of an electrical system, other than a conductor, that carries or controls electric energy as its principal function. [**70:**100]

Dielectric Absorption.

The property of certain capacitors to recharge after being discharged. (360)

Informational Note: A voltage recharge 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.

Discharge Time.

The time required to discharge a capacitor to below electrical thresholds. (360)

Disconnecting Means.

A device, or group of devices, or other means by which the conductors of a circuit can be disconnected from their source of supply. [**70:**100]

Disconnecting (or Isolating) Switch (Disconnector, Isolator).

A mechanical switching device used for isolating a circuit or equipment from a source of power.

Dwelling Unit.

A single unit providing complete and independent living facilities for one or more persons, including permanent provisions for living, sleeping, cooking, and sanitation. [**70:**100]

Electrical Hazard.

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

> Informational Note: Class 2 power supplies, listed low voltage lighting systems, and similar sources are examples of circuits or systems that are not considered an electrical hazard.

Electrical Safety.

Identifying hazards associated with the use of electrical energy and taking precautions to reduce the risk associated with those hazards.

Electrical Safety Program.

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

Electrically Safe Work Condition.

A state in which an electrical conductor or circuit part has been disconnected from energized parts, locked/tagged in accordance with established standards, tested to 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 eliminating electrical hazards for the period of time for which the state is maintained.

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)

Enclosed.

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

Enclosure.

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

Energized.

Electrically connected to, or is, a source of voltage. [**70:**100]

Equipment.

A general term, including fittings, devices, appliances, luminaires, apparatus, machinery, and the like, used as a part of, or in connection with, an electrical installation. [**70:**100]

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: 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.

Exposed (as applied to energized electrical conductors or circuit parts).

Capable of being inadvertently touched or approached nearer than a safe distance by a person. It is applied to electrical conductors or circuit parts that are not suitably guarded, isolated, or insulated.

Exposed (as applied to wiring methods).

On or attached to the surface or behind panels designed to allow access. [**70:**100]

Fault Current.

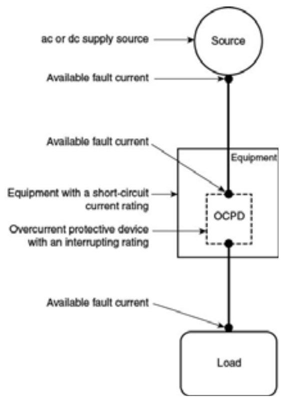
The amount of current delivered at a point on the system during a short-circuit condition.

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. .

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.

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.

Fitting.

An accessory such as a locknut, bushing, or other part of a wiring system that is intended primarily to perform a mechanical rather than an electrical function. [**70:**100]

Fuse.

An overcurrent protective device with a circuit-opening fusible part that is heated and severed by the passage of overcurrent through it.

Informational Note: A fuse comprises all the parts that form a unit capable of performing the prescribed functions. It may or may not be the complete device necessary to connect it into an electrical circuit.

Ground.

The earth. [**70:**100]

Ground Fault.

An unintentional, electrically conductive connection between an ungrounded conductor of an electrical circuit and the normally non–current-carrying conductors, metallic enclosures, metallic raceways, metallic equipment, or earth. [**70:**100]

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.

Grounded (Grounding).

Connected (connecting) to ground or to a conductive body that extends the ground connection. [**70:**100]

Grounded, Solidly. (Solidly Grounded)

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

Grounded Conductor.

A system or circuit conductor that is intentionally grounded. [**70:**100]

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

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.

Grounding Electrode.

A conducting object through which a direct connection to earth is established. [**70:**100]

Grounding Electrode Conductor.

A conductor used to connect the system grounded conductor or the equipment to a grounding electrode or to a point on the grounding electrode system. [**70:**100]

Guarded.

Covered, shielded, fenced, enclosed, or otherwise protected by means of suitable covers, casings, barriers, rails, screens, mats, or platforms to remove the likelihood of approach or contact by persons or objects to a point of danger. [**70:**100]

Hard Grounding (Low-Z).

The practice of discharging a capacitor through a low impedance, also called Low-Z (impedance) grounding. (360)

Hazard.

A source of possible injury or damage to health.

Hazardous.

Involving exposure to at least one hazard.

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)

Incident Energy.

The amount of thermal energy impressed on a surface, a certain distance from the source, generated during an electrical arc event. Incident energy is typically expressed in calories per square centimeter (cal/cm^2).

Incident Energy Analysis.

A component of an arc flash risk assessment used to predict the incident energy of an arc flash for a specified set of conditions.

Insulated.

Separated from other conducting surfaces by a dielectric (including air space) offering a high resistance to the passage of current.

> Informational Note: When an object is said to be insulated, it is understood to be insulated for the conditions to which it is normally subject. Otherwise, it is, within the purpose of these rules, uninsulated.

Interrupter Switch.

A switch capable of making, carrying, and interrupting specified currents.

Interrupting Rating.

The highest current at rated voltage that a device is identified to interrupt under standard test conditions. [**70:**100]

> Informational Note: Equipment intended to interrupt current at other than fault levels may have its interrupting rating implied in other ratings, such as horsepower or locked rotor current.

Isolated (as applied to location).

Not readily accessible to persons unless special means for access are used. [**70:**100]

Labeled.

Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

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)

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)

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)

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)

Laser System.

A laser in combination with an appropriate laser energy source with or without additional incorporated components. (330)

Listed.

Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

> Informational Note: The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

Luminaire.

A complete lighting unit consisting of a light source, such as a lamp or lamps, together with the parts designed to position the light source and connect it to the power supply. It may also include parts to protect the light source or the ballast or to distribute the light. A lampholder itself is not a luminaire. [**70:**100]

Lung Protection Boundary.

Worker distance at which a 1 percent probability of lung damage exists from a 70 kPa (10 psi) shock wave. (360)

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.

Motor Control Center.

An assembly of one or more enclosed sections having a common power bus and principally containing motor control units. [**70:**100]

Neutral Conductor. The conductor connected to the neutral point of a system that is intended to carry current under normal condition. [70:100]

Outlet.

A point on the wiring system at which current is taken to supply utilization equipment. [**70:**100]

Overcurrent.

Any current in excess of the rated current of equipment or the ampacity of a conductor. It may result from overload, short circuit, or ground fault. [**70:**100]

> Informational Note: A current in excess of rating may be accommodated by certain equipment and conductors for a given set of conditions. Therefore, the rules for overcurrent protection are specific for particular situations.

Overload.

Operation of equipment in excess of normal, full-load rating, or of a conductor in excess of rated ampacity that, when it persists for a sufficient length of time, would cause damage or dangerous overheating. A fault, such as a short circuit or ground fault, is not an overload. [**70:**100]

Panelboard.

A single panel or group of panel units designed for assembly in the form of a single panel, including buses and automatic overcurrent devices, and equipped with or without switches for the control of light, heat, or power circuits; designed to be placed in a cabinet or cutout box placed in or against a wall, partition, or other support; and accessible only from the front. [**70:**100]

Pilot Cell.

One or more cells chosen to represent the operating parameters of the entire battery (sometimes called "temperature reference" cell). (320)

Premises Wiring (System).

Interior and exterior wiring, including power, lighting, control, and signal circuit wiring together with all their associated hardware, fittings, and wiring devices, both permanently and temporarily installed. This includes: (a) wiring from the service point or power source to the outlets; or (b) wiring from and including the power source to the outlets where there is no service point.

Such wiring does not include wiring internal to appliances, luminaires, motors, controllers, motor control centers, and similar equipment. [**70:**100]

> Informational Note: Power sources include, but are not limited to, interconnected or stand-alone batteries, solar photovoltaic systems, other distributed generation systems, or generators.

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.

Protective Barrier.

Prevents user access to a hazardous voltage, current, or stored energy area. (330)

Protector.

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

Qualified Person.

One who has demonstrated skills and knowledge related to the construction and operation of electrical equipment and installations and has received safety training to identify the hazards and reduce the associated risk.

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)

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)

Raceway.

An enclosed channel of metal or nonmetallic materials designed expressly for holding wires, cables, or busbars, with additional functions as permitted in this standard. [**70:**100]

Receptacle.

A contact device installed at the outlet for the connection of an attachment plug, or for the direct connection of electrical utilization equipment designed to mate with the corresponding contact device. A single receptacle is a single contact device with no other contact device on the same yoke. A multiple receptacle is two or more contact devices on the same yoke. [**70:**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)

Resistor, Bleeder. (Bleeder Resistor)

A resistor network connected in parallel with a capacitor’s terminals that drains the charge after power has been disconnected. (360)

Risk.

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

Risk Assessment.

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

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

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)

Service Drop.

The overhead conductors between the utility electric supply system and the service point. [**70:**100]

Service Lateral.

The underground conductors between the utility electric supply system and the service point. [**70:**100]

Service Point.

The point of connection between the facilities of the serving utility and the premises wiring. [**70:**100]

> Informational Note: The service point can be described as the point of demarcation between where the serving utility ends and the premises wiring begins. The serving utility generally specifies the location of the service point based on the conditions of service.

Shock Hazard.

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

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

Short-Circuit Current Rating.

The prospective symmetrical fault current at a nominal voltage to which an apparatus or system is able to be connected without sustaining damage exceeding defined acceptance criteria. [**70:**100]

Single-Line Diagram.

A diagram that shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used in the circuit or system.

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)

Special Permission.

The written consent of the authority having jurisdiction. [**70:**100]

Step Potential.

A ground potential gradient difference that can cause current flow from foot to foot through the body.

Structure.

That which is built or constructed. [**70:**100]

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]

Switchboard.

A large single panel, frame, or assembly of panels on which are mounted on the face, back, or both, switches, overcurrent and other protective devices, buses, and usually instruments. These assemblies are generally accessible from the rear as well as from the front and are not intended to be installed in cabinets. [**70:**100]

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.

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.

Switching Device.

A device designed to close, open, or both, one or more electric circuits.

Temporary Protective Grounding. The final conditional step when establishing and verifying an electrically safe work condition exists that provides safeguards of employees from electric shock protection due to hazardous differences of potential which is temporarily installed for the duration of the job. It also minimizes hazardous step and touch potential.

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.

Time Constant.

The time it takes for voltage to drop by ~63 percent (1/e) during discharge. (360)

Touch Potential.

A ground potential gradient difference that can cause current flow from hand to hand, hand to foot, or another path, other than foot to foot, through the body.

Ungrounded.

Not connected to ground or to a conductive body that extends the ground connection. [**70:**100]

Unqualified Person.

A person who is not a qualified person.

Utilization Equipment.

Equipment that utilizes electric energy for electronic, electromechanical, chemical, heating, lighting, or similar purposes. [**70:**100]

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)

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)

Voltage (of a Circuit).

The greatest root-mean-square (rms) (effective) difference of potential between any two conductors of the circuit concerned. [**70:**100]

Informational Note: Some systems, such as three-phase 4-wire, single-phase 3-wire, and 3-wire direct-current, may have various circuits of various voltages.

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.

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.

Working Distance.

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

Informational Note: See 130.5(C)(1) and Annex D – Incident Energy and Arc Flash Boundary Calculation Methods for further information. Incident energy increases as the distance from the arc source decreases.

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: Examples of "working on" 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 physical alteration of electrical equipment, conductors, or circuit parts (such as making or tightening connections, removing or replacing components, etc.).

Additional Proposed Changes

File Name	Description	Approved
Article_100_New_Definitions_03-20-2022.docx	New definitions should be added to article 100 because they are or will be used within the context of the 2024 70E body and/or annexes, consisting of "Assured Equipment Grounding Conductor Program", "Neutral Conductor" (new PI under electrically safe work condition 120.6), "Temporary Protective Grounding". Also the Informational note under the definition of "Working Distance" should also direct the reader back to "Annex D - Incident Energy and Arc Flash Boundary Calculation Methods" for further information of the specific working distances of 18", 24" and 36".	

Statement of Problem and Substantiation for Public Comment

Justification for my submitted new definitions to article 100 are listed as follows:
"Assured Equipment Grounding Conductor Program", because this term is used in article 110.8
"Neutral Conductor", because of my new PI to update article 120.6 as an another conductor or circuit part to be verified to be absence of hazardous electric current.

"Temporary Protective Grounding", because it is used in article 120.6 and is directly related to minimizing step potential and touch potential which are new definitions added to the 2024 NFPA 70E article 100.
"Working Distance" Informational Note should be updated to point the reader to Annex D - Incident Energy and Arc Flash Boundary Calculation Methods which establishes the various physical working distances of 18, 24 and 36 inches depending on the type and class of equipment.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 14-NFPA 70E-2022 [Section No. 120.6]	Neutral Conductor in article 100 with ESWC in article 120.6
Public Comment No. 14-NFPA 70E-2022 [Section No. 120.6]	

Related Item

- PI

Submitter Information Verification

Submitter Full Name:	George Cole
Organization:	PVNGS/APS
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Sun Mar 20 13:04:13 EDT 2022
Committee:	EEW-AAA

2024 NFPA 70E Public Input article 100 New Definitions
George Cole

Assured Equipment Grounding Conductor Program. An alternative method for GFCI protection of temporary circuits that are greater than 125-volt, 15, 20, or 30 amperes or for equipment, which by design, is not compatible with GFCI protection.

Informational Note: For further information regarding the specifics of an assured equipment grounding conductor program, see NFPA 70 article 590.6(B)(2).

Neutral Conductor. The conductor connected to the neutral point of a system that is intended to carry current under normal condition. [70:100]

Temporary Protective Grounding. The final conditional step when establishing and verifying an electrically safe work condition exists that provides safeguards of employees from electric shock protection due to hazardous differences of potential which is temporarily installed for the duration of the job. It also minimizes hazardous step and touch potential to safe levels.

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

Informational Note: See 130.5(C)(1) and Annex D – Incident Energy and Arc Flash Boundary Calculation Methods for further information. Incident energy increases as the distance from the arc source decreases.

Public Comment No. 84-NFPA 70E-2022 [Definition: Authorized Personnel.]

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)~~

Statement of Problem and Substantiation for Public Comment

This problem was created when the definition from Article 320 was moved. It was deemed important by the original authors, as it is. But to have it apply only to batteries does not make any sense. This term "Authorized Person" is used throughout all classes of work. Either leave it out completely, or provide a broader definition that applies to all electrical work. In addition, this term is interpreted differently by the authorizing company. I recommend leaving it out. IF putting (320) at the end of the definition means that this definition ONLY applies to article 320, then my recommendation can be ignored. HOWEVER, that must be carefully explained in the beginning of this Article on definitions, otherwise, the reader will assume the definitions apply to the whole document.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 90-NFPA 70E-2022 [Definition: Safeguarding.]	

Related Item

- PI No. 108

Submitter Information Verification

Submitter Full Name: Lloyd Gordon

Organization: retired

Street Address:

City:

State:

Zip:

Submittal Date: Sun May 29 21:32:57 EDT 2022

Committee: EEW-AAA

Public Comment No. 85-NFPA 70E-2022 [Definition: Battery Effect.]

Battery Effect.

A voltage that exists on the electrolytic 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.

Statement of Problem and Substantiation for Public Comment

This lack of clarity was created when the definition was moved from article 310. The term cell is used for both batteries (article 320) and electrolytic cells (article 310). By moving the definition from Article 310, it is no longer obvious that the "cell" being referred to was electrolytic. The additional word clarifies the definition.

Related Item

- PI No. 108

Submitter Information Verification

Submitter Full Name: Lloyd Gordon
Organization: retired
Street Address:
City:
State:
Zip:
Submittal Date: Sun May 29 21:44:36 EDT 2022
Committee: EEW-AAA

Public Comment No. 101-NFPA 70E-2022 [Definition: Charge Transfer.]

Charge Transfer.

Improper discharging of capacitor networks that results in transferring charge from one capacitor to another capacitor instead of fully discharging the stored energy. (360)

Statement of Problem and Substantiation for Public Comment

a slight grammatical change for clarity

Related Item

- PI No. 309

Submitter Information Verification

Submitter Full Name: Lloyd Gordon
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Mon May 30 09:57:50 EDT 2022
Committee: EEW-AAA

Public Comment No. 102-NFPA 70E-2022 [Definition: Discharge Time.]

Discharge Time.

The time required to discharge a capacitor to below electrical hazard thresholds. (360)

Statement of Problem and Substantiation for Public Comment

A very important word was left out from the approved PI No. 311.
As written, "The time required to discharge a capacitor to below electrical thresholds" is meaningless, as the threshold could be anything.
"to below hazardous electrical thresholds" links this definition to the capacitor hazards thresholds defined in Article 360.3.

Related Item

- PI No. 311

Submitter Information Verification

Submitter Full Name: Lloyd Gordon
Organization: [Not Specified]
Street Address:
City:
State:
Zip:

Submittal Date: Mon May 30 10:00:50 EDT 2022
Committee: EEW-AAA

Public Comment No. 113-NFPA 70E-2022 [Definition: Discharge Time.]

Discharge Time.

The time required to discharge a capacitor to below electrical hazard thresholds. (360)

Statement of Problem and Substantiation for Public Comment

"Hazard" is added to "electrical thresholds" to align with 360.3. As presently written, "electrical thresholds" is vague.

Related Item

- FR-175

Submitter Information Verification

Submitter Full Name:	Louis Barrios
Organization:	Shell Global Solutions
Affiliation:	API
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Mon May 30 12:20:41 EDT 2022
Committee:	EEW-AAA

Public Comment No. 130-NFPA 70E-2022 [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~~ for 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 eliminating electrical hazards for the period of time for which the state is maintained.

Statement of Problem and Substantiation for Public Comment

Replace the word “to verify” with “for” to be consistent with how the process of establishing and verifying an electrical safe work condition is described in 120.6(7). The wording in 120.6(7) is “test for the absence of voltage” then “verify (verification) the test instrument operates satisfactorily. In many training presentations the definition is described just before the process is explained. The wording needs to be consistent and the suggested wording does not change the intent of the definition and improves clarity.

Related Item

- pi 344

Submitter Information Verification

Submitter Full Name:	Paul Dobrowsky
Organization:	Innovative Technology Services
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Tue May 31 06:27:42 EDT 2022
Committee:	EEW-AAA

Public Comment No. 156-NFPA 70E-2022 [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 eliminating electrical hazards for the period of time for which the state is maintained.

Additional Proposed Changes

File Name	Description	Approved
CN_10.pdf	70E_CN10_PC156	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 10 appeared in the First Draft Report on First Revisions No. 10.

The Correlating Committee directs that the technical committee revise this informational note to comply with 3.1.3 of the 2020 NEC Style Manual so that it does "not contain requirements, make interpretations, or make recommendations." Specifically, per 3.1.3 of the 2020 NEC Style Manual, "if an Informational note is needed to explain the text of the document, consideration should be given to rewriting the text of the document to make the rule clear." Accordingly, the technical committee can relocate the non-compliant content of the informational note as a requirement.

Likewise, resolved Public Input 64 addressed a similar issue and its action should be reconsidered by the technical committee for correlation and compliance with 3.1.3 of the 2020 NEC Style Manual.

Related Item

- First Revision No. 10

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC

Organization: NEC Correlating Committee

Street Address:

City:

State:

Zip:

Submittal Date: Thu Jun 02 13:36:20 EDT 2022

Committee: EEW-AAA

Correlating Committee Note No. 10-NFPA 70E-2022 [Definition: Electrically Safe Work Condition.]

Submitter Information Verification

Committee: NEC-AAC

Submittal Date: Thu Jan 20 11:14:44 EST 2022

Committee Statement

Committee Statement: The Correlating Committee directs that the technical committee revise this informational note to comply with 3.1.3 of the 2020 NEC Style Manual so that it does “not contain requirements, make interpretations, or make recommendations.” Specifically, per 3.1.3 of the 2020 NEC Style Manual, “if an Informational note is needed to explain the text of the document, consideration should be given to rewriting the text of the document to make the rule clear.” Accordingly, the technical committee can relocate the non-compliant content of the informational note as a requirement.

Likewise, resolved Public Input 64 addressed a similar issue and its action should be reconsidered by the technical committee for correlation and compliance with 3.1.3 of the 2020 NEC Style Manual.

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

Ballot Results

✔ **This item has passed ballot**

12 Eligible Voters
1 Not Returned
11 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.

Gallo, Ernest J.

Hickman, Palmer L.

Holub, Richard A.

Hunter, Dean C.

Kendall, David H.

Kovacik, John R.

Manche, Alan

Porter, Christine T.

Schultheis, Timothy James

Williams, David A.

Public Comment No. 5-NFPA 70E-2022 [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 eliminating electrical hazards for the period of time for which the state is maintained.~~

Statement of Problem and Substantiation for Public Comment

Delete this informational note as it does not comply with 3.1.3 of the NEC Style Manual. Specifically, "Informational
notes shall not be written in mandatory language and shall not contain requirements, make interpretations, or make recommendations." In addition, it is unnecessary as it is redundant as a similar informational note exists in Article 110, General Requirements, now as Informational Note No. 2 to 110.2(A) in the 2024 First Draft report. While that 110.2(A) informational note also does not comply with 3.1.3. of the NEC Style Manual, a Public Comment is being submitted to relocate the non-compliant informational note as a requirement as directed by 3.1.3 of the NEC Style Manual. Specifically, "If an Informational note is needed to explain the text of the document, consideration should be given to rewriting the text of the document to
make the rule clear."

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 8-NFPA 70E-2022 [Section No. 110.2(A)]	

Related Item

- PI-64

Submitter Information Verification

Submitter Full Name:	Palmer Hickman
Organization:	Electrical Training Alliance
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Fri Mar 04 08:16:55 EST 2022
Committee:	EEW-AAA

Public Comment No. 79-NFPA 70E-2022 [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 eliminating electrical hazards for the period of time for which the state is maintained.

<u>Informational Note: After the procedures in Art. 120 have been followed and a system is in an electrically safe work condition, there could still be hazards from unknown sources that won't be found until a neutral is disconnected and voltage appears on the disconnected neutral.</u>

Statement of Problem and Substantiation for Public Comment

Electrocutions, and many shocks, have occurred from workers separating neutrals, even when all the known sources have been locked out. Unfortunately, circuits that have a line conductor that come from one panel and a neutral conductor that terminates in a different panel are not uncommon. Wiring errors like this cannot be known until the neutral conductor is lifted. Companies have found this to be true and have written procedures on how to disconnect neutrals. Some companies require a current measurement before disconnecting a neutral, but what value of current indicates a potential problem? Some companies require dielectric gloves to be used when neutral conductors are disconnected, with a subsequent voltage check.

Another possible source of voltage from disconnected neutrals are from perfectly Code compliant multiwire branch circuit installations that were performed before 2008. Handle ties for multiwire branch circuits were not required before the 2008 version of NFPA 70. Workers replacing ballasts in light fixtures often learned this the hard way. Workers need to be aware that when they are working on a 15 are 20 amp circuit that originates from a single-pole breaker, there is a good chance that the circuit could actually be part of a multiwire branch circuit. The only way to determine this is to take the dead front off of the panel and trace the wiring.

<u>Related Item</u>

• 60-NFPA 70E-2021

Submitter Information Verification

Submitter Full Name:	Eric Stromberg
Organization:	Strategic Management Solutions, Inc.
Affiliation:	Self
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Sun May 29 13:44:16 EDT 2022
Committee:	EEW-AAA

Public Comment No. 157-NFPA 70E-2022 [Definition: Equipment, Arc-Resistant. (Arc-Resistant Equipm...]

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: 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.

Additional Proposed Changes

File Name	Description	Approved
CN_11.pdf	70E_CN11_PC157	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 11 appeared in the First Draft Report on First Revisions No. 11.

The Correlating Committee directs that the technical committee revise Informational Note No. 2 to “See Informative Annex O 2.4(9) for information on arc-resistant equipment” to comply with the NEC Style Manual 3.1.3.1.

Related Item

- First Revision No. 11

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC
Organization: NEC Correlating Committee
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jun 02 13:39:01 EDT 2022
Committee: EEW-AAA

Correlating Committee Note No. 11-NFPA 70E-2022 [Definition: Equipment, Arc-Resistant.]

Submitter Information Verification

Committee: NEC-AAC

Submittal Date: Thu Jan 20 11:16:07 EST 2022

Committee Statement

Committee Statement: The Correlating Committee directs that the technical committee revise Informational Note No. 2 to "See Informative Annex O 2.4(9) for information on arc-resistant equipment" to comply with the NEC Style Manual 3.1.3.1.

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

Ballot Results

✔ **This item has passed ballot**

12 Eligible Voters
1 Not Returned
11 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.
Gallo, Ernest J.
Hickman, Palmer L.
Holub, Richard A.
Hunter, Dean C.
Kendall, David H.
Kovacik, John R.
Manche, Alan
Porter, Christine T.
Schultheis, Timothy James
Williams, David A.

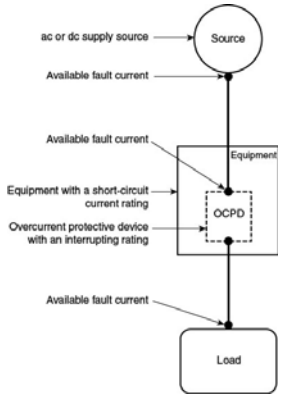
Public Comment No. 76-NFPA 70E-2022 [Definition: Fault Current, Available. (Available Fault Curr...]

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. .

~~Figure Informational Note Figure 100~~
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.

Statement of Problem and Substantiation for Public Comment

The original change during the FD meeting moved "See Figure 100.0" to the front of the text in order to align with the NEC Style Manual. During balloting, "Informational Note" was added to the figure number, making this Informational Note 1 much more cumbersome to read.

Related Item

- FR-13

Submitter Information Verification

Submitter Full Name: Louis Barrios
Organization: Shell Global Solutions
Affiliation: API
Street Address:
City:
State:
Zip:
Submittal Date: Sun May 29 13:25:50 EDT 2022
Committee: EEW-AAA

Public Comment No. 158-NFPA 70E-2022 [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. (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.

Additional Proposed Changes

File Name	Description	Approved
CN_33.pdf	70E_CN33_PC158	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 33 appeared in the First Draft Report on First Revisions No. 166.

The Correlating Committee directs the technical committee to review the use of the word “thorough” in the definition as a possible vague and unenforceable term and revise the text in Informational Note No. 3 to read “...for requirements on evaluating third-party entities.”

Related Item

• First Revision No. 166

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC
Organization: NEC Correlating Committee
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jun 02 13:41:43 EDT 2022
Committee: EEW-AAA

Correlating Committee Note No. 33-NFPA 70E-2022 [Definition: Field Evaluated.]

Submitter Information Verification

Committee: NEC-AAC

Submittal Date: Thu Jan 20 12:31:32 EST 2022

Committee Statement

Committee Statement: The Correlating Committee directs the technical committee to review the use of the word “thorough” in the definition as a possible vague and unenforceable term and revise the text in Informational Note No. 3 to read “...for requirements on evaluating third-party entities.”

First Revision No. 166-NFPA 70E-2021 [Definition: Field Evaluated.]

Ballot Results

This item has passed ballot

12 Eligible Voters
1 Not Returned
11 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.
Gallo, Ernest J.
Hickman, Palmer L.
Holub, Richard A.
Hunter, Dean C.
Kendall, David H.
Kovacik, John R.
Manche, Alan
Porter, Christine T.
Schultheis, Timothy James
Williams, David A.

Public Comment No. 159-NFPA 70E-2022 [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: See ANSI/UL 943, *Standard for Ground-Fault Circuit Interrupters*, for further information. A ground-fault circuit interrupter trips when the current to ground is 6 mA or higher and does not trip when the current to ground is less than 4 mA.

Additional Proposed Changes

File Name	Description	Approved
CN_12.pdf	70E_CN12_PC159	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 12 appeared in the First Draft Report on First Revisions No. 14.

The Correlating Committee directs the technical committee to review the informational note for correlation with the NEC definition including the informational note in accordance with the extract policy.

Related Item

- First Revision No. 14

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC
Organization: NEC Correlating Committee
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jun 02 13:43:15 EDT 2022
Committee: EEW-AAA

Correlating Committee Note No. 12-NFPA 70E-2022 [Definition: Ground-Fault Circuit Interrupter (GFCI).]

Submitter Information Verification

Committee: NEC-AAC

Submittal Date: Thu Jan 20 11:17:11 EST 2022

Committee Statement

Committee Statement: The Correlating Committee directs the technical committee to review the informational note for correlation with the NEC definition including the informational note in accordance with the extract policy.

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

Ballot Results

✔ **This item has passed ballot**

12 Eligible Voters
1 Not Returned
11 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.
Gallo, Ernest J.
Hickman, Palmer L.
Holub, Richard A.
Hunter, Dean C.
Kendall, David H.
Kovacik, John R.
Manche, Alan
Porter, Christine T.
Schultheis, Timothy James
Williams, David A.

Public Comment No. 114-NFPA 70E-2022 [Definition: Hard Grounding (Low-Z).]

~~Hard~~ Grounding, Hard (Low-Z) (Hard Grounding) .

The practice of discharging a capacitor through a low impedance, also called Low-Z (impedance) grounding. (360)

Statement of Problem and Substantiation for Public Comment

Changed to "Grounding, Hard (Low-Z) (Hard Grounding) so that it is grouped together with "soft grounding" in the list of definitions. See related public comment.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 115-NFPA 70E-2022 [Definition: Soft Grounding (High-Z).]	
Public Comment No. 115-NFPA 70E-2022 [Definition: Soft Grounding (High-Z).]	

Related Item

- FR-177

Submitter Information Verification

Submitter Full Name:	Louis Barrios
Organization:	Shell Global Solutions
Affiliation:	API
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Mon May 30 12:34:24 EDT 2022
Committee:	EEW-AAA

Public Comment No. 86-NFPA 70E-2022 [Definition: Hard Grounding (Low-Z).]

Grounding, Hard ~~Grounding~~ (Low-Z).

The practice of discharging a capacitor through a low impedance, also called Low-Z (impedance) grounding. (360)

Statement of Problem and Substantiation for Public Comment

This seems to be in line with other changes made on the order of words in definitions. The searchable term should not be the modifier (Hard or Soft), but Ground. This also puts the Hard Ground and Soft Ground, near each other in the definition list.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 87-NFPA 70E-2022 [Definition: Hearing Protection Boundary.]	
Public Comment No. 91-NFPA 70E-2022 [Definition: Soft Grounding (High-Z).]	

Related Item

- PI No. 108

Submitter Information Verification

Submitter Full Name: Lloyd Gordon
Organization: retired
Street Address:
City:
State:
Zip:
Submittal Date: Sun May 29 22:02:43 EDT 2022
Committee: EEW-AAA

Public Comment No. 116-NFPA 70E-2022 [Definition: Hearing Protection Boundary.]

Boundary, Hearing Protection (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)

Statement of Problem and Substantiation for Public Comment

Changed to "Boundary, Hearing Protection (Hearing Protection Boundary)" so that it is grouped together with the other boundary definitions.

Related Item

- FR-178

Submitter Information Verification

Submitter Full Name:	Louis Barrios
Organization:	Shell Global Solutions
Affiliation:	API
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Mon May 30 12:43:44 EDT 2022
Committee:	EEW-AAA

Public Comment No. 160-NFPA 70E-2022 [Definition: Hearing Protection Boundary.]

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)

Additional Proposed Changes

File Name	Description	Approved
CN_35.pdf	70E_CN35_PC160	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 35 appeared in the First Draft Report on First Revisions No. 178.

The Correlating Committee directs the technical committee to consider the ballot comment regarding changing the definition title to Boundary, Hearing Protection (Hearing Protection Boundary) so that it is grouped with the other boundary terms in the definitions for usability.

Related Item

- First Revision No. 178

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC
Organization: NEC Correlating Committee
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jun 02 13:45:00 EDT 2022
Committee: EEW-AAA

Correlating Committee Note No. 35-NFPA 70E-2022 [Definition: Hearing Protection Boundary.]

Submitter Information Verification

Committee: NEC-AAC

Submittal Date: Thu Jan 20 12:38:41 EST 2022

Committee Statement

Committee Statement: The Correlating Committee directs the technical committee to consider the ballot comment regarding changing the definition title to Boundary, Hearing Protection (Hearing Protection Boundary) so that it is grouped with the other boundary terms in the definitions for usability.

First Revision No. 178-NFPA 70E-2021 [Definition: Hearing Protection Boundary.]

Ballot Results

✔ **This item has passed ballot**

12 Eligible Voters
1 Not Returned
11 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.
Gallo, Ernest J.
Hickman, Palmer L.
Holub, Richard A.
Hunter, Dean C.
Kendall, David H.
Kovacik, John R.
Manche, Alan
Porter, Christine T.
Schultheis, Timothy James
Williams, David A.

Public Comment No. 87-NFPA 70E-2022 [Definition: Hearing Protection Boundary.]

Boundary, 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)

Statement of Problem and Substantiation for Public Comment

this would be in line with the changes to Arc, Limited and Restricted Boundaries

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 86-NFPA 70E-2022 [Definition: Hard Grounding (Low-Z).]	proper word order for definition
Public Comment No. 88-NFPA 70E-2022 [Definition: Lung Protection Boundary.]	

Related Item

- PI No. 108

Submitter Information Verification

Submitter Full Name: Lloyd Gordon
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Sun May 29 22:07:12 EDT 2022
Committee: EEW-AAA

Public Comment No. 117-NFPA 70E-2022 [Definition: Lung Protection Boundary.]

Boundary, Lung Protection (Lung Protection Boundary) .

Worker distance at which a 1 percent probability of lung damage exists from a 70 kPa (10 psi) shock wave. (360)

Statement of Problem and Substantiation for Public Comment

Changed to "Boundary, Lung Protection (Lung Protection Boundary)" so that it is grouped together with the other boundary definitions.

Related Item

- FR-179

Submitter Information Verification

Submitter Full Name:	Louis Barrios
Organization:	Shell Global Solutions
Affiliation:	API
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Mon May 30 12:46:54 EDT 2022
Committee:	EEW-AAA

Public Comment No. 161-NFPA 70E-2022 [Definition: Lung Protection Boundary.]

Lung Protection Boundary.

Worker distance at which a 1 percent probability of lung damage exists from a 70 kPa (10 psi) shock wave. (360)

Additional Proposed Changes

File Name	Description	Approved
CN_36.pdf	70E_CN36_PC161	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 36 appeared in the First Draft Report on First Revisions No. 161.

The Correlating Committee directs the technical committee to consider the ballot comment regarding changing the definition title to Boundary, Lung Protection (Lung Protection Boundary) so that it is grouped with the other boundary terms in the definitions for usability.

Related Item

- First Revision No. 179

Submitter Information Verification

Submitter Full Name:	CC on NEC-AAC
Organization:	NEC Correlating Committee
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Thu Jun 02 13:46:39 EDT 2022
Committee:	EEW-AAA

Correlating Committee Note No. 36-NFPA 70E-2022 [Definition: Lung Protection Boundary.]

Submitter Information Verification

Committee: NEC-AAC

Submittal Date: Thu Jan 20 12:39:33 EST 2022

Committee Statement

Committee Statement: The Correlating Committee directs the technical committee to consider the ballot comment regarding changing the definition title to Boundary, Lung Protection (Lung Protection Boundary) so that it is grouped with the other boundary terms in the definitions for usability.

First Revision No. 179-NFPA 70E-2021 [Definition: Lung Protection Boundary.]

Ballot Results

✔ **This item has passed ballot**

12 Eligible Voters
1 Not Returned
11 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.
Gallo, Ernest J.
Hickman, Palmer L.
Holub, Richard A.
Hunter, Dean C.
Kendall, David H.
Kovacik, John R.
Manche, Alan
Porter, Christine T.
Schultheis, Timothy James
Williams, David A.

Public Comment No. 88-NFPA 70E-2022 [Definition: Lung Protection Boundary.]

Boundary, Lung Protection ~~Boundary~~ .

Worker distance at which a 1 percent probability of lung damage exists from a 70 kPa (10 psi) shock wave. (360)

Statement of Problem and Substantiation for Public Comment

This is in line with previous recommendations on word order

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 87-NFPA 70E-2022 [Definition: Hearing Protection Boundary.]	
Public Comment No. 89-NFPA 70E-2022 [Definition: Prospective Short-Circuit Current.]	

Related Item

- PI No. 108

Submitter Information Verification

Submitter Full Name:	Lloyd Gordon
Organization:	[Not Specified]
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Sun May 29 22:10:10 EDT 2022
Committee:	EEW-AAA

Public Comment No. 89-NFPA 70E-2022 [Definition: Prospective Short-Circuit Current.]

~~Prospective~~ Short-Circuit Current, Prospective .

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.

Statement of Problem and Substantiation for Public Comment

This is in line with previous changes to follow NFPA style where the first word is not the modifier word.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 88-NFPA 70E-2022 [Definition: Lung Protection Boundary.]	

Related Item

- PI No. 108

Submitter Information Verification

Submitter Full Name: Lloyd Gordon
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Sun May 29 22:12:52 EDT 2022
Committee: EEW-AAA

Public Comment No. 129-NFPA 70E-2022 [Definition: Protector.]

Protector.

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

Statement of Problem and Substantiation for Public Comment

Delete the words “leather or non leather” because they do not add anything. If a protector is not made of leather then it is made of something other than leather, that is obvious. The understanding of the change allowing protectors that are made of material other than leather can be better dealt with by the committee statement and education.

Related Item

- fr 62

Submitter Information Verification

Submitter Full Name:	Paul Dobrowsky
Organization:	Innovative Technology Services
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Tue May 31 05:50:34 EDT 2022
Committee:	EEW-AAA

Public Comment No. 163-NFPA 70E-2022 [Definition: Protector.]

Protector.

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

Additional Proposed Changes

File Name	Description	Approved
CN_13.pdf	70E_CN13_PC163	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 13 appeared in the First Draft Report on First Revisions No. 62.

The Correlating Committee directs that the technical committee review the use of the term protectors throughout the document for clarity and consistency and review the negative ballot comment with regards to the terminology change.

Related Item

- First Revision No. 62

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC
Organization: NEC Correlating Committee
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jun 02 13:51:49 EDT 2022
Committee: EEW-AAA

Correlating Committee Note No. 13-NFPA 70E-2022 [New Definition after Definition: Premises Wiring (System).]

Submitter Information Verification

Committee: NEC-AAC

Submittal Date: Thu Jan 20 11:17:59 EST 2022

Committee Statement

Committee Statement: The Correlating Committee directs that the technical committee review the use of the term protectors throughout the document for clarity and consistency and review the negative ballot comment with regards to the terminology change.

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

Ballot Results

✔ **This item has passed ballot**

12 Eligible Voters
1 Not Returned
11 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.
Gallo, Ernest J.
Hickman, Palmer L.
Holub, Richard A.
Hunter, Dean C.
Kendall, David H.
Kovacik, John R.
Manche, Alan
Porter, Christine T.
Schultheis, Timothy James
Williams, David A.

Public Comment No. 164-NFPA 70E-2022 [Definition: Radiation, Nonionizing. (Nonionizing Radiation)]

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)

Additional Proposed Changes

File Name	Description	Approved
CN_14.pdf	70E_CN14_PC164	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 14 appeared in the First Draft Report on First Revisions No. 148.

The Correlating Committee directs the technical committee to review the last sentence in the definition “and near UV” and define the acronym “UV” for clarification of the defined term.

Related Item

- First Revision No. 148

Submitter Information Verification

Submitter Full Name:	CC on NEC-AAC
Organization:	NEC Correlating Committee
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Thu Jun 02 13:53:42 EDT 2022
Committee:	EEW-AAA

Correlating Committee Note No. 14-NFPA 70E-2022 [New Definition after Definition: Qualified Person.]

Submitter Information Verification

Committee: NEC-AAC

Submittal Date: Thu Jan 20 11:18:56 EST 2022

Committee Statement

Committee Statement: The Correlating Committee directs the technical committee to review the last sentence in the definition “and near UV” and define the acronym “UV” for clarification of the defined term.

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

Ballot Results

✔ **This item has passed ballot**

12 Eligible Voters
1 Not Returned
11 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.
Gallo, Ernest J.
Hickman, Palmer L.
Holub, Richard A.
Hunter, Dean C.
Kendall, David H.
Kovacik, John R.
Manche, Alan
Porter, Christine T.
Schultheis, Timothy James
Williams, David A.

Public Comment No. 96-NFPA 70E-2022 [Definition: Radiation, Nonionizing. (Nonionizing Radiation)]

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~~ ; and infrared, visible light, and near UV that cannot ionize an atom or molecule. (340)

Statement of Problem and Substantiation for Public Comment

The original submission was rewritten, perhaps by a technical editor. The rewritten version changed the meaning, and it was no longer accurate. If the issue was the long string of nouns with two "ands", I improved the grammar by using semicolons. You can not separate the first three in the list, from the second three in the list, because they all need to be followed by the rest of the definition, "that cannot ionize an atom or molecule". The list needs to be contiguous.

Related Item

- PI No. 299

Submitter Information Verification

Submitter Full Name: Lloyd Gordon

Organization: [Not Specified]

Street Address:

City:

State:

Zip:

Submittal Date: Sun May 29 23:04:02 EDT 2022

Committee: EEW-AAA

Public Comment No. 100-NFPA 70E-2022 [Definition: Resistor, Bleeder. (Bleeder Resistor)]

Resistor, Bleeder. (Bleeder Resistor)

A resistor or resistor network connected in parallel with a capacitor's terminals that drains the charge after power has been disconnected. (360)

Statement of Problem and Substantiation for Public Comment

Most small capacitors have a single resistor as a bleeder resistor. Only capacitor banks will have a resistor network. A "network" is more than one, or a "group" of resistors. The wording in the original PI No. 341 is important.

Related Item

• PI No. 341

Submitter Information Verification

Submitter Full Name:	Lloyd Gordon
Organization:	[Not Specified]
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Mon May 30 09:51:34 EDT 2022
Committee:	EEW-AAA

Public Comment No. 11-NFPA 70E-2022 [Definition: Resistor, Bleeder. (Bleeder Resistor)]

Resistor, Bleeder. (Bleeder Resistor)

A resistor network connected in parallel with a capacitor's terminals that ~~drains~~ dissipates the ~~charge~~ stored energy after power has been disconnected. (360)

Statement of Problem and Substantiation for Public Comment

Revised the definition for technical accuracy and clarity.

Related Item

• FR-172-NFPA 70E-2021

Submitter Information Verification

Submitter Full Name: James Niemira
Organization: S&C Electric Company
Street Address:
City:
State:
Zip:

Submittal Date: Thu Mar 17 15:56:45 EDT 2022
Committee: EEW-AAA

Public Comment No. 90-NFPA 70E-2022 [Definition: Safeguarding.]

Safeguarding.

Safeguards for personnel include the consistent administrative enforcement of safe work practices. Safeguards include training in safe work practices, ~~cell line~~ equipment design, safety equipment, PPE, operating procedures, and work checklists. ~~(310)~~

Statement of Problem and Substantiation for Public Comment

this is another case where moving a definition from a specific Article (310) really applies to all electrical work. This concept is not unique to electrolytic cell lines.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 84-NFPA 70E-2022 [Definition: Authorized Personnel.]	

Related Item

- PI No. 108

Submitter Information Verification

Submitter Full Name: Lloyd Gordon
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Sun May 29 22:15:09 EDT 2022
Committee: EEW-AAA

Public Comment No. 139-NFPA 70E-2022 [Definition: Shock Hazard.]

Electric Shock Hazard.

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

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

Statement of Problem and Substantiation for Public Comment

Inserting the word "Electric" to the words "Shock Hazard" will distinguish it from the general term of shock as used by the health and medical communities. The Mayo Clinic states a person suffers "Shock" when the individual suffers a sudden drop in blood flow through the body caused by physical trauma, heatstroke, blood loss, an allergic reaction, severe infection, poisoning, severe burns or other causes.

A worker who is severely burned after an arc flash accident, can go into "shock" but he was injured by a "shock hazard" so it makes sense to provide clarification that we're speaking of Electric Shock Hazards.

While it is assumed that "Shock Hazard" means when electric current flows through the human body, the readers of 70E would be better served if it was definitively stated.

Related Item

- PI

Submitter Information Verification

Submitter Full Name: George Cole
Organization: PVNGS/APS
Street Address:
City:
State:
Zip:

Submittal Date: Tue May 31 19:36:49 EDT 2022
Committee: EEW-AAA

Public Comment No. 115-NFPA 70E-2022 [Definition: Soft Grounding (High-Z).]

Grounding, Soft ~~Grounding~~ (High-Z) (Soft Grounding) .

The practice of connecting a capacitor to ground through a power resistor to avoid the hazards related with hard grounding. (360)

Statement of Problem and Substantiation for Public Comment

Changed to "Grounding, Soft (High-Z) (Soft Grounding)" so that it is grouped together with "hard grounding" in the list of definitions. See related public comment.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 114-NFPA 70E-2022 [Definition: Hard Grounding (Low-Z).]	
Public Comment No. 114-NFPA 70E-2022 [Definition: Hard Grounding (Low-Z).]	

Related Item

- FR-180

Submitter Information Verification

Submitter Full Name:	Louis Barrios
Organization:	Shell Global Solutions
Affiliation:	API
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Mon May 30 12:38:39 EDT 2022
Committee:	EEW-AAA

Public Comment No. 162-NFPA 70E-2022 [Definition: Soft Grounding (High-Z).]

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)

Additional Proposed Changes

File Name	Description	Approved
CN_37.pdf	70E_CN37_PC162	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 37 appeared in the First Draft Report on First Revisions No. 180.

The Correlating Committee directs the Technical Committee to consider the ballot comment regarding changing the definition title to Grounding, Soft (High-Z)(Soft Grounding) so that it is grouped with High Grounding in the definitions for usability.

Related Item

• First Revision No. 180

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC
Organization: NEC Correlating Committee
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jun 02 13:48:15 EDT 2022
Committee: EEW-AAA

Correlating Committee Note No. 37-NFPA 70E-2022 [Definition: Soft Grounding (High-Z).]

Submitter Information Verification

Committee: NEC-AAC

Submittal Date: Thu Jan 20 12:40:13 EST 2022

Committee Statement

Committee Statement: The Correlating Committee directs the Technical Committee to consider the ballot comment regarding changing the definition title to Grounding, Soft (High-Z)(Soft Grounding) so that it is grouped with High Grounding in the definitions for usability.

First Revision No. 180-NFPA 70E-2021 [Definition: Soft Grounding (High-Z).]

Ballot Results

✔ **This item has passed ballot**

12 Eligible Voters

1 Not Returned

11 Affirmative All

0 Affirmative with Comments

0 Negative with Comments

0 Abstention

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.

Gallo, Ernest J.

Hickman, Palmer L.

Holub, Richard A.

Hunter, Dean C.

Kendall, David H.

Kovacik, John R.

Manche, Alan

Porter, Christine T.

Schultheis, Timothy James

Williams, David A.

Public Comment No. 91-NFPA 70E-2022 [Definition: Soft Grounding (High-Z).]

~~Soft~~ Grounding, Soft (High-Z).

The practice of connecting a capacitor to ground through a power resistor to avoid the hazards related with hard grounding. (360)

Statement of Problem and Substantiation for Public Comment

Another case of reordering to meet NFPA style. Don't lead with the modifier word.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 86-NFPA 70E-2022 [Definition: Hard Grounding (Low-Z).]	

Related Item

- PI No. 108

Submitter Information Verification

Submitter Full Name:	Lloyd Gordon
Organization:	[Not Specified]
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Sun May 29 22:17:34 EDT 2022
Committee:	EEW-AAA

Public Comment No. 12-NFPA 70E-2022 [Definition: Thermal Contact Hazard.]

Thermal Contact Hazard.

A source of possible injury or damage to health ~~associated with current through~~ resulting in burns to the skin caused by contact with conductive tools or jewelry ~~in contact with the body from heating of the metal resulting in burns to the skin~~ the metal of which has been heated or becomes heated due to the passage of current .

Statement of Problem and Substantiation for Public Comment

The definition was reworded to clarify the intended meaning.

Related Item

• FR-106-NFPA 70E-2021

Submitter Information Verification

Submitter Full Name: James Niemira

Organization: S&C Electric Company

Street Address:

City:

State:

Zip:

Submittal Date: Thu Mar 17 16:05:00 EDT 2022

Committee: EEW-AAA

Public Comment No. 165-NFPA 70E-2022 [Definition: Thermal Contact Hazard.]

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.

Additional Proposed Changes

File Name	Description	Approved
CN_15.pdf	70E_CN15_PC165	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 15 appeared in the First Draft Report on First Revisions No. 106.

The Correlating Committee directs the technical committee to review the standard to ensure that this newly defined term is used in the standard.

Related Item

- First Revision No. 106

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC
Organization: NEC Correlating Committee
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jun 02 13:55:32 EDT 2022
Committee: EEW-AAA

Correlating Committee Note No. 15-NFPA 70E-2022 [New Definition after Definition: Switching Device.]

Submitter Information Verification

Committee: NEC-AAC

Submittal Date: Thu Jan 20 11:20:39 EST 2022

Committee Statement

Committee Statement: The Correlating Committee directs the technical committee to review the standard to ensure that this newly defined term is used in the standard.

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

Ballot Results

✔ **This item has passed ballot**

12 Eligible Voters
1 Not Returned
11 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.
Gallo, Ernest J.
Hickman, Palmer L.
Holub, Richard A.
Hunter, Dean C.
Kendall, David H.
Kovacik, John R.
Manche, Alan
Porter, Christine T.
Schultheis, Timothy James
Williams, David A.

Public Comment No. 92-NFPA 70E-2022 [Definition: Valve-Regulated Lead Acid (VRLA) Cell.]

Cell, 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)

Statement of Problem and Substantiation for Public Comment

This put the definition adjacent to that of "Cell", with the modifiers following the key word

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 93-NFPA 70E-2022 [Definition: Vented Cell.]	

Related Item

- PI No. 108

Submitter Information Verification

Submitter Full Name: Lloyd Gordon
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Sun May 29 22:20:19 EDT 2022
Committee: EEW-AAA

Public Comment No. 93-NFPA 70E-2022 [Definition: Vented Cell.]

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)

Statement of Problem and Substantiation for Public Comment

This put the definition adjacent to that of "Cell", with the modifiers following the key word

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 92-NFPA 70E-2022 [Definition: Valve-Regulated Lead Acid (VRLA) Cell.]	

Related Item

- PI No. 108

Submitter Information Verification

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Committee:	EEW-AAA

Public Comment No. 27-NFPA 70E-2022 [Definition: Voltage, Nominal (as applied to cell or battery...]

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 volts per cell for Li-ion batteries. Nominal voltages might vary with different chemistries.

Statement of Problem and Substantiation for Public Comment

informational note revised for clarity.

Related Item

- FR-160-NFPA 70E-2021

Submitter Information Verification

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Submittal Date: Fri Apr 08 16:00:15 EDT 2022
Committee: EEW-AAA

Public Comment No. 34-NFPA 70E-2022 [Definition: Voltage, Nominal. (Nominal Voltage)]

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.~~

Statement of Problem and Substantiation for Public Comment

For correlation and consistency between standards, the definition for "nominal voltage" should be the same in the NEC (NFPA 70) and NFPA 70E. The NEC has deleted IFN # 3 as not necessary. The current IFN #1 covers the information currently in IFN #3 and covers the situation where a 48 volt nominal battery system operates at higher voltage during charging and lower voltage during operational discharge.

Related Item

- PI88 on definition of nominal voltage

Submitter Information Verification

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Submittal Date:	Mon Apr 18 21:24:53 EDT 2022
Committee:	EEW-AAA

Public Comment No. 133-NFPA 70E-2022 [New Definition after Definition: Electrically Safe Work Con...]

Employee-in-Charge

An employee assigned by the employer for the duration of a specified task or work method as the primary qualified person to oversee the work being performed when employees are exposed to hazards.

Informational Note: See 105.3(C) for responsibilities of an employee assigned this role.

Statement of Problem and Substantiation for Public Comment

Section 110.5(I) requires the employee in charge to develop a job safety plan and conduct a job safety briefing with the employees involved when the work involves exposure to electrical hazards. Defining this role and defining which responsibilities an employer might want to assign to this individual in NFPA 70E helps to build awareness for employers using NFPA 70E as a basis for their ESP as to how they can use this concept to improve safety. Many of the human performance tools referenced in Annex Q would either require this type of role or would greatly benefit from this role. To be clear, this role can be assigned to the individual performing the work as well. However, currently outside of 110.5(I) requiring an EIC to complete a job safety plan & briefing, there is no guidance for employers as to what this role is. There were multiple public inputs submitted asking to clarify this role in NFPA 70E and much of the discussion was around what would this individual be required or prohibited from doing. I am also submitting a comment to section 105.3 to define the responsibilities of the employee-in-charge if the employer should choose to assign this role.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 134-NFPA 70E-2022 [New Section after 105.3(B)]	

Related Item

- Public Input 251

Submitter Information Verification

Submitter Full Name:	Derek Vigstol
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Submittal Date:	Tue May 31 09:59:04 EDT 2022
Committee:	EEW-AAA

Public Comment No. 135-NFPA 70E-2022 [New Definition after Definition: Motor Control Center.]

Operation, Normal

Interaction with electrical equipment in a manner that is consitent with the manufacturer's or engineered system's specified design function and operational parameters.

Informational Note: Examples of normal operation of electrical equipment include opening or closing switches, circuit breakers, or contactors either by manual means or by activating their automatic controls.

Statement of Problem and Substantiation for Public Comment

This definition would add clarity to a very misinterpreted section that allows interaction with electrical equipment in a manner that could potentially injure an employee. First, by stating that normal operation of equipment in a normal operating condition is an acceptable form of interaction with energized electrical equipment and an exception to the rule that requires an electrically safe work condition, there needs to be zero confusion as to what constitutes normal operation of equipment. Well over 50% of the facilities that I either teach in or audit do not have a clear view of this concept and this definition could help them immensely. Second, the informational note helps give clarification about what is considered operation. This is needed as one of the biggest mistakes, in my experience, is that employers deem racking of circuit breakers as normal operation. This is potentially one of the most dangerous tasks performed with energized equipment when it comes to arc flash and the current language leaves it up to interpretation on whether it fits into the category of normal operation and this is not simply limited to employers who don't understand NFPA 70E. I have had this conversation with employers and employees that have representation on the committee. This term needs to be clearly defined in NFPA 70E.

Related Item

- Public Input 298

Submitter Information Verification

Submitter Full Name: Derek Vigstol
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Submittal Date: Tue May 31 12:04:16 EDT 2022
Committee: EEW-AAA

Public Comment No. 166-NFPA 70E-2022 [Section No. 105.1]

105.1 Scope.

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.

Additional Proposed Changes

File Name	Description	Approved
CN_16.pdf	70E_CN16_PC166	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 16 appeared in the First Draft Report on First Revisions No. 23.

The Correlating Committee advises that article scope statements are the responsibility of the Correlating Committee and directs the technical committee to consider revising the last part of the scope statement and clarify “covered in the scope of this standard”.

Further, it appears that the technical committee attempted to editorially replace “Chapter 1” with “This article,” the action was not editorial. While it was true that Chapter 1 addresses safety related work practices and procedures, that is not the case for Article 105 and therefore the action is not accurate. The Correlating Committee notes that the scope of Article 105 must correlate with the title of Article 105 which includes the phrase “application of.”

Related Item

- First Revision No. 23

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC
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Submittal Date: Thu Jun 02 13:57:05 EDT 2022
Committee: EEW-AAA

Correlating Committee Note No. 16-NFPA 70E-2022 [Section No. 105.1]

Submitter Information Verification

Committee: NEC-AAC

Submittal Date: Thu Jan 20 11:27:20 EST 2022

Committee Statement

Committee Statement: The Correlating Committee advises that article scope statements are the responsibility of the Correlating Committee and directs the technical committee to consider revising the last part of the scope statement and clarify “covered in the scope of this standard”.

Further, it appears that the technical committee attempted to editorially replace “Chapter 1” with “This article,” the action was not editorial. While it was true that Chapter 1 addresses safety related work practices and procedures, that is not the case for Article 105 and therefore the action is not accurate. The Correlating Committee notes that the scope of Article 105 must correlate with the title of Article 105 which includes the phrase “application of.”

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

Ballot Results

✔ **This item has passed ballot**

12 Eligible Voters
1 Not Returned
11 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.
Gallo, Ernest J.
Hickman, Palmer L.
Holub, Richard A.
Hunter, Dean C.
Kendall, David H.
Kovacik, John R.

Manche, Alan

Porter, Christine T.

Schultheis, Timothy James

Williams, David A.

Public Comment No. 78-NFPA 70E-2022 [Section No. 105.2]

105.2 Purpose.

These practices and procedures are intended to ~~provide for employee safety relative~~ reduce the risk for employees, relative to electrical hazards in the workplace.

Informational Note: See Informative Annex K for general categories of electrical hazards.

Statement of Problem and Substantiation for Public Comment

No system should ever be considered safe to work on. When a worker thinks he/she is 'safe,' the worker will often lose awareness of potential hazards. By rephrasing this to 'reduce risk,' the worker is made aware that there is always risk involved and that awareness must be maintained.

Related Item

- 59-NFPA 70E-2021

Submitter Information Verification

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Submittal Date: Sun May 29 13:35:48 EDT 2022
Committee: EEW-AAA

Public Comment No. 134-NFPA 70E-2022 [New Section after 105.3(B)]

(1) Employee-in-charge Responsibility

The employer shall be permitted to establish the role of an employee-in-charge for certain tasks. The employee-in-charge shall have the following responsibilities:

(1) Complete a job safety plan for tasks that expose employees to electrical hazards

(2) Conduct a job briefing for all employees involved or affected by the work to be performed.

(3) Ensure an energized electrical work permit has been completed if one is required

(4) Ensure compliance with the safety-related work practices and procedures provided by the employer for the duration of the task.

Statement of Problem and Substantiation for Public Comment

This comment is in response to the committee statement given to numerous public inputs seeking to define the role of an employee or person in charge. The committee statements mentioned that the proposed definitions did not add clarity. This comment seeks to establish two parameters: 1) that the role of an employee-in-charge is up to the employer on whether they choose to assign this role or not, 2) the responsibilities of the person who is assigned this role. This will hopefully clear up any confusion that existed about what an employee in charge role is meant to accomplish and what limitations were being put on the work they could perform. By understanding that they can define this role and assign them clear responsibility, an employer is given better guidance into how to implement this successful human performance tool in their approach to safe work practices. This PC is tied to PC 133 which sought to clarify the definition of an employee in charge that was proposed during the first draft meeting so as not to place unnecessary restrictions on what duties this person can perform.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 133-NFPA 70E-2022 [New Definition after Definition: Electrically Safe Work Con...]	

Related Item

- Public Input No. 251

Submitter Information Verification

Submitter Full Name: Derek Vigstol
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Submittal Date: Tue May 31 11:19:37 EDT 2022
Committee: EEW-AAA

Public Comment No. 167-NFPA 70E-2022 [Sections 110.1, 110.2, 110.3, 110.4]

Sections 110.1, 110.2, 110.3, 110.4

110.1 Scope.

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

110.2 Electrically Safe Work Condition.

(A) Policy.

An employer shall establish, document, and implement an electrically safe work condition policy that does both of the following:

(1) Requires hazard elimination 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).

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.

Informational Note No. 3: See 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) 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 120.6 have been met.

Safe work practices applicable to the circuit voltage and energy level shall be used until such time that electrical conductors and circuit parts are in 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 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, 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: 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: 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: 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.

110.3 Electrical Safety Program.

(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.

(B) Inspection.

The electrical safety program shall include elements to verify that newly installed or modified electrical equipment or systems have been inspected to comply with applicable installation codes and standards prior to being placed into service.

(C) Condition of Maintenance.

The electrical safety program shall include elements that consider condition of maintenance of electrical equipment and systems.

(D) Awareness and Self-Discipline.

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

(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 examples of typical electrical safety program principles.

(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 examples of typical electrical safety program controls.

(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 an example of a typical electrical safety program procedure.

(H) Risk Assessment Procedure.

The electrical safety program shall include a risk assessment procedure and shall comply with 110.3(H)(1) through 110.3(H)(3).

(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 more information regarding risk assessment and the hierarchy of risk control.

(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.

(3) Hierarchy of Risk Control Methods.

The risk assessment procedure shall require that preventive and protective risk control methods be implemented in accordance with the following hierarchy:

(1) Elimination

(2) Substitution

(3) Engineering controls

(4) Awareness

(5) Administrative controls

(6) PPE

Informational Note No. 1: Elimination, substitution, and engineering controls are the most effective methods to reduce risk as they are usually applied at the source of possible injury or damage to health and they are less likely to be affected by human error. Awareness, administrative controls, and PPE are the least effective methods to reduce risk as they are not applied at the source and they are more likely to be affected by human error.

Informational Note No. 2: See Informative Annex F for more information regarding the hierarchy of risk control methods and examples of those methods.

(I) Job Safety Planning and Job Briefing.

Before starting each job that involves exposure to electrical hazards, the employee in charge shall complete a job safety plan and conduct a job briefing with the employees involved.

(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 an example of a job safety planning checklist.

(2) Job Briefing.

The job briefing shall cover the job safety plan and the information on the energized electrical work permit, if a permit is required.

(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.1for an example of a job briefing checklist.

(J) Incident Investigations.

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

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

(K) Lockout/Tagout Program.

The electrical safety program shall include the information required by one of the following:

(1) A lockout/tagout program in accordance with 120.2(A)

(2) A reference to the employer’s lockout/tagout program established in accordance with 120.2(A)

(L) Auditing.

(1) Electrical Safety Program Audit.

The electrical safety program shall be audited to verify that the principles and procedures of the electrical safety program are in compliance with this standard. Audits shall be performed at intervals not to exceed 3 years.

(2) Field Work Audit.

Field work shall be audited to verify that the requirements contained in the procedures of the electrical safety program are being followed. When the auditing determines that the principles and procedures of the electrical safety program are not being followed, the appropriate revisions to the training program or revisions to the procedures shall be made. Audits shall be performed at intervals not to exceed 1 year.

(3) Lockout/Tagout Program and Procedure Audit.

The lockout/tagout program and procedures required by 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

(4) Documentation.

The audits required by 110.3(L) shall be documented.

110.4 Training Requirements.

(A) Electrical Safety Training.

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 further information concerning installation requirements.

(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 applicable precautionary techniques, electrical policies, procedures, PPE, insulating materials, shielding materials, and insulated tools and test equipment.

(b) A person shall be qualified for certain equipment and tasks 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.

(2) Unqualified Persons.

Unqualified persons shall be trained in, and be familiar with, any electrical safety-related practices necessary for their safety.

(3) Additional Training and Retraining.

Additional training and retraining in safety-related work practices and applicable changes in this standard shall be performed at intervals not to exceed 3 years. An employee shall receive additional training or retraining if any of the following conditions exists:

(1) The supervision or annual inspections indicate the employee is not complying with the safety-related work practices.

(2) New technology, new types of equipment, or changes in procedures necessitate the use of safety-related work practices different from those that the employee would normally use.

(3) The employee needs to review tasks that are performed less often than once per year.

(4) The employee needs to review safety-related work practices not normally used by the employee during regular job duties.

(5) The employee's job duties change.

(4) Type of Training.

The training required by 110.4(A) shall be classroom, on-the-job, or a combination of the two. The type and extent of the training provided shall be determined by the risk to the employee.

Informational Note: Classroom training can include interactive electronic or interactive web-based training components.

(5) Electrical Safety Training Documentation.

The employer shall document that each employee has received the training required by 110.4(A). This documentation shall be in accordance with the following:

(1) Be made when the employee demonstrates proficiency in the work practices involved

(2) Be retained for the duration of the employee's employment

(3) Contain the content of the training, each employee's name, and dates of training

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

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

(B) Lockout/Tagout Procedure Training.

(1) Initial Training.

Employees involved in the lockout/tagout procedures required by 120.3(B) shall be trained in the following:

(1) The lockout/tagout procedures

(2) Their responsibility in the execution of the procedures

(2) Retraining.

Retraining in the lockout/tagout procedures shall be performed as follows:

(1) When the procedures are revised

(2) At intervals not to exceed 3 years

(3) When supervision or annual inspections indicate that the employee is not complying with the lockout/tagout procedures

(3) Lockout/Tagout Training Documentation.

(a) The employer shall document that each employee has received the training required by 110.4(B).

(b) The documentation shall be made when the employee demonstrates proficiency in the work practices involved.

(c) The documentation shall contain the content of the training, each employee's name, and the dates of the training.

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

(C) Emergency Response Training.

(1) Contact Release.

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

(2) First Aid, Emergency Response, and Resuscitation.

(a) Employees responsible for responding to medical emergencies shall be trained in first aid and emergency procedures.

(b) Employees responsible for responding to medical emergencies shall be trained in cardiopulmonary resuscitation (CPR).

(c) Employees responsible for responding to medical emergencies shall be trained in the use of an automated external defibrillator (AED) if an employer's emergency response plan includes the use of this device.

(d) Training shall occur at a frequency that satisfies the requirements of the certifying body.

Informational Note: Employees responsible for responding to medical emergencies might not be first responders or medical professionals. Such employees could be a second person, a safety watch, or a craftsperson.

(3) Training Verification.

Employers shall verify at least annually that employee training required by 110.4(C) is current.

(4) Documentation.

The employer shall document that the training required by 110.4(C) has occurred.

Additional Proposed Changes

File Name	Description	Approved
CN_17.pdf	70E_CN17_PC167	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 17 appeared in the First Draft Report on First Revisions No. 52.

The Correlating Committee directs the technical committee to reconsider the action on this first revision based on the comments expressed in both the affirmative and negative ballot statements as follows:

Annex F be revised to "Informative Annex F."

Section 110.2(A)(2) may be unnecessary as it is restating what is already required by 110.2(C) which applies generally, including within the same section.

The Correlating Committee directs that the Technical Committee reconsider its action on Public Input 64 and consider revising Informational Note No. 2 to correlate with the Correlating Committee's recommendation on First Revision 10.

The attempt at an editorial revision in Informational Note No. 3 changing “Article 120” to “120.6” to comply with the NEC Style Manual was not editorial. Further, the committee statement does not accurately reflect the action in this first revision. Accordingly, the Correlating Committee directs that this action be reconsidered, and consideration be given to replacing “Article 120” with “120.2 through 120.6” to comply with the NEC Style Manual.

Related Item

- First Revision No. 52

Submitter Information Verification

Submitter Full Name:	CC on NEC-AAC
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Submittal Date:	Thu Jun 02 13:58:57 EDT 2022
Committee:	EEW-AAA

Correlating Committee Note No. 17-NFPA 70E-2022 [Sections 110.1, 110.2, 110.3, 110.4]

Submitter Information Verification

Committee: NEC-AAC

Submittal Date: Thu Jan 20 11:35:26 EST 2022

Committee Statement

Committee Statement: The Correlating Committee directs the technical committee to reconsider the action on this first revision based on the comments expressed in both the affirmative and negative ballot statements as follows:

Annex F be revised to “Informative Annex F.”

Section 110.2(A)(2) may be unnecessary as it is restating what is already required by 110.2(C) which applies generally, including within the same section.

The Correlating Committee directs that the Technical Committee reconsider its action on Public Input 64 and consider revising Informational Note No. 2 to correlate with the Correlating Committee’s recommendation on First Revision 10.

The attempt at an editorial revision in Informational Note No. 3 changing “Article 120” to “120.6” to comply with the NEC Style Manual was not editorial. Further, the committee statement does not accurately reflect the action in this first revision. Accordingly, the Correlating Committee directs that this action be reconsidered, and consideration be given to replacing “Article 120” with “120.2 through 120.6” to comply with the NEC Style Manual.

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

Ballot Results

✔ **This item has passed ballot**

12 Eligible Voters
1 Not Returned
11 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.

Gallo, Ernest J.

Hickman, Palmer L.

Holub, Richard A.

Hunter, Dean C.

Kendall, David H.

Kovacik, John R.

Manche, Alan

Porter, Christine T.

Schultheis, Timothy James

Williams, David A.

Public Comment No. 8-NFPA 70E-2022 [Section No. 110.2(A)]

(A) Policy.

An employer shall establish, document, and implement an electrically safe work condition policy that does both of the following:

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

(2) Complies with 110.2(C)

Informational Note No. 1: See Informative 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).

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. Informational Note No. 3:~~ 2: See 120.6 for requirements to establish and verify an electrically safe work condition for the period of time for which the state is maintained.

Informational Note No. ~~4~~ 3 : 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.

Statement of Problem and Substantiation for Public Comment

This comment is in response to Correlating Note 10 from the First Draft which states, in part, that "[l]ikewise, resolved Public Input 64 addressed a similar issue and its action should be reconsidered by the technical committee for correlation and compliance with 3.1.3 of the 2020 NEC Style Manual. This recommendation deletes Informational Note No. 2 with the remaining informational notes renumbered as this informational note does not comply with the NEC Style Manual - specifically, 3.1.3 which states, in part, that "[i]nformational notes shall not be written in mandatory language and shall not contain requirements, make interpretations, or make recommendations." Further, 3.1.3 states that "[i]f an informational note is needed to explain the text of the document, consideration should be given to rewriting the text of the document to make the rule clear. Accordingly, this informational note needs to be deleted and the text of the document rewritten "to make the rule clear." Relocating and/or rewriting this non-compliant informational note text into the existing requirement, rather than as an informational note, would seem to be a means to accomplish what is necessary.

Other editorial revisions are made to make the standard technically correct including adding "Informative" and "and verify" in their respective locations in this section.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 5-NFPA 70E-2022 [Definition: Electrically Safe Work Condition.]	CN-10 directs that this be revisited for deletion due to non-compliance with the NEC Style Manual.
Public Comment No. 9-NFPA 70E-2022 [Section No. 110.2(B)]	

Related Item

• CN-10, FR-52, and PI-64

Submitter Information Verification

Submitter Full Name: Palmer Hickman
Organization: Electrical Training Alliance
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Submittal Date:	Wed Mar 09 17:24:30 EST 2022
Committee:	EEW-AAA

Public Comment No. 103-NFPA 70E-2022 [Sections 110.2(A), 110.2(B), 110.2(C)]

Sections 110.2(A), 110.2(B), 110.2(C)

(A) Policy.

An employer shall establish, document, and implement an electrically safe work condition policy that does both of the following:

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

(2) Complies with 110.2(~~C~~ B)

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).

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.

Informational Note No. 3: See 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~~ C) 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 120.6 have been met.

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

(~~C~~ B) 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 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, 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: 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: 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: 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.

Statement of Problem and Substantiation for Public Comment

Swapping 110.2(B) and 110.2(C) improves usability by moving the requirements for de-energizing and establishing an electrically safe work condition before the "requirements until established".

Related Item

- FR-52

Submitter Information Verification

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Submittal Date:	Mon May 30 10:28:54 EDT 2022
Committee:	EEW-AAA

Public Comment No. 104-NFPA 70E-2022 [Sections 110.2(A), 110.2(B), 110.2(C)]

Sections 110.2(A), 110.2(B), 110.2(C)

(A) Policy.

An employer shall establish, document, and implement an electrically safe work condition policy that does both of the following:

(1) Requires hazard elimination 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).

~~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.~~

~~Informational Note No. 3: See 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) 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 120.6 have been met.

Safe work practices applicable to the circuit voltage and energy level shall be used until such time that electrical conductors and circuit parts are in 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.

Informational Note No. 1: 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.

Informational Note No. 2: See 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. 3: 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.

Exception No. 1: 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, 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: 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: 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: 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.

Statement of Problem and Substantiation for Public Comment

The only change is relocating Informational Notes (2), (3) and (4) from 110.2(A) to 110.2(C). These informational notes are related to establishing an electrically safe work condition and not hierarchy of controls, and therefore better located in 110.2(C).

Related Item

- FR-52

Submitter Information Verification

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Submittal Date:	Mon May 30 10:40:41 EDT 2022
Committee:	EEW-AAA

Public Comment No. 9-NFPA 70E-2022 [Section No. 110.2(B)]

(B) Requirements Until Established.

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. 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~~.6~~ - have been met.

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

Informational Note: See the Article 100 definition of an electrically safe work condition and the 120.2 through 120.6 requirements for information on establishing and verifying and electrically safe work condition.

Statement of Problem and Substantiation for Public Comment

This public comment relocates much of the text from from two informational notes that did not comply with 3.1.3 of the NEC Style Manual. This section appears to be a logical location to detail "what an electrically safe work condition is." An informational note is added to remind users of NFPA 70E that, while this section now details what an electrically safe work condition is, an electrically safe work condition is both defined in Article 100 and that the applicable requirements that must be met to achieve and verify and electrically safe work condition are contained in sections 120.2 through 120.6. Further, clarification is provided that all of Article 120 must be met, rather than only 120.6, for an electrically safe work condition to be achieved as set forth in the scope of Article 120.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 8-NFPA 70E-2022 [Section No. 110.2(A)]	Relocates non-compliant informational note interpretation to this subdivision.

Related Item

- CN-10, FR-52, and PI-64

Submitter Information Verification

Submitter Full Name: Palmer Hickman
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Submittal Date: Wed Mar 09 17:49:31 EST 2022
Committee: EEW-AAA

Public Comment No. 49-NFPA 70E-2022 [Section No. 110.2(C)]

(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, Unless allowed by 130.2(C) or 120.5(B)(6), 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 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, 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: 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: 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: 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.

Statement of Problem and Substantiation for Public Comment

As written, this section states that all work must be done de-energized. However, 130.2(C) is the exemption that allows for troubleshooting and 120.5(B)(6) requires the worker to perform a zero voltage test. This test is considered energized work until proven otherwise.

This public comment is in response to the Resolution statement on PI 61-NFPA 70E-2021

Related Item

• 61-NFPA 70E-2021 Committee Statement

Submitter Information Verification

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Submittal Date:	Sun May 22 20:50:36 EDT 2022
Committee:	EEW-AAA

Public Comment No. 45-NFPA 70E-2022 [Section No. 110.3]

110.3 Electrical Safety Program.

(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.

(B) Inspection.

The electrical safety program shall include elements to verify that newly installed or modified electrical equipment or systems have been inspected to comply with applicable installation codes and standards prior to being placed into service.

(C) Condition of Maintenance.

The electrical safety program shall include elements that consider condition of maintenance of electrical equipment and systems.

(D) Awareness and Self-Discipline.

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

(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 examples of typical electrical safety program principles.

(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 examples of typical electrical safety program controls.

(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 an example of a typical electrical safety program procedure.

(H) Risk Assessment Procedure.

The electrical safety program shall include a risk assessment procedure and shall comply with 110.3(H)(1) through 110.3(H)(3).

(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 more information regarding risk assessment and the hierarchy of risk control.

(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.

(3) Hierarchy of Risk Control Methods.

The risk assessment procedure shall require that preventive and protective risk control methods be implemented in accordance with the following hierarchy:

(1) Elimination

(2) Substitution

(3) Engineering controls

(4) Awareness

(5) Administrative controls

(6) PPE

Informational Note No. 1: Elimination, substitution, and engineering controls are the most effective methods to reduce risk as they are usually applied at the source of possible injury or damage to health and they are less likely to be affected by human error. Awareness, administrative controls, and PPE are the least effective methods to reduce risk as they are not applied at the source and they are more likely to be affected by human error.

Informational Note No. 2: See Informative Annex F for more information regarding the hierarchy of risk control methods and examples of those methods.

(I) Job Safety Planning and Job Briefing.

Before starting each job that involves exposure to electrical hazards, the employee in charge shall complete a job safety plan and conduct a job briefing with the employees involved.

(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:

- (4) A description of the job and the individual tasks
- (5) Identification of the electrical hazards associated with each task
- (6) A shock risk assessment in accordance with 130.4 for tasks involving a shock hazard
- (7) An arc flash risk assessment in accordance with 130.5 for tasks involving an arc flash hazard
- (8) Work procedures involved, special precautions, and energy source controls
- (9) An emergency response plan

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

(2) Job Briefing.

The job briefing shall cover the job safety plan and the information on the energized electrical work permit, if a permit is required.

(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.1for an example of a job briefing checklist.

(J) Incident Investigations.

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

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

(K) Lockout/Tagout Program.

The electrical safety program shall include the information required by one of the following:

(1) A lockout/tagout program in accordance with 120.2(A)

(2) A reference to the employer’s lockout/tagout program established in accordance with 120.2(A)

(L) Auditing.

(1) Electrical Safety Program Audit.

The electrical safety program shall be audited to verify that the principles and procedures of the electrical safety program are in compliance with this standard. Audits shall be performed at intervals not to exceed 3 years.

(2) Field Work Audit.

Field work shall be audited to verify that the requirements contained in the procedures of the electrical safety program are being followed. When the auditing determines that the principles and procedures of the electrical safety program are not being followed, the appropriate revisions to the training program or revisions to the procedures shall be made. Audits shall be performed at intervals not to exceed 1 year.

(3) Lockout/Tagout Program and Procedure Audit.

The lockout/tagout program and procedures required by 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

(4) Documentation.

The audits required by 110.3(L) shall be documented.

(M) Electrical Safety Training Program

(1) The electrical safety program shall include training requirements in accordance with 110.6 for both qualified persons and unqualified persons.

Statement of Problem and Substantiation for Public Comment

Since article 110.3 sets forth the necessary elements needed for an effective Electrical Safety Program, an electrical safety training programs should be listed as one of these essential elements. High quality and adequate electrical safety training of employees is one of the important keys to help employees recognize when an electrical hazard exists and then take the necessary actions to eliminate or mitigate them.

This addition will ensure electrical safety training is critical part of an electrical safety program.

I understand 110.6 is titled "Training Requirements" but this is where the specific of a training program is to be found. My public input with a new step 110.5(M)(1) would point back to 110.6 for the details of an electrical safety program.

Related Item

- PI

Submitter Information Verification

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Zip:
Submittal Date: Wed May 18 17:11:38 EDT 2022
Committee:

Public Comment No. 82-NFPA 70E-2022 [Section No. 110.3(C)]

(C) Condition of Maintenance.

The electrical safety program shall include elements that consider condition of maintenance of electrical equipment and systems.

Informational Note: Condition of Maintenance includes both safety-related maintenance and maintenance for reliability purposes. This Standard is only concerned with safety-related maintenance. i.e. that maintenance where, if not performed, could result in a shock are arc flash event to the employee.

Statement of Problem and Substantiation for Public Comment

The scope of 70E is protection of the worker from shock and exposure to arc flash. Companies have used statements in 70E to try to justify their reliability-based maintenance programs as well. With the initiative for NFPA70B to become a Standard, most of NFPA70E chapter 2 could be deleted. The portions of Chapter 2 that could remain would be the portions that deal with the testing of overcurrent protection. This is necessary to ensure the accuracy of the incident energy calculations. The employer is supposed to develop a safety program (70E) and is supposed to develop a Maintenance program (70B). The two really are different and could even be handled by two different departments. Safety-related maintenance should be driven by the safety department and reliability related maintenance should be driven by the maintenance department. I use the word 'driven' because the underlying concepts are different. The maintenance itself could be performed by the same department, but the drivers are different.

Related Item

- 63-NFPA 70E-2021

Submitter Information Verification

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Submittal Date: Sun May 29 15:37:02 EDT 2022
Committee: EEW-AAA

Public Comment No. 48-NFPA 70E-2022 [Section No. 110.3(I) [Excluding any Sub-Sections]]

Before starting each job that involves exposure to electrical hazards, the employee in charge shall complete a job safety plan and conduct a job briefing with the employees involved.

<u>Informational Note: The role of the employee in charge should be defined, and that individual identified prior to beginning work.</u>

Statement of Problem and Substantiation for Public Comment

"[T]he individual physical configurations of transmission and distribution systems and circuits are variable. This, and the fact that each worksite has unique physical features, means that there are different hazards at each work location. This underscores the importance of determining existing conditions, such as nominal line and equipment voltages, maximum transient voltage level, locations of circuits and equipment, and environmental conditions relative to safety. This assessment, which is required by 29 CFR 1910.269(a)(3), must be done before an employee starts working on or near electric lines and equipment. After the pre-work assessment is performed, 29 CFR 1910.269(c) requires the employee in charge to brief the involved employees on a variety of topics, including the hazards associated with the work, the work procedures involved, any special precautions that need to be taken, energy source controls, and the personal protective equipment required." (9/27/05 OSHA Letter Determining voltage ratings for electrical insulating equipment used during electrical power distribution and transmission work.) According to OSHA, an employee in charge is responsible, under paragraph (c)(10) [of §1926.961, or equivalently, §1910.269(m)(3)(x)], for (1) notifying each employee under his or her direction of the pending release of the clearance, (2) ensuring that all employees on the crew are clear of the lines and equipment, (3) ensuring the removal of all protective grounds installed by the crew, (4) reporting this information to the system operator, and (5) releasing the clearance. An employee in charge can implement these required activities and the necessary reporting at a worksite. Having an Informational Note reminding the employer to consider defining the role and identifying a particular individual to be the employee in charge will help eliminate human error. For example, there are reports of 39 accidents from temporary grounds incorrectly applied. (Figure 8 Number accidents per TPG application type, Analysis of Accidents Caused By Induced Current and Voltages on Transmission Lines and Substations Between 1985-2021, Paper No. ESW2022-29, Marcia L. Eblen, et.al.)

Related Item

- PI 251

Submitter Information Verification

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Committee:	EEW-AAA

Public Comment No. 43-NFPA 70E-2022 [Section No. 110.4(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, or with respect to how it may affect other persons present in the work field .

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

(b) A person shall be qualified for certain equipment and tasks 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:

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

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

(7) 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

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

- (9) Perform the job safety planning
- (10) Identify electrical hazards
- (11) Assess the associated risk
- (12) Select the appropriate risk control methods from the hierarchy of controls identified in 110.3(H)(3) , including PPE

(m) 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.

(n) 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.

(o) 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.

(p) Skills and techniques necessary to advert to an unqualified person, present near the electrical safe work area, about the hazards and risks.

Statement of Problem and Substantiation for Public Comment

The issue that We detected is related to the commitment reached by qualified person, which it some cases is not enough to care about the safety related to other persons working near him (crew partners).

We assume that the arc-flash risk is augmented by this situation because the injuries (in case the event occurs) could be related to others persons instead of just one (the worker)

This is directly related to the Bradley Curve evidence (Overview of DuPont's Safety Model and Sustainability Initiatives-Meeting with DOE-December 14, 2009; 2-4 pm). Where the Safety culture has to evolve from independent to Interdepent percepction.

Also, this asumption is related to the studies made by Dave Logan (Tribal Leadership- 2008), where He finds same conclution (Signs of Stage Four-Page 36- tribal leadership).

Best regards.

Alexis Ibarra

https://sps-argentina.com

Related Item

- https://www.consultdss.com/bradley-curve/
- https://www.youtube.com/watch?v=qos_3oz1El0&ab_channel=consultdss
- https://www.ted.com/talks/david_logan_tribal_leadership

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Committee:	EEW-AAA

Public Comment No. 106-NFPA 70E-2022 [Section No. 110.4(C)(1)]

(1) Contact Release.

Employees exposed to shock hazards and those responsible for the safe release of victims from contact with energized electrical conductors or circuit parts shall be trained in methods of safe release. Refresher training shall occur annually at a frequency that satisfies the requirements of the certifying body .

Statement of Problem and Substantiation for Public Comment

Electrical Safety and LOTO training is required every three years (Article 110.3 (A)(3)
First Aid, Emergency Response, and Resuscitation training occurs "at a frequency that satisfies the requirements of the certifying body" (Article 110.3(C)(2).
Because the American Red Cross, The American Heart Association, and the National Safety Council all typically provide 2-yr certificates for CPR/AED training, many organizations have settled on CPR/AED training every two years.

That makes requiring annual training for methods of release the ONLY annual training requirement for electrical workers in NFPA 70E.
This is difficult for employers, since it can not be included in either electrical worker (every three years) or CPR/AED trainiing (every two years) as a part of their course content. That requires a special annual training for this item only.

It does not make sense to leave CPR/AED training up to the organization and not leave methods of release up to the organization. They are equally important.

By the way, I was a supporter of annual CPR/AED training, but that requirement was softened in 70E. If annual CPR/AED training was required by 70E, this issue goes away, as you can easily incorporate methods of release into annual CPR/AED training.

Related Item

- PI No. 274

Submitter Information Verification

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Committee: EEW-AAA

Public Comment No. 168-NFPA 70E-2022 [Section No. 110.5]

110.5 Host and Contract Employers' Responsibilities.

(A) Host Employer Responsibilities.

(1)

The host employer shall inform contract employers of the following:

(1) Known hazards that are covered by this standard, that are related to the contract employer's work, and that might not be recognized by the contract employer or its employees

(2) Information about the employer's installation that the contract employer needs to make the assessments required by Chapter 1

(2)

The host employer shall report observed contract employer–related violations of this standard to the contract employer.

> Informational Note: Examples of a host employer can include owner or their designee, construction manager, general contractor, or employer.

(B) Contract Employer Responsibilities.

(1)

The contract employer shall ensure that each of his or her employees is instructed in the hazards communicated to the contract employer by the host employer. This instruction shall be in addition to the basic training required by this standard.

(2)

The contract employer shall ensure that each of his or her employees follows the work practices required by this standard and safety-related work rules required by the host employer.

(3)

The contract employer shall advise the host employer of the following:

(1) Any unique hazards presented by the contract employer's work

(2) Hazards identified during the course of work by the contract employer that were not communicated by the host employer

(3) The measures the contractor took to correct any violations reported by the host employer under 110.5(A)(2) and to prevent such violation from recurring in the future

(C) Documentation.

Where the host employer has knowledge of hazards covered by this standard that are related to the contract employer's work, there shall be a documented meeting between the host employer and the contract employer.

> Informational Note to 110.7: On multi-employer work sites (in all industry sectors), more than one employer can be responsible for identifying hazardous conditions and creating safe work practices.

Additional Proposed Changes

File Name	Description	Approved
CN_18.pdf	70E_CN18_PC168	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 18 appeared in the First Draft Report on First Revisions No. 32.

The Correlating Committee directs that this action be reconsidered for correlation with the action on FR-45 which included 120.2 through 120.6.

Related Item

- First Revision No. 32

Submitter Information Verification

Submitter Full Name:	CC on NEC-AAC
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Submittal Date:	Thu Jun 02 16:29:31 EDT 2022
Committee:	EEW-AAA

Correlating Committee Note No. 18-NFPA 70E-2022 [Section No. 110.5(M)(3)]

Submitter Information Verification

Committee: NEC-AAC

Submittal Date: Thu Jan 20 11:37:06 EST 2022

Committee Statement

Committee Statement: The Correlating Committee directs that this action be reconsidered for correlation with the action on FR-45 which included 120.2 through 120.6.

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

Ballot Results

✔ **This item has passed ballot**

12 Eligible Voters
1 Not Returned
11 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.
Gallo, Ernest J.
Hickman, Palmer L.
Holub, Richard A.
Hunter, Dean C.
Kendall, David H.
Kovacik, John R.
Manche, Alan
Porter, Christine T.
Schultheis, Timothy James
Williams, David A.

Public Comment No. 169-NFPA 70E-2022 [Section No. 110.6]

110.6 Test Instruments and Equipment.

(A) Testing.

Only qualified persons shall perform tasks such as testing, troubleshooting, and voltage measuring on electrical equipment where an electrical hazard exists.

(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*, 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.

(C) Design.

Test instruments, equipment, and their accessories shall be designed for the environment to which they will be exposed and for the manner in which they will be utilized.

(D) Visual Inspection and Repair.

Test instruments and equipment and all associated test leads, cables, power cords, probes, and connectors shall be visually inspected for external defects and damage before each use. If there is a defect or evidence of damage that might expose an employee to injury, the defective or damaged item shall be removed from service. No employee shall use it until a person(s) qualified to perform the repairs and tests that are necessary to render the equipment safe has done so.

(E) Operation Verification.

When test instruments are used for testing the absence of voltage on conductors or circuit parts operating at voltages equal to or greater than 50 volts, the operation of the test instrument shall be verified on any known voltage source before and after an absence of voltage test is performed.

Additional Proposed Changes

File Name	Description	Approved
CN_19.pdf	70E_CN19_PC169	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 19 appeared in the First Draft Report on First Revisions No. 33.

The Correlating Committee directs the technical committee to review the concerns addressed in the negative and affirmative ballot statements and clarify the requirements in (1)(b) and 1(c).

Related Item

• First Revision No. 33

Submitter Information Verification

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Submittal Date:	Thu Jun 02 16:31:05 EDT 2022
Committee:	EEW-AAA

Correlating Committee Note No. 19-NFPA 70E-2022 [Section No. 110.6(A)(1)]

Submitter Information Verification

Committee: NEC-AAC

Submittal Date: Thu Jan 20 11:39:32 EST 2022

Committee Statement

Committee Statement: The Correlating Committee directs the technical committee to review the concerns addressed in the negative and affirmative ballot statements and clarify the requirements in (1)(b) and 1(c).

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

Ballot Results

This item has passed ballot

12 Eligible Voters
1 Not Returned
11 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.

Gallo, Ernest J.

Hickman, Palmer L.

Holub, Richard A.

Hunter, Dean C.

Kendall, David H.

Kovacik, John R.

Manche, Alan

Porter, Christine T.

Schultheis, Timothy James

Williams, David A.

Public Comment No. 13-NFPA 70E-2022 [Sections 110.8(B), 110.8(C)]

Sections 110.8(B), 110.8(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 120-volt, 15-, 20-, or 30-ampere circuits. ~~Where employees operate or use equipment supplied by greater than 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. ~~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 120-volt, 15-, 20-, or 30-ampere circuits.

Informational Note No. 1: See Informative Annex O Where

~~employees working outdoors~~

an assured equipment grounding conductor program is used, a special purpose ground-fault circuit interrupter may provide additional protection.

110.8(D) Temporary Circuits Greater than 125-Volt, 15, 20, or 30 Amperes

Where employees operate or use equipment supplied by greater than

~~120~~

125 -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. Informational Note No. 2: See~~

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.

110.8(E) Testing Ground-Fault Circuit -Interrupter Protection Devices

GFCI protection devices shall be tested in accordance with the manufacturer's instructions.

Additional Proposed Changes

File Name	Description	Approved
Article_110.8_GFCI_Protection_03-20-2022.docx	To reduce redundancy of identical information, move the information regarding if the temporary circuit is greater that 125V, 15, 20 or 30A then GFCI protection or the assured equipment grounding conductor program out from both 110.8(B) "maintenance and construction" and 110.8(C) "outdoors" into its own new section 110.8(D) titled "Temporary Circuits Greater than 125-Volt, 15, 20 or 30 Amperes". This will renumber the current 110.8(D) "Testing Ground-Fault Circuit Interrupter Protection Devices" to a new position as 110.8(E).	

Statement of Problem and Substantiation for Public Comment

I appreciate the 70E technical committee finally adding informational note #2 to articles 110.8(B) and 110.8(C) which points the reader back to either federal OSHA regulations and NEC article 590.6(B)(2) for the specific directions required for the implementation of the assured equipment grounding conductor program of temporary circuits greater than 125V, 15, 20 or 30A.
However, to reduce identical information redundancy, rather than repeating the information in both 110.8(B) for "maintenance and construction" and 110.8(C) for "outdoors" the statement "...greater than 125V, 15, 20, 30 ampere circuits, GFCI protection or an assured equipment grounding conductor program shall be implemented." should have its own new section 110.8(D). This will require the existing 110.8(D) "Testing GFCI Devices" to be moved to a new section 110.8(E).

Related Item

- PI

Submitter Information Verification

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Submittal Date: Sat Mar 19 20:53:58 EDT 2022
Committee: EEW-AAA

2024 NFPA 70E Public Input article 110.8
George Cole

110.8(D) Temporary Circuits Greater than 125-Volt, 15, 20, or 30 Amperes

Where employees operate or use equipment supplied by greater than 125-volt, 15, 20 or 30-ampere circuits, GFCI protection or an assured equipment grounding conductor program shall be implemented.

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.

110.8(E) Testing Ground-Fault Circuit -Interrupter Protection Devices

GFCI protection devices shall be tested in accordance with the manufacturer's instructions.

Public Comment No. 77-NFPA 70E-2022 [Section No. 120.2(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 authorized 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 120.2 through 120.6

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

Statement of Problem and Substantiation for Public Comment

Locks only protect the authorized worker. The committee statement, in response to PI 77, indicates that the intent of LOTO is to protect all workers. This is in conflict with Article 120. 120.2(A) states that "each person who could be exposed directly or indirectly to a source of electrical energy shall be involved in the LOTO procedure." Barricades prevent affected workers, or other employees, from entering the area. The other principal of LOTO is that a lock protects a specific, named, person. A person's lock does not protect anyone else.

Anyone who could be exposed, is required by Article 120 to become an authorized worker and must be added to the LOTO plan.

There is a mis-understanding in the electrical world that LOTO locks protect others. Adding the word "Authorized" makes it clear that each LOTO lock only protects the one worker.

Related Item

• 77-NFPA 70E-2021

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Committee: EEW-AAA

Public Comment No. 26-NFPA 70E-2022 [Section No. 120.5(A)(5)]

(5) Complex Lockout/Tagout.

(a) A complex lockout/tagout procedure shall be ~~permitted~~ ***used*** where one or more of the following exists:

(2) Multiple energy source

(3) Multiple crews

(4) Multiple crafts

(5) Multiple locations

(6) Multiple employers

(7) Multiple disconnecting means

(8) Particular sequences

(9) Job or task that continues for more than one work period

(j) All complex lockout/tagout procedures shall require a written plan of execution that identifies the person in charge.

(k) The complex lockout/tagout procedure shall vest primary responsibility in an authorized employee for employees working under the protection of a group lockout or tagout device, such as an operation lock or lockbox. The person in charge shall be held accountable for safe execution of the complex lockout/tagout.

(l) Each authorized employee shall affix a personal lockout or tagout device to the group lockout device, group lockbox, or comparable mechanism when he or she begins work and shall remove those devices when he or she stops working on the machine or equipment being serviced or maintained.

(m) All complex lockout/tagout plans shall identify the method to account for all persons who might be exposed to electrical hazards in the course of the lockout/tagout.

Statement of Problem and Substantiation for Public Comment

Currently 120.4(A)(5)(a) is written as a permissive statement ("shall be permitted"), yet (1) lists multiple energy sources. The very first item listed (1) Multiple energy sources already eliminates the possibility of using a simple Lockout Tagout.

Anyone of the 8 listed is more than enough reason to require a complex Lockout Tagout, not allow one (shall be permitted). Each of these 8 could possibly pose a great safety risk in only allowing, and not requiring. Commentary found in the 21 NFPA 70e handbook clearly states "If one or more of the conditions listed in 120.4(A)(5)(a) exist, the lock out is defined as complex, and a person in charge must be assigned."

So the commentary in the handbook (the extra details) contradicts the current wording used. We need to remove "shall be permitted" and use "shall be required" in 120.4(A)(5)(a).

Thank you for your time and consideration in this matter.

Casey Lynn
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270-709-4300

Related Item

• Lockout Tagout

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Committee: EEW-AAA

Public Comment No. 67-NFPA 70E-2022 [Section No. 120.5(B)(6)]

(6) Testing.

The procedure shall establish the following:

(1) Test instrument to be used, the required PPE, and the person who will use it to verify proper operation of the test instrument on a known voltage source before and after use

(2) Requirement to define the boundary of the electrically safe work condition

(3) Requirement to test before touching every exposed conductor or circuit part(s) within the defined boundary of the work area

(4) Requirement to retest for absence of voltage when circuit conditions change or when the job location has been left unattended

(5) Planning considerations that include methods of verification where there is no accessible exposed point to take voltage measurements

(6) Requirement to test for absence of voltage if moving from the original defined work area of the same equipment to a different area that has not been previously tested for the absence of voltage, for example moving from one compartment, enclosure or part to a different compartment, enclosure or part.

Statement of Problem and Substantiation for Public Comment

There are many types of electrical equipment, such as 'main-tie-main', switchgear and similar that has more than one source that can provide power to the equipment which can remain energized. For example, switchgear with a primary and alternate sources where the primary source can be placed into an ESWC with temporary protective grounds attached. However, the cubicle being fed by the alternate source may not be able to be de-energized and placed into an ESWC for a variety of reasons. During routine clean and inspections of such switchgear, the energized enclosures must be identified and flagged off IAW article 130.7(E), 130.7(F) and annex Q Q.6.9, however due to human errors sometime an energized cubicle might not be flagged off.
During October 2021, my power plant had an electrician seriously injured when he inadvertently opened a cubicle containing energized parts. The primary feed was verified to be in an ESWC and he had properly flagged off the cubicle with the energized 13.8kV from the alternate source. However he inadvertently opened an adjacent cubicle which contained the two sets of potential transformers, one for the primary source which was ESWC but the one for the alternate source was still energized.
Also the Los Alamos National Laboratory suffered a very similar arc flash event during routine clean and inspection of switchgear. The details of this serious injury accident was presented by Tommy Martinez and Julian Trujillo during the 2020 IEEE Electrical Safety Workshop conference in Reno, NV, see ESW2020-31 for details.
Therefore, it is imperative that workers reperform absence of voltage testing as they move from one part to a different part of the same equipment during normal routine maintenance. In both cases, if this was performed then these near fatal events would have been prevented.
Therefore

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 66-NFPA 70E-2022 [Section No. 120.5(B)(7)]	Related comments

Related Item

- pi

Submitter Information Verification

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Submittal Date:	Fri May 27 23:08:08 EDT 2022
Committee:	EEW-AAA

Public Comment No. 66-NFPA 70E-2022 [Section No. 120.5(B)(7)]

(7) Temporary Protective Grounding.

~~Grounding~~ Temporary protective grounding requirements for the circuit shall be established, including whether the temporary protective grounding equipment shall be installed for the duration of the task or is temporarily established by the procedure. ~~Grounding~~ Temporary protective grounding needs or requirements shall be permitted to be covered in other work rules and might not be part of the lockout/tagout procedure.

Statement of Problem and Substantiation for Public Comment

The term "Grounding" is ambiguous and can mislead the reader to think this is referring to general grounding and bonding of electrical equipment IAW article 250 of the NEC (NFPA 70) which is permanently installed during initial installation. Since we're speaking of electrical safety work practices, the correct term is "Temporary Protective Grounding" which is used throughout NFPA 70E.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 67-NFPA 70E-2022 [Section No. 120.5(B)(6)]	

Related Item

- pi

Submitter Information Verification

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Submittal Date: Fri May 27 22:55:22 EDT 2022
Committee: EEW-AAA

Public Comment No. 68-NFPA 70E-2022 [New Section after 120.5(B)(14)]

(14) Temporary Release for Testing/Positioning. The procedure shall clearly identify the steps and qualified persons' responsibilities when the job or task requiring lockout/tagout is to be interrupted temporarily for testing or positioning of equipment; then the steps shall be identical to the steps for return to service.

(1) Upon completion of the testing or positioning of the equipment, then all the steps required to verify an electrically safe work condition exists shall be reperformed in accordance with 120.5.

Statement of Problem and Substantiation for Public Comment

Once the LOTO has been temporarily released for testing or positioning of equipment (such as verifying rotation direction of a new polyphase motor) and the LOTO has been reapplied, then all the steps required to verify and establish an ESWC exists must be reperformed IAW 120.5. This is because the circuit or equipment was temporarily reenergized by its normal source which is no different than when the equipment was first taken down and placed under the original LOTO.

Related Item

- pi

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Submittal Date:	Fri May 27 23:40:18 EDT 2022
Committee:	EEW-AAA

Public Comment No. 19-NFPA 70E-2022 [New Section after 120.6]

TITLE OF NEW CONTENT

120.6(8)(d) *Method and Sequence of Attachment and Removal .*

Temporary protective grounding cables shall be attached to the ground end connection first then attach the other end to the normally energized line or part through the use of a live-line-tool of adequate length to keep the employee out of the restricted approach boundary. When removing temporary protective grounding cable, the connection to the normally energized line or part shall be removed first through the use of a live-line-tool of adequate length to keep the employee out of the restricted approach boundary, then the ground connection removed.

For lines or equipment normally energized at 600 volts or less, the use of insulting equipment such as insulating rubber gloves may be used in lieu of live-line-tools however the sequence of attachment and removal shall be the same.

Additional Proposed Changes

File Name	Description	Approved
New_Article_120.6_8_d_Method_and_Sequence_of_Attachment_and_Removal_03-24-2022.docx	New article 120.6(8)(d) for Method and Sequence of Attachment and Removal of temporary ground cables	

Statement of Problem and Substantiation for Public Comment

Article 120.6(8) is a conditional last step when establishing and verifying an electrically safe work condition exists "where the possibility of induced voltages or stored electrical energy exists..." or "where it could be reasonably anticipated that the conductors or circuit parts being de-energized could contact other exposed energized conductors or circuit parts..."
Since these two conditions pose a significant risk of electric shock to the worker applying or removing the temporary protective grounds (TPG), it only makes sense that proven protective methods derived from OSHA 1910.269(n)(6)9i) and (n)(6)(ii) for the safe installation and removal of TPG be added as a new sub-step 120.6(8)(d). Linemen and electricians who work for electric utility companies are very familiar with TPG, even within power generation plants which have identical medium voltage distribution equipment such as metal enclosed switch gear, bus ducts, open air transformers, etc. commonly found in many large industrial facilities and mining operations. During 2014 OSHA added "electric generation" to the scope of 1910.269(n) "Grounding for the Protection of Employees" for good reason.
Some have argued against this claiming induction hazard inside power plants and especially with medium voltage switch gear is "minimal" however this belief is a myth. Because several years ago at my power generating plant, a very experienced but careless power plant electrician removed the ground connection clamp end of a TPG cable first inside a metal clad 13.8kV switch gear cubicle while the other ends were still attached to the normally energized underground shielded cables going to the load using standard leather work gloves. When the grounding clamp was unscrewed and pulled away from the grounding point, the individual received a very nasty electric shock due to induction. Thankfully he wasn't seriously injured, probably because the leather gloves provided some level of resistance, but this event could have easily been a fatality. Therefore, the specific sequence and the use of live line tools to keep the worker outside of the restricted approach boundary is an essential element to help keep workers safe especially when they're establishing and verifying an ESWC exists.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 14-NFPA 70E-2022 [Section No. 120.6]	This PI is directly related to my other PI for updates to 120.6 ESWC

Related Item

- PI

Submitter Information Verification

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Committee:	EEW-AAA

2024 NFPA 70E New Article 120.6(8)(d) "*Method and Sequence of Attachment and Removal*"
George T. Cole

120.6(8)(d) *Method and Sequence of Attachment and Removal*. Temporary protective grounding cables shall be attached to the ground end connection first then attach the other end to the normally energized line or part through the use of a live-line-tool of adequate length to keep the employee out of the restricted approach boundary. When removing temporary protective grounding cable, the connection to the normally energized line or part shall be removed first through the use of a live-line-tool of adequate length to keep the employee out of the restricted approach boundary, then the ground connection removed.

For lines or equipment normally energized at 600 volts or less, the use of insulting equipment such as insulating rubber gloves may be used in lieu of live-line-tools however the sequence of attachment and removal shall be the same.

Public Comment No. 108-NFPA 70E-2022 [Section No. 120.6]

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

(5) Release stored electrical energy.

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

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

(8) 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 Note No. 2: See UL 1436, *Outlet Circuit Testers and Other Similar Indicating Devices* , for additional information on rating and design requirements for permanently mounted absence of voltage testers.

Informational Note No. 3: 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.

(9) 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:

(10) *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.

(11) *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.

(12) *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.

Statement of Problem and Substantiation for Public Comment

To have an order that removes stored energy BEFORE applying a lock is UNSAFE because the energy can reappear in the storage device before the source is locked out.
This has nothing to do with capacitor banks. This is fundamental to any process to achieve an electrically safe work condition.
It is in direct contradiction to 29CRF1910.147(d) Application of Control in Control of Hazardous Energy.

No DOE or DOD laboratory will follow the current unsafe order in NFPA 70E and this is documented in their Electrical Safety Programs
The lock MUST be applied before the energy is removed to assure energy can NOT reappear. This is common sense.

Related Item

- PI No. 276

Submitter Information Verification

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Submittal Date: Mon May 30 11:25:00 EDT 2022
Committee: EEW-AAA

Public Comment No. 136-NFPA 70E-2022 [Section No. 120.6]

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~~ Where means to do so are readily available , 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 additional information on rating and design requirements for permanently mounted absence of voltage testers.

Informational Note No. 3: 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:

(9) *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.

(10) *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.

(11) *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.

Statement of Problem and Substantiation for Public Comment

There are two revisions suggested in this public comment.

First, a clarification to item (3) to make it clear that visual verification of open blades is only necessary if the means to visually verify open contacts are readily available. There is confusion that because the current language uses "wherever possible" that employers should be making employees disassemble equipment to visually verify open contacts because it is possible. This exposes employees to hazards they don't need to be exposed to during the process of establishing an electrically safe work condition. Besides, the visual verification is only a bonus since the verification that really matters is the electrical verification of absence of voltage in step (7). Plus, if an employer were to utilize AVTs, misinterpretation of step (3) would have them open an enclosure that they don't need to open at all.

Second, please delete the requirement to verify absence of voltage at each point of work from step (7). This will require an absence of voltage test at every single place within an electrical system that work will be performed, even if the upstream feeder or service has already been verified in an ESWC. This will create a situation where employees will need to test for dead on equipment that poses no risk of injury to them. For example, a building under demolition is placed in an ESWC at the service equipment meaning de-energized, LOTO, and verified 0 volts at the load side of the Service OCPD and grounded if necessary. However, I am still going to need to test for absence of voltage at every receptacle I take out, every light fixture I open up, and every other point of work I will be at within the building. This will create a mentality among those doing the work that either this verification test is unwarranted, or that testing for absence of voltage isn't really that big of a danger because they do it all the time on equipment that is already in an ESWC. It is hard enough to explain how the absence of voltage test is to be considered energized work as it is, this will create a potential downgrade in safety at many workplaces.

Related Item

• Public Input 278 • First Revision 50

Submitter Information Verification

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Committee:	EEW-AAA

Public Comment No. 138-NFPA 70E-2022 [Section No. 120.6]

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~~ part 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~~

each point of 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 additional information on rating and design requirements for permanently mounted absence of voltage testers.

Informational Note No. 3: 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:

(9) *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.

(10) *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.

(11) *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.

Statement of Problem and Substantiation for Public Comment

The words “at each point of work” should be deleted. If a qualified person is truly a qualified person, they will know where to test for the absence of voltage. There is no definition of “point of work”. To some, this will mean the point of work is the entire industrial control panel so checking for the absence of voltage at the line side where power enters will be enough. To some, this will mean the line side of every conductor and circuit part in the industrial control panel. This new wording will not be enforceable unless there is a definition.

The wording “at each point of work” could also make testing for the absence of voltage more difficult than it needs to be. For example, a motor needs to be replaced. There is a disconnect switch within a few feet of the motor. Metallic sealtite exits the disconnect and runs to the motor. With the wording in the 2021 edition, the qualified person opens the disconnect and continues to complete steps 1-6 of 120.5. When the qualified person gets to step 7 and while they are “suited up”, they test for the absence of voltage on the load side of the disconnect switch. After completing 120.5 and closing the cover to the disconnect, they remove shock and arc-flash PPE and proceed to disconnect power to the motor. With the new wording, they will have to remain “suited up” until they test for the absence of voltage inside the junction box at the motor. There are a lot motors that have conductors split bolted and taped with rubber tape and electrical tape. Trying to remove all that tape while still wearing rubber gloves with leather protectors could be extremely difficult.

Here is another example showing this new wording is not needed. An old industrial building will be torn down. The local utility company disconnects power to the building and even removes the service conductors supplying power to the building. With the new wording, a qualified person will be required to check every conductor and circuit part outside and inside the building for the absence of voltage while wearing shock and arc-rated PPE.

If this new wording stays, the exception for an absence of voltage tester should also say “at each point of work”. Why would testing at each point of work be required in the main body of the text but it would not be required in the exception? If “at each point of work” is deleted from the main requirement, do not add the wording to the exception.

Related Item

• FR-50

Submitter Information Verification

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Committee: EEW-AAA

Public Comment No. 14-NFPA 70E-2022 [Section No. 120.6]

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~~ For grounded ac systems, test each phase conductor or circuit part both phase-to-phase and phase-to-ground. For ungrounded ac systems, test each phase conductor or circuit part both phase-to-phase and phase-to-common or neutral. For dc systems, test each conductor or circuit part both positive (+) to negative (-) and each polarity to ground. Before and after each test, determine that the test instrument is operating satisfactorily through verification on any known voltage source of the applicable current type (ac and/or dc). The neutral conductor or circuit part shall be verified to be absence of hazardous current.

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 for ac systems or positive to negative and each polarity to ground for dc systems; (4) The test device is verified as operating satisfactorily on any known voltage source of the applicable current type (ac and/or dc) 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 additional information on rating and design requirements for permanently mounted absence of voltage testers.

Informational Note No. 3: 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:

(9) *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.

(10) *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.

(11) *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.

Additional Proposed Changes

File Name	Description	Approved
Article_120.6_Establishing_an_Electrically_Safe_Work_Condition_03-20-2022.docx	Update article 120.6(7) to include testing of dc systems across positive (+) to negative (-) and each polarity to ground. Also the neutral conductor (related to my PI for a new definition in article 100) must be verified to be absent of hazardous electric current.	

Statement of Problem and Substantiation for Public Comment

Justification for updating 120.6(3) - Most breakers when placed in the "test position" will still keep control circuits or secondary voltages energized to the load, (normally 120vac or 130vdc), such as motor space heaters, transducers, MCCs, switch gear, etc.. If the motor or MCC, etc. is going to be replaced or worked on then can it be said the utilization equipment is actually in an electrically safe work condition if the heaters are still energized at hazardous voltages greater than 50 volts? Obviously the motor is not in an ESWC if the heaters, transducers or similar control circuits at the motor are still energized at greater than 50 volts because the breaker is still in test position.

Justification for updating 120.6(7) and Exception Number 1 to 7 - When checking for the absence of voltage prior to starting work, the term "phase to phase" and "phase to ground" are terms related to only grounded AC systems. However, verifying for absence of voltage of ungrounded AC systems and DC systems is just as important for the safety of the worker and with the astronomical growth of large commercial solar plants, large storage batteries and other equipment associated with DC systems it only make sense to now specify DC absence of voltage practices into the article and exception which will increase electrical safety of workers. Therefore adding ungrounded AC voltage testing "phase-to-phase" and "phase to common or neutral" and DC voltage testing positive (+) to negative (-) and each polarity to ground instructions will bridge this gap for ungrounded AC and DC systems.
Also due to the NEC still permitting shared neutral conductors through multi-wire branch circuits, there have been many electric shock injuries and fatalities caused by electric current still flowing through the neutral,

especially with lighting circuits. Over the last 3 years, there have been several papers presented during the IEEE Electrical Safety Workshop (ESW) citing the hazards of neutral conductors to electricians even after the ungrounded phase conductor was verified to be absent of voltage but there was still return current on the grounded neutral conductor originating from another breaker or mis-wiring error.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 15-NFPA 70E-2022 [Article 100]	relating "neutral conductors" to be verfied to be free of electric current under 120.6 for an ESWC with the new definition of neutral conductor to be added to article 100
Public Comment No. 15-NFPA 70E-2022 [Article 100]	
Public Comment No. 19-NFPA 70E-2022 [New Section after 120.6]	

Related Item

- PI

Submitter Information Verification

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Committee: EEW-AAA

2024 NFPA 70E article 120.6
George Cole

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. For ac systems, test each phase conductor or circuit part both phase-to-phase and phase-to-ground. For dc systems, test each conductor or circuit part both positive (+) to negative (-) and each polarity to ground. Before and after each test, determine ~~that~~ the test instrument is operating satisfactorily through verification on any known voltage source of the applicable current type (ac and/or dc). The neutral conductor or circuit part shall be verified to be absence of hazardous current.

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 for ac systems or positive to negative and each polarity to ground for dc systems; (4) The test device is verified as operating satisfactorily on any known voltage source of the applicable current type (ac and/or dc) before and after testing for the absence of voltage.

Public Comment No. 18-NFPA 70E-2022 [Section No. 120.6]

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 for the absence of voltage in lieu of testing each phase conductor both phase-to-phase and phase-to-ground .

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 additional information on rating and design requirements for permanently mounted absence of voltage testers.

Informational Note No. 3: 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:

(9) *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.

(10) *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.

(11) *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.

Statement of Problem and Substantiation for Public Comment

This recommendation revises the exception so that the requirement can be complied with using this type of test equipment. The requirement, as presently written, cannot be complied with as the test instrument in the exception cannot test both phase-to-phase and phase-to-ground.

Related Item

• PI-50

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Public Comment No. 55-NFPA 70E-2022 [Section No. 120.6]

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 additional information on rating and design requirements for permanently mounted absence of voltage testers.

Informational Note No. 3: 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.

Informational Note No. 4: When using a portable test instrument in combination with a permanently mounted accessory (such as a test portal) to test for the absence of voltage, the permanently mounted accessory should meet the requirements of Exception No. 1 .

(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:

(9) *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.

(10) *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.

(11) *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.

Statement of Problem and Substantiation for Public Comment

There is confusion as to whether the requirement of Step 7 or the Exception to Step 7 applies when using a portable test instrument in conjunction with a permanently mounted accessory, such as a test portal.
Although test portals are a valuable tool for troubleshooting and measuring voltage presence, they may provide inaccurate readings when used to test for the absence of voltage.
- Verifying the absence of voltage through a permanently mounted device requires assurance that you are in contact with the test point when the measurement is taken. If the device is not properly terminated, and the device leads are disconnected, no voltage will be detected, regardless of whether or not the conductor is energized. This is why permanently mounted absence of voltage testers are required to have an installation test to confirm that the product is in contact with the conductor at the time the voltage measurement is taken (UL 1436 12.1.7 and 12.1.8). Test portals do not have a feature to verify sensor leads are connected to the source conductor when a measurement with a portable test instrument is taken. This condition could result in reading zero voltage at the portal when voltage is present at the source.
- Overcurrent protection is often required for test portals with leads longer than 12 inches in order for the installation to meet NEC or UL 508A requirements. For fused installations, the portals will only be testing the load side of the fuse, NOT the actual source conductor. The circuit part i.e. source conductor could be energized if the fuse is open and a portable test instrument would not detect voltage through the test portal. This condition could result in reading zero voltage at the portal when voltage is present at the source. A distinction should be made between the use of test portals for voltage presence testing and absence of voltage testing.
UL 1436 has requirements several requirements for addressing these concerns when testing for the absence of voltage with a permanently mounted device. If permanently mounted accessories such as a test portal are used to test for the absence of voltage, these requirements should also be satisfied (Part (2) of Exception No 1 to Step (7)).

Related Item

• PI 224 • FR 50

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Public Comment No. 74-NFPA 70E-2022 [Section No. 120.6]

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 additional information on rating and design requirements for permanently mounted absence of voltage testers.

Informational Note No. 3: 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) The use of temporary protective grounding equipment

(9) Where the conductors or circuit parts are not connected to a source of electricity but where the possibility of induced voltages or stored electrical energy exists, ground all circuit conductors and circuit parts before touching them. Apply temporary protective grounding in accordance with the following:

(10) After a capacitor has been discharged, per 360.5, connect a grounding wire across the terminals of the capacitor to prevent the capacitor from recharging internally.

(11) Conductors being worked on, when in the vicinity of other current carrying conductors, might develop an inductive charge. Connect a grounding wire on the conductor being worked on in order to keep the conductor at a non-hazardous potential.

(12) 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:

(13) 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.

~~,~~

(1)

(1) _ hazardous differences in electrical potential). _ The location, sizing, and application of temporary protective grounding equipment shall be identified as part of the

~~employer's~~

(1)

(1) employer's job planning.

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

Informational Note:

~~See~~

(1)

(1) _ ASTM F855, _ *Standard*

~~Specification~~

(1)

(1) _ *for Temporary Protective Grounds to be*

~~Used~~

(1)

(1) *used on De-energized*

~~Electric~~

(1)

(1) *Electrical Power Lines and Equipment* ,

~~which~~

(1)

(1) _ is an example of a standard that contains information on capacity of temporary protective grounding equipment.

(1) 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. _

Additional Proposed Changes

File Name	Description	Approved
The_use_of_temporary_protective_grounding_equipment.docx	Changes in separate word document	

Statement of Problem and Substantiation for Public Comment

The committee statement for my PI 227 was that the discharge of capacitors is covered elsewhere. This was not the intent of my PI. When i submitted my PI, the bullets got very confused and i apologize for that. Currently, the section for temporary protective grounding all runs together. My submission breaks up the applications into Capacitive, Inductive, and fault current. Only the TPGs for Fault current have to be engineered for the potential fault current. The TPGs to prevent capacitor recharging and to mitigate induced voltages are entirely different.

Related Item

• 227-NFPA 70E-2021

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Committee:	EEW-AAA

(8) The use of temporary protective grounding equipment

1. Where the conductors or circuit parts are not connected to a source of electricity but where the possibility of induced voltages or stored electrical energy exists, ground all circuit conductors and circuit parts before touching them. Apply temporary protective grounding in accordance with the following:
    1. After a capacitor has been discharged, per 360.5, connect a grounding wire across the terminals of the capacitor to prevent the capacitor from recharging internally.
    2. Conductors being worked on, when in the vicinity of other current carrying conductors, might develop an inductive charge. Connect a grounding wire on the conductor being worked on in order to keep the conductor at a non-hazardous potential.
2. 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:
    1. 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.
    2. Capacity. Temporary protective grounding equipment shall be capable of conducting the maximum fault current that could flow at the point of the grounding for the time necessary to clear the fault.

        Informational Note: ASTM F855, *Standard for Temporary Protective Grounds to be used on De-energized Electrical Power Lines and Equipment*, is an example of a standard that contains information on capacity of temporary protective grounding equipment.
    3. 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.

Public Comment No. 170-NFPA 70E-2022 [Section No. 130.2]

130.2 Energized Electrical Work Permit.

(A) When Required.

When work is performed as permitted in accordance with 110.2(C), an energized electrical work permit shall be required and documented under any of the following conditions:

(1) When work is performed within the restricted approach boundary

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

(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)(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)(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 an example of an acceptable energized work permit.

(C) Exemptions to Work Permit.

Electrical work shall be permitted without an energized electrical work permit if a qualified person is provided with and uses appropriate safe work practices and PPE in accordance with Chapter 1 under any of the following conditions:

(1) Testing, troubleshooting, or voltage measuring

(2) Thermography, ultrasound, or visual inspections if the restricted approach boundary is not crossed

(3) Access to and egress from an area with energized electrical equipment if no electrical work is performed and the restricted approach boundary is not crossed

(4) General housekeeping and miscellaneous non-electrical tasks if the restricted approach boundary is not crossed

Additional Proposed Changes

File Name	Description	Approved
CN_20.pdf	70E_CN20_PC170	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 20 appeared in the First Draft Report on First Revisions No. 55

The Correlating Committee directs the technical committee to revise the informational note in list item (9) to See Informative Annex J Figure J.1 to comply with the NEC Style Manual 2.1.6.

Related Item

- First Revision No. 55

Submitter Information Verification

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Correlating Committee Note No. 20-NFPA 70E-2022 [Section No. 130.2(B)]

Submitter Information Verification

Committee: NEC-AAC

Submittal Date: Thu Jan 20 11:42:16 EST 2022

Committee Statement

Committee Statement: The Correlating Committee directs the technical committee to revise the informational note in list item (9) to See Informative Annex J Figure J.1 to comply with the NEC Style Manual 2.1.6.

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

Ballot Results

✔ **This item has passed ballot**

12 Eligible Voters
1 Not Returned
11 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.

Gallo, Ernest J.

Hickman, Palmer L.

Holub, Richard A.

Hunter, Dean C.

Kendall, David H.

Kovacik, John R.

Manche, Alan

Porter, Christine T.

Schultheis, Timothy James

Williams, David A.

Public Comment No. 141-NFPA 70E-2022 [Section No. 130.2(A)]

(A) When Required.

When work is performed as permitted in accordance with 110.2(C), an energized electrical work permit shall be required and documented under any of the following conditions:

(1) When work is performed within the restricted approach boundary

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

(3) When performing the task of Working On – Repairs as defined by article 100.

Statement of Problem and Substantiation for Public Comment

To provide the reader with clarity when an energized work permit is also required, a new sub-step (3) should be added to article 130.2(A) "When Required" which includes any task that falls under the definition of Working On – Repairs as defined by article 100.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 140-NFPA 70E-2022 [Section No. 130.2(C)]	Defines additional conditions when an EEWP is required and not required
Public Comment No. 140-NFPA 70E-2022 [Section No. 130.2(C)]	

Related Item

- PI

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Public Comment No. 83-NFPA 70E-2022 [Section No. 130.2(A)]

(A) When Required.

When ~~work is performed as permitted in accordance with 110.2(C) , an~~ energized ~~electrical~~ work ~~permit shall be required and documented under any of the following conditions: When work is performed within~~ is performed within the restricted approach boundary

- ~~When the employee interacts with the equipment when conductors or circuit parts are not exposed but an increased likelihood of injury from an exposure to an arc flash hazard exists~~

~~.~~

Statement of Problem and Substantiation for Public Comment

Bullet (2) is ambiguous and could mean anything. Companies have used this to require EEWPs when racking in/out breakers, stabbing/pulling MCC buckets, and even removing covers from panels.

Related Item

- 72-NFPA 70E-2021

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Public Comment No. 140-NFPA 70E-2022 [Section No. 130.2(C)]

(C) Exemptions to Work Permit.

Electrical work shall be permitted without an energized electrical work permit if a qualified person is provided with and uses appropriate safe work practices and PPE in accordance with Chapter 1 under any of the following conditions:

(1) Testing, troubleshooting, or voltage measuring

(2) Thermography, ultrasound, or visual inspections if the restricted approach boundary is not crossed

(3) Access to and egress from an area with energized electrical equipment if no electrical work is performed and the restricted approach boundary is not crossed

(4) General housekeeping and miscellaneous non-electrical tasks if the restricted approach boundary is not crossed

(5) When performing the task of Working On – Diagnostics (testing) as defined by article 100.

Statement of Problem and Substantiation for Public Comment

To provide the reader with clarity when an energized work permit is not required, a new sub-step (5) should be added to article 130.2(C) Exemption to Work Permit which includes any task that falls under the definition of Working On -Diagnostic (testing) as defined by article 100.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 141-NFPA 70E-2022 [Section No. 130.2(A)]	Adds additional conditions when an EEWP is required and not required
Public Comment No. 141-NFPA 70E-2022 [Section No. 130.2(A)]	

Related Item

- PI

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Public Comment No. 81-NFPA 70E-2022 [Section No. 130.2(C)]

(C) Exemptions to Work Permit.

Electrical work shall be permitted without an energized electrical work permit if a qualified person is provided with and uses appropriate safe work practices and PPE in accordance with Chapter 1 under any of the following conditions:

(1) Testing, troubleshooting, or voltage measuring

(2) Thermography, ultrasound, or visual inspections if the restricted approach boundary is not crossed

(3) ~~Access to and egress from an area with energized electrical equipment if no electrical work is performed and the restricted approach boundary is not crossed~~

(4) ~~General housekeeping and miscellaneous non-electrical tasks if the restricted approach boundary is not crossed~~

Statement of Problem and Substantiation for Public Comment

Bullets (3) and (4) are very confusing. The requirements for an EEWP are clearly indicated in 130.2(A). Furthermore, unqualified persons are not allowed within the limited approach boundary without being escorted. The exemptions in 130.2(C) make it look like entrance, egress, and general housekeeping all require EEWPs, which they do not. The focus should be on when are EEWPs required. 130.2(A) indicates that they are required when the work is performed within the restricted approach boundary. There is no need to put these under the exemptions.

Related Item

- 73-NFPA 70E-2021

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Public Comment No. 40-NFPA 70E-2022 [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,e] Includes Inadvertent Movement Adder
Less than 50 V	Not specified	Not specified	Not specified	
50 V–150 V[d]	3.~~0 m~~ 1 m (10 ft 0 in.)	1.0 m (3 ft 6 in.)	Avoid contact	
151 V–750 V	3.~~0 m~~ 1 m (10 ft 0 in.)	1.0 m (3 ft 6 in.)	~~0~~ 3 .~~3 m~~ 1 m (1 ft 0 in.)	
-	-	-	-	
~~751 V–15 kV~~	~~3.0 m (10 ft 0 in~~ 751 V - 5 kV 5.1 kV - 15 kV	3.1 m (10 ft 0 in.) 3.1 m (10 ft 0 in.)	1.0 m (3 ft 6 in .) 1. ~~5 m (5 ft 0 in~~ 5 m (5 ft 0 in .)	0. ~~7 m (2 ft 2 in~~ 63 m (2 ft 1 in .) 0.65 m (2 ft 2 in.)
15.1 kV–36 kV	3.~~0 m~~ 1 m (10 ft 0 in.)	1.8 m (6 ft 0 in.)	0.~~8 m (2 ft 9 in~~ 77 m (2 ft 7 in .)	
36.1 kV–46 kV	3.~~0 m~~ 1 m (10 ft 0 in.)	2.5 m (8 ft 0 in.)	0.~~8 m (2 ft 9 in~~ 84 m (2 ft 10 in .)	
-	-	-	-	
46.1 kV–72.5 kV	3.~~0 m~~ 1 m (10 ft 0 in.)	2.5 m (8 ft 0 in.)	1.~~0 m (3 ft 6 in~~ 0 m (3 ft 4 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~~ 2 m (3 ft 9 in .)	
~~138~~ 121.1 kV–145 kV	3.4 m (11 ft 0 in.)	3.~~0 m~~ 1 m (10 ft 0 in.)	1.~~2 m (3 ft 10 in~~ 3 m (4 ft 4 in .)	
-	-	-	-	
~~161~~ 145.1 kV–169 kV	3.6 m (11 ft 8 in.)	3.6 m (11 ft 8 in.)	1.~~3 m (4 ft 3 in~~ 5 m (4 ft 10 in .)	
~~230~~ 169.1 kV–242 kV	4.0 m (13 ft 0 in.)	4.0 m (13 ft 0 in.)	2. 1 ~~.7 m (5 ft 8 in~~ m (6 ft 8 in .)	

(1) Nominal System Voltage Range, Phase to Phase[a]	(2) Exposed Movable Conductor[c]	(3) Limited Approach Boundary[b]: Exposed Fixed Circuit Part	(4) Restricted Approach Boundary[b,e] Includes Inadvertent Movement Adder
~~345~~ 242.1 kV–362 kV 362.1 kV-420 kV	4.7 m (15 ft 4 in.) 5.8 m (19 ft 0 in.)	4.7 m (15 ft 4 in.) ~~2~~ 5 . ~~8 m (9 ft 2 in~~ 8 m (19 ft 0 in .)	
_	_	_	_
~~500~~ 3.5 m (11 ft 2 in.) 4.3 m (14 ft 0 in.)			
420.1 kV–550 kV	5.8 m (19 ft 0 in.)	5.8 m (19 ft 0 in.)~~3~~	5 .~~6 m (11 ft 8 in~~ 1 m (16 ft 8 in .)
~~765~~ 550.1 kV–800 kV	7.2 m (23 ft 9 in.)	7.2 m (23 ft 9 in.)4	6 .~~9 m (15 ft 11 in~~ 9 m (22 ft 7 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(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.

e The restricted approach boundary in Column 4 is based on an elevation not exceeding 900 m (3000 ft). For higher elevations, adjustment of the restricted approach boundary shall be considered.

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)
	Limited Approach Boundary		
Nominal Potential Difference	Exposed Movable Conductor*[a]	Exposed Fixed Circuit Part	Restricted Approach Boundary; Includes Inadvertent Movement Adder
Less than 50 V	Not specified	Not specified	Not specified
50 V–300 V	3.~~0 m~~ 1 m (10 ft 0 in.)	1.0 m (3 ft 6 in.)	Avoid contact
301 V–1 kV	3.~~0 m~~ 1 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~~ 1 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~~ 1 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~~ 1 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~~ 1 m (10 ft 0 in.)	2.5 m (8 ft 0 in.)	1.0 m (3 ft 6 in.)

(1)	(2)	(3)	(4)
	Limited Approach Boundary		
Nominal Potential Difference	Exposed Movable Conductor*[a]	Exposed Fixed Circuit Part	Restricted Approach Boundary; Includes Inadvertent Movement Adder
75.1 kV–150 kV	3.3 m (10 ft 8 in.)	3.~~0 m~~ 1 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.

a The restricted approach boundary in Column 4 is based on an elevation not exceeding 900 m (3000 ft). For higher elevations, adjustment of the restricted approach boundary shall be considered.

Additional Proposed Changes

File Name	Description	Approved
70E_130.4_Shock_Approach_Tables_TG_2_Phase_to_Ground_Final.docx		
70E_130.4_Shock_Approach_Tables_TG_2_Table_E_b_.docx		

Statement of Problem and Substantiation for Public Comment

This public comment is being submitted on behalf of 2024 NFPA 70E Task Group 2, Shock Protection Boundaries. The members of the task group included Ernie Gallo, Thomas Dyson, Mark Hilbert, James Stallcup, Jr., James Stallcup, Sr. and David Wallis.

The restricted approach boundaries in Table 130.4(E)(a) have been revised to correlate with OSHA's minimum approach distances in 29 CFR 1910.269, Tables R-3, R-6, and R-7. This public comment leaves the limited approach boundaries unchanged, except with respect to added voltages ranges and harmonizing the metric measurements with the OSHA 10-foot rule. The revision applies Informative Annex C, C.2.1.3, to derive the values for the added rows. As a consequence of the correlation with the OSHA tables, the nominal system voltage ranges for voltages of more than 750 V have been adjusted to also align with the OSHA tables.

At the end of the 2021 Second Draft meeting, under new business, it was recommended that a task group be formed for the 2024 Edition to review Table 130.4(E)(a) and consider revising the shock approach boundaries to be more consistent with the OSHA and NESC tables, because there was concern that NFPA 70E Table 130.4(E)(a) was not sufficiently protective when compared to relevant approach distances in other standards.

The Task Group reviewed OSHA Tables R-2 (in 29 CFR 1910.268), R-3, R-6, and R-7 (in 29 CFR 1910.269), and S-5 (in 29 CFR 1910.333) and NESC Tables 440-1 and 431-1. After reviewing those other tables, the Task Group chose to correlate Table 130.4(E)(a) with OSHA Tables R-6 and R-7. The minimum approach distances in those tables are based on the latest scientific information available, and the resulting changes to NFPA 70E Table 130.4(E)(a) are minimal for voltages up to 15 kV, the most common voltages in commercial and industrial establishments and would generally not require changes to employer's approach-distance tables. The increases in the restricted approach boundaries for higher voltages are necessary for safety.

OSHA Tables R-6 and R-7 and NESC Table 440-1 apply to work on electric power installations that are outside the scope of NFPA 70E. However, the minimum approach distances were adopted when OSHA promulgated revisions of 29 CFR 1910.269 and 29 CFR Part 1926, Subpart V and are based on the most recent scientific data. The 2017 NESC adopted minimum approach distances in Table 441-1 that correlated with OSHA's then-recent revision. Thus, the consensus of the scientific basis for setting minimum approach distances (MAD) is the OSHA and NESC methodologies. It should be noted that OSHA Table R-7 represents safe working distances for electric power workers with no action on the utility's part to control maximum transient overvoltages.

This approach yields scientifically valid restricted approach boundaries. The Task Group thus concluded that this is an appropriate approach to use for setting restricted approach boundaries in Table 130.4(E)(a). The restricted approach boundary in Column 4 is based on an elevation not exceeding 900 m (3000 ft). A new Note e has been added to the table as a reminder to adjust the restricted approach boundary distances for higher elevations.

Table 130.4(E)(B): The metric measurements were updated to correlate with the changes made to Table 130.4(E)(a) with regard to harmonizing the metric measurements with the OSHA 10-foot rule. A new Note a has been added to the table as a reminder to adjust the restricted approach boundary distances for higher elevations.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 41-NFPA 70E-2022 [Section No. C.2]	
Public Comment No. 41-NFPA 70E-2022 [Section No. C.2]	

Related Item

- PI 94

Submitter Information Verification

Submitter Full Name:	Mark Hilbert
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Submittal Date:	Tue May 10 17:47:25 EDT 2022
Committee:	EEW-AAA

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) [b]
	Limited Approach Boundary		
Nominal Potential Difference	Exposed Movable Conductor~~*~~ [a]	Exposed Fixed Circuit Part	Restricted Approach Boundary; Includes Inadvertent Movement Adder
Less than 50 V	Not specified	Not specified	Not specified 50 V–300 V 3.1~~0~~ m (10 ft
0 in.)	1.0 m (3 ft 6 in.)	Avoid contact	
301 V–1 kV	~~3.0~~ 3.1 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~~ 3.1 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~~ 3.1 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~~ 3.1 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~~ 3.1 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.)	3.1~~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 the worker.

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

a The restricted approach boundary in Column 4 is based on an elevation not exceeding 900 m (3000 ft). For higher elevations, adjustment of the restricted approach boundary shall be considered.

Substantiation: The metric measurements were updated to correlate with the changes made to Table 130.4(E)(a) with regard to harmonizing the metric measurements with the OSHA 10-foot rule. A new Note a has been added to the table as a reminder to adjust the restricted approach boundary distances for higher elevations.

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]		Restricted Approach Boundary[b];, e
Nominal System Voltage Range, Phase to Phase[a]	Exposed Movable Conductor[c]	Exposed Fixed Circuit Part	Includes Inadvertent Movement Adder
Less than 50 V	Not specified	Not specified	Not specified
50 V–150 V[d]	~~3.0~~ 3.1 m (10 ft 0 in.)	1.0 m (3 ft 6 in.)	Avoid contact
151 V–750 V	~~3.0~~ 3.1 m (10 ft 0 in.)	1.0 m (3 ft 6 in.)	~~0.3 m (1 ft 0 in.)~~ 0.31 m (1 ft 0 in.)
751 V-5 kV	3.1 m (10 ft 0 in.)	1.0 m (3 ft 6 in.)	0.63 m (2 ft 1 in.)
~~751~~5.1 kV–15 kV	~~3.0~~ 3.1 m (10 ft 0 in.)	1.5 m (5 ft 0 in.)	~~0.7 m (2 ft 2 in.)~~ 0.65 m (2 ft 2 in.)
15.1 kV–36 kV	~~3.0~~ 3.1 m (10 ft 0 in.)	1.8 m (6 ft 0 in.)	~~0.8 m (2 ft 9 in.)~~ 0.77 m (2 ft 7 in.)
36.1 kV–46 kV	~~3.0~~ 3.1 m (10 ft 0 in.)	2.5 m (8 ft 0 in.)	~~0.8 m (2 ft 9 in.)~~ 0.84 m (2 ft 10 in.)
46.1 kV–72.5 kV	~~3.0~~ 3.1 m (10 ft 0 in.)	2.5 m (8 ft 0 in.)	~~1.0 m (3 ft 6 in.)~~ 1.0 m (3 ft 4 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.)~~ 1.2 m (3 ft 9 in.)
~~138~~121.1 kV–145 kV	3.4 m (11 ft 0 in.)	~~3.0~~ 3.1 m (10 ft 0 in.)	~~1.2 m (3 ft 10 in.)~~ 1.3 m (4 ft 4 in.)
~~161~~145.1 kV–169 kV	3.6 m (11 ft 8 in.)	3.6 m (11 ft 8 in.)	~~1.3 m (4 ft 3 in.)~~ 1.5 m (4 ft 10 in.)
~~230~~169.1 kV–242 kV	4.0 m (13 ft 0 in.)	4.0 m (13 ft 0 in.)	~~1.7 m (5 ft 8 in.)~~ 2.1 m (6 ft 8 in.)
~~345~~ 242.1 kV–362 kV	4.7 m (15 ft 4 in.)	4.7 m (15 ft 4 in.)	~~2.8 m (9 ft 2 in.)~~ 3.5 m (11 ft 2 in.)
362.1 kV–420 kV	5.8 m (19 ft 0 in.)	5.8 m (19 ft 0 in.)	4.3 m (14 ft 0 in.)
~~500~~420.1 kV–550 kV	5.8 m (19 ft 0 in.)	5.8 m (19 ft 0 in.)	~~3.6 m (11 ft 8 in.)~~ 5.1 m (16 ft 8 in.)
~~765~~550.1 kV–800 kV	7.2 m (23 ft 9 in.)	7.2 m (23 ft 9 in.)	4.9 m (15 ft 11 in.) 6.9 m (22 ft 7 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) 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.

e The restricted approach boundary in Column 4 is based on an elevation not exceeding 900 m (3000 ft). For higher elevations, adjustment of the restricted approach boundary shall be considered.

Substantiation:

This public comment is being submitted on behalf of 2024 NFPA 70E Task Group 2, Shock Protection Boundaries. The members of the task group included Ernie Gallo, Thomas Dyson, Mark Hilbert, James Stallcup, Jr., James Stallcup, Sr. and David Wallis.

The restricted approach boundaries in Table 130.4(E)(a) have been revised to correlate with OSHA's minimum approach distances in 29 CFR 1910.269, Tables R-3, R-6, and R-7. This public comment leaves the limited approach boundaries unchanged, except with respect to added voltages ranges and harmonizing the metric measurements with the OSHA 10-foot rule. The revision applies Informative Annex C, C.2.1.3, to derive the values for the added rows. As a consequence of the correlation with the OSHA tables, the nominal system voltage ranges for voltages of more than 750 V have been adjusted to also align with the OSHA tables.

At the end of the 2021 Second Draft meeting, under new business, it was recommended that a task group be formed for the 2024 Edition to review Table 130.4(E)(a) and consider revising the shock approach boundaries to be more consistent with the OSHA and NESC tables, because there was concern that NFPA 70E Table 130.4(E)(a) was not sufficiently protective when compared to relevant approach distances in other standards.

The Task Group reviewed OSHA Tables R-2 (in 29 CFR 1910.268), R-3, R-6, and R-7 (in 29 CFR 1910.269), and S-5 (in 29 CFR 1910.333) and NESC Tables 440-1 and 431-1. After reviewing those other tables, the Task Group chose to correlate Table 130.4(E)(a) with OSHA Tables R-6 and R-7. The minimum approach distances in those tables are based on the latest scientific information available, and the resulting changes to NFPA 70E Table 130.4(E)(a) are minimal for voltages up to 15 kV, the most common voltages in commercial and industrial establishments and would generally not require changes to employer's approach-distance tables. The increases in the restricted approach boundaries for higher voltages are necessary for safety.

OSHA Tables R-6 and R-7 and NESC Table 440-1 apply to work on electric power installations that are outside the scope of NFPA 70E. However, the minimum approach distances were adopted when OSHA promulgated revisions of 29 CFR 1910.269 and 29 CFR Part 1926, Subpart V and are based on the most recent scientific data. The 2017 NESC adopted minimum approach distances in Table 441-1 that correlated with OSHA's then-recent revision. Thus, the consensus of the scientific basis for setting minimum approach distances (MAD) is the OSHA and NESC methodologies. It should be noted that OSHA Table R-7 represents safe working distances for electric power workers with no action on the utility's part to control maximum transient overvoltages.

This approach yields scientifically valid restricted approach boundaries. The Task Group thus concluded that this is an appropriate approach to use for setting restricted approach boundaries in Table 130.4(E)(a). The restricted approach boundary in Column 4 is based on an elevation not exceeding 900 m (3000 ft). A new Note e has been added to the table as a reminder to adjust the restricted approach boundary distances for higher elevations.

Public Comment No. 69-NFPA 70E-2022 [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(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)
	Limited Approach Boundary		
Nominal Potential Difference	Exposed Movable Conductor*	Exposed Fixed Circuit Part	Restricted Approach Boundary; Includes Inadvertent Movement Adder
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.

Statement of Problem and Substantiation for Public Comment

The term "Avoid Contact" currently used for the RAB in Table 130.4(E)(a) for the ac voltage range of 50 - 150 vac and Table 130.4(E)(b) for the dc voltage range of 50 - 300 vdc is very subjective and has lead to much confusion and debate among users as to what "avoid contact" actually means. When asked what "Avoid Contact" means to them, the vast majority of electrical workers will reply "Don't touch it" or something similar. And when questioned further about how they will protect themselves from not inadvertently touching the exposed energized part, their replies will be something to the effect of "I'm trained to know what to touch and not to touch" or "I won't get my hands near it".
Also how does "Avoid Contact" contain an "Inadvertent Movement Adder" as listed in Tables 130.4(E)(a) and 130.4(E)(b) under the restricted approach boundary column?
Therefore a physical distance, such as 2 inches, 6 inches or something similar should be inserted as used for all the other ac and dc voltage ranges currently listed in the two Tables.

Related Item

- pi

Submitter Information Verification

Submitter Full Name: George Cole

Organization: PVNGS/APS

Street Address:

City:

State:

Zip:	
Submittal Date:	Fri May 27 23:58:00 EDT 2022
Committee:	EEW-AAA

Public Comment No. 71-NFPA 70E-2022 [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~~ Line to Line [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(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.

Statement of Problem and Substantiation for Public Comment

Single winding (single phase) systems do not have phases, they have lines. Phases only exist on three phase systems where the phases are in time displacement with one another.
Using the title "Phase to Phase" makes it appear that this table does not apply to single phase (single winding) systems. But it must apply because it is a shock table. Digging down in the notes shows that the intent is for this table to apply. Changing the wording from phase to line encompasses all systems, and addresses the majority of my previous PI on this.

Related Item

- 74-NFPA 70E-2021

Submitter Information Verification

Submitter Full Name: Eric Stromberg
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Submittal Date: Sun May 29 12:40:06 EDT 2022

Committee: EEW-AAA

Public Comment No. 171-NFPA 70E-2022 [Section No. 130.5]

130.5 Arc Flash Risk Assessment.

(A) General.

An arc flash risk assessment shall be performed:

(1) To identify arc flash hazards

(2) To estimate the likelihood of occurrence of injury or damage to health and the potential severity of injury or damage to health

(3) To determine if additional protective measures are required, including the use of PPE

(B) Estimate of Likelihood and Severity.

The estimate of the likelihood of occurrence of injury or damage to health and the potential severity of injury or damage to health shall take into consideration the following:

(1) The design of the electrical equipment, including its overcurrent protective device and its operating time

(2) The electrical equipment operating condition and condition of maintenance

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).

(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	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).		
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).		

Task	Operating Condition[a]	Likelihood of Occurrence[b]
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 Abnormal	No 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 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 (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 110.2(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*, as an example of a standard that provides information for arc-resistant equipment referred to in Table 130.5(C).

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.

Informational Note No. 5: See Chapter 2 for additional direction for performing maintenance on overcurrent protective devices.

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.

(D) Documentation.

The results of the arc flash risk assessment shall be documented.

(E) Arc Flash Boundary.

(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 information on estimating the arc flash boundary.

(2)

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

(F) Arc Flash PPE.

One of the following methods shall be used for the selection of arc flash PPE:

(1) The incident energy analysis method in accordance with 130.5(G)

(2) The arc flash PPE category method in accordance with 130.7(C)(15)

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

(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 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 information on estimating the incident energy.

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

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 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 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 protectors provide arc flash protection in addition to shock protection. Higher class rubber insulating gloves with 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.

(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.

Additional Proposed Changes

File Name	Description	Approved
CN_21.pdf	70E_CN21_PC171	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 21 appeared in the First Draft Report on First Revisions No. 110.

The Correlating Committee directs the technical committee to remove the reference to Chapter 2 in Informational Note No. 5. References shall not be made to an entire article. References to parts within articles shall be permitted as specified in Section 4.1.4 of the 2020 NEC Style Manual.

Related Item

• First Revision No. 110

Submitter Information Verification

Submitter Full Name:	CC on NEC-AAC
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Street Address:	
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Submittal Date:	Thu Jun 02 16:35:37 EDT 2022
Committee:	EEW-AAA

Correlating Committee Note No. 21-NFPA 70E-2022 [Section No. 130.5(C)]

Submitter Information Verification

Committee: NEC-AAC

Submittal Date: Thu Jan 20 11:43:25 EST 2022

Committee Statement

Committee Statement: The Correlating Committee directs the technical committee to remove the reference to Chapter 2 in Informational Note No. 5. References shall not be made to an entire article. References to parts within articles shall be permitted as specified in Section 4.1.4 of the 2020 NEC Style Manual.

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

Ballot Results

✔ **This item has passed ballot**

12 Eligible Voters
1 Not Returned
11 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.
Gallo, Ernest J.
Hickman, Palmer L.
Holub, Richard A.
Hunter, Dean C.
Kendall, David H.
Kovacik, John R.
Manche, Alan
Porter, Christine T.
Schultheis, Timothy James
Williams, David A.

Public Comment No. 172-NFPA 70E-2022 [Section No. 130.5]

130.5 Arc Flash Risk Assessment.

(A) General.

An arc flash risk assessment shall be performed:

(1) To identify arc flash hazards

(2) To estimate the likelihood of occurrence of injury or damage to health and the potential severity of injury or damage to health

(3) To determine if additional protective measures are required, including the use of PPE

(B) Estimate of Likelihood and Severity.

The estimate of the likelihood of occurrence of injury or damage to health and the potential severity of injury or damage to health shall take into consideration the following:

(1) The design of the electrical equipment, including its overcurrent protective device and its operating time

(2) The electrical equipment operating condition and condition of maintenance

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).

(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	Operating Condition[a]	Likelihood of Occurrence[b]
Reading a panel meter while operating a meter switch. 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.	Any	No
For ac systems, work on energized electrical conductors and circuit parts, including electrical testing. 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). 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).	Any	Yes

Task	Operating Condition[a]	Likelihood of Occurrence[b]
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		
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		
(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 110.2(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*, as an example of a standard that provides information for arc-resistant equipment referred to in Table 130.5(C).

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.

Informational Note No. 5: See Chapter 2 for additional direction for performing maintenance on overcurrent protective devices.

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.

(D) Documentation.

The results of the arc flash risk assessment shall be documented.

(E) Arc Flash Boundary.

(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 information on estimating the arc flash boundary.

(2)

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

(F) Arc Flash PPE.

One of the following methods shall be used for the selection of arc flash PPE:

(1) The incident energy analysis method in accordance with 130.5(G)

(2) The arc flash PPE category method in accordance with 130.7(C)(15)

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

(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 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 information on estimating the incident energy.

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

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 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 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 protectors provide arc flash protection in addition to shock protection. Higher class rubber insulating gloves with 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.

(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.

Additional Proposed Changes

File Name	Description	Approved
CN_22.pdf	70E_CN22_PC172	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 22 appeared in the First Draft Report on First Revisions No. 59.

The word “the” in the phrase “identifies the arc-rated" should be removed to correlate with the removal of “of Article 130” because “the” connected “requirements” to “Article 130”.

Related Item

• First Revision No. 59

Submitter Information Verification

Submitter Full Name:	CC on NEC-AAC
Organization:	NEC Correlating Committee
Street Address:	
City:	
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Zip:	
Submittal Date:	Thu Jun 02 16:37:34 EDT 2022
Committee:	EEW-AAA

Correlating Committee Note No. 22-NFPA 70E-2022 [Section No. 130.5(G)]

Submitter Information Verification

Committee: NEC-AAC

Submittal Date: Thu Jan 20 11:44:20 EST 2022

Committee Statement

Committee Statement: The word "the" in the phrase "identifies the arc-rated" should be removed to correlate with the removal of "of Article 130" because "the" connected "requirements" to "Article 130".

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

Ballot Results

✔ **This item has passed ballot**

12 Eligible Voters
1 Not Returned
11 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.
Gallo, Ernest J.
Hickman, Palmer L.
Holub, Richard A.
Hunter, Dean C.
Kendall, David H.
Kovacik, John R.
Manche, Alan
Porter, Christine T.
Schultheis, Timothy James
Williams, David A.

Public Comment No. 25-NFPA 70E-2022 [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	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~~ centers (MCC).	-	-
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~~ 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).	-	-

Task	Operating Condition[a]	Likelihood of Occurrence[b]	
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	–	–	
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	–	–	
(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 110.2(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*, as an example of a standard that provides information for arc-resistant equipment referred to in Table 130.5(C).

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.

Informational Note No. 5: See Chapter 2 for additional direction for performing maintenance on overcurrent protective devices.

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.

Statement of Problem and Substantiation for Public Comment

Table 130.5(C)'s use of the word "energized" within the content of various tasks on the "Task" list. Several times the word energized is used throughout some of the tasks listed in this table such as, energized electrical conductors and circuit parts, or energized equipment. Then when I look at another task for instance, Insertion or removal of plug-in devices into or from busways, I don't see the word energized included here. Should this task be understood as meaning "energized" busways, yes of course I do believe it does, however it doesn't state as much? Why does this table use energized within some tasks and leave it to be be understood for others? After reading each and every task currently containing the word energized and then re-reading it again without the word energized in it, to me they could all easily enough be understood as energized. Standardization one way or the other is my recommendation here for this table in it's entirety, such as completely removing it from where it could be understood, or adding it everywhere that it should be understood. Here are some examples of tasks with energized included, Insertion or removal of individual starter starter buckets from energized motor control center(s) (MCC). Or, Insertion or removal of plug-in devices into or from energized busways. Or, Examination of energized insulated cable with manipulation of cable. My personal preference would be to include the word energized every where that it should be understood, if not at the very least make a notation denoting everything that should be understood as being energized is clearly defined as such, regardless of the overall essence of article 130. Even something as simple as a table name change may suffice, Estimate of the Likelihood of Occurrence of An Arc Flash Incident for Energized ac and dc Systems, after all Energized is utilized in table titles 130.4(E)(a) & 130.4(E)(b) and they too are within the confines of article 130.

Related Item

• Table 130.5(C); Energized

Submitter Information Verification

Submitter Full Name: Daryl Colloms
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Submittal Date: Tue Apr 05 09:00:37 EDT 2022
Committee: EEW-AAA

Public Comment No. 70-NFPA 70E-2022 [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	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.~~	-	-	switch
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).	-	-	
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).	-	-	

Task	Operating Condition[a]	Likelihood of Occurrence[b]	
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	–	–	
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	–	–	
(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 110.2(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*, as an example of a standard that provides information for arc-resistant equipment referred to in Table 130.5(C).

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.

Informational Note No. 5: See Chapter 2 for additional direction for performing maintenance on overcurrent protective devices.

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.

Statement of Problem and Substantiation for Public Comment

Table 130.5(C) the task of "Operation of a CB or switch the first time after installation or completion of maintenance in the equipment." should be changed by removing the caveat "the first time after installation or completion of maintenance in the equipment".
At my power plant we've had two arc flash events where a molded case circuit breaker in one case and a power breaker in the other case, catastrophically failed when it was closed locally by our operators. No work was performed on the breakers but they were opened as a LOTO isolation point for work downstream. But when the breakers were reclosed upon completion of the work they unexpectantly faulted resulting in a significant arc flash event. In both cases the workers were not injured because they were wearing the correct level of arc flash PPE as mandated by our electrical safety procedure. And in a nuclear plant we test our breakers and perform routine maintenance quite often so a lack of maintenance wasn't the cause.

Related Item

- pi

Submitter Information Verification

Submitter Full Name:	George Cole
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Submittal Date:	Sat May 28 00:15:01 EDT 2022
Committee:	EEW-AAA

Public Comment No. 10-NFPA 70E-2022 [Section No. 130.5(G)]

(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 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 information on estimating the incident energy.

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

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 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 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 protectors provide arc flash protection in addition to shock protection. Higher class rubber insulating gloves with 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.

Statement of Problem and Substantiation for Public Comment

In Table 130.5(G); within the 1.2 cal/cm2 up to and including 12 cal/cm2, it contains "arc flash suit hood". Within the greater than 12 cal/cm2 portion, it's a arc-rated arc flash suit hood. Changing one if not both of these would standardize the nomenclature and eliminate any possible confusion, currently there are three different terms utilized with Table 130.7(C)(15)(c) PPE, Category 1; "arc flash suit hood", Category 2; "Arc-rated flash suit hood" and Categories; 3 & 4 "Arc-rated arc flash suit hood".

Furthermore in 130.7(C)(10)(b)(1 & 2) it's a "arc-rated hood"

Related Item

• Table 130.5(G) Hoods

Submitter Information Verification

Submitter Full Name: Daryl Colloms
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Zip:
Submittal Date: Tue Mar 15 14:45:40 EDT 2022
Committee: EEW-AAA

Public Comment No. 17-NFPA 70E-2022 [Section No. 130.5(G)]

(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 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 information on estimating the incident energy.

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

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

Incident energy exposures less than 1.2 cal/cm^2 [f]

100% cotton long-sleeve shirt and pants

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

Hard hat

Safety glasses or safety goggles (SR) [G]

Hearing protection

Leather footwear

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 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 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 protectors provide arc flash protection in addition to shock protection. Higher class rubber insulating gloves with 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.

[f] Exposure to incident energy hazards less than 1.2 cal/cm^2 may not require arc-rated PPE. 100% cotton clothing shall be worn as well as means of hand protection.

[g] Protective eyewear such as safety glasses or safety goggles shall have frames constructed of a non-conductive material.

Statement of Problem and Substantiation for Public Comment

No guidance is provided for arc flash hazard exposures less than 1.2 cal/cm^2. It is my belief that this is due to these hazards not being at a level which would result in second degree burns to the core (chest or face) of an individual. We understand that body parts nearer to the arcing point (hands, arms, etc.) are exposed to a greater amount of incident energy. I feel the 70E standard should do its due diligence to protect workers from these "lesser" hazards. In my experience it is believed that for hazards less than 1.2 cal/cm^2 personnel should wear 100% cotton long-sleeve shirt and pants along with other standard PPE (hard hat, glasses, earing protection, leather footwear). This leaves personnel to assume no protection of the hands is necessary. Should an individual be exposed to a hazard of this "lesser" magnitude it is plausible that the persons hands and arms will be exposed to greater than 1.2 cal/cm^2 of incident energy. I feel it is this standards place to address this and set the standard PPE as 100% cotton long-sleeve shirt and pants, hand protection, along with other standard items of PPE.

While I did not mark it up, I also feel associated clarification should be added to 130.7(b) Arc Flash Protection. It states hand and arm protection shall be worn when there is a possible exposure to arc flash burn. The standard identifies this as being when the incident energy exposure is 1.2 cal/cm^2 (to the core of the body). Many users of the 70E standard, I feel, will take this to mean no hand protection is necessary from an arc flash hazard if the IE is less than 1.2 cal/cm^2. I am fortunate to perform arc flash incident energy analysis and understand that while the label may state as much as 1.1 cal/cm^2 if I am to operate a disconnect handle or be near a point where an arc flash may occur, my hands ARE exposed to an arc flash hazard. The label nor this standard currently educates them to understand this.

To resolve, require hand protection as simple as leather gloves when exposed to an an incident energy less than 1.2 cal/cm^2. These gloves, arc-rated gloves, or others come into play as the IE increases.

Related Item

- FR

Submitter Information Verification

Submitter Full Name: Jason Moore

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Submittal Date:	Mon Mar 21 22:52:50 EDT 2022
Committee:	EEW-AAA

Public Comment No. 173-NFPA 70E-2022 [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.

Additional Proposed Changes

File Name	Description	Approved
CN_23.pdf	70E_CN23_PC173	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 23 appeared in the First Draft Report on First Revisions No. 60.

The Correlating Committee recommends the Technical Committee review the word "sufficient" and consider replacing it with "a" to comply with Section and Table 3.2.1 of the NEC Style Manual, Unenforceable Terms.

Related Item

• First Revision No. 60

Submitter Information Verification

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Submittal Date:	Thu Jun 02 16:39:47 EDT 2022
Committee:	EEW-AAA

Correlating Committee Note No. 23-NFPA 70E-2022 [Section No. 130.5(H)]

Submitter Information Verification

Committee: NEC-AAC

Submittal Date: Thu Jan 20 11:45:23 EST 2022

Committee Statement

Committee Statement: The Correlating Committee recommends the Technical Committee review the word "sufficient" and consider replacing it with "a" to comply with Section and Table 3.2.1 of the NEC Style Manual, Unenforceable Terms.

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

Ballot Results

✔ **This item has passed ballot**

12 Eligible Voters
1 Not Returned
11 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.
Gallo, Ernest J.
Hickman, Palmer L.
Holub, Richard A.
Hunter, Dean C.
Kendall, David H.
Kovacik, John R.
Manche, Alan
Porter, Christine T.
Schultheis, Timothy James
Williams, David A.

Public Comment No. 39-NFPA 70E-2022 [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:

(4) _ 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

(5) _ Minimum arc rating of clothing

(6) _ 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.

Informational Note 1 : Labels containing the necessary information as stated in 103.5(H) shall be properly installed to best inform personnel of the electrical hazards. Often times this shall mean applying a label that identifies an equipments electrical hazards directly to said equipment. Equipment which due to its location or obstructed view make it difficult for electrical hazard labels to be easily viewed by personnel from a safe working surface may use alternate means of hazard identification. Example equipment conditions may be: overhead mounted bus plugs, disconnects or other devices installed within a confined space, or components otherwise not easily accessed. While applying electrical hazard labels directly to them is recommended, a secondary label may be placed in a logical location nearby. Personnel shall be trained to understand the means of hazard identification for these devices. Equipment which is easily accessible should only have a single electrical hazard label which is applied directly to it.

Informational Note 2: Power systems which are being re-evaluated whether due to system changes or intervals as identified in 130.5(H) shall have their electrical hazards clearly identified. Labels associated with previous system studies shall be removed or noted to indicate that they are for historical purposes and shall not be used for the purposes of hazard identification. When electrical hazard labels are left for historical purposes, all affected personnel shall be properly trained to identify the appropriate hazard label.

Statement of Problem and Substantiation for Public Comment

I find it to be a bad practice to put a label for one hazard on the wrong device. A few years ago I found an analysis had been performed for my customer that I believed to be quite negligent. I was hired to do a full review of one of the power systems. Many issues were found. My public comment is associated with these issues. The firm completing the analysis installed the electrical hazard labels for "field" equipment on the upstream MCC compartment which fed the device. As a result, the MCC main compartment had a correct label (we'll say identifying > 12 cal/cm^2). The feeder compartments had incorrect labels (they were meant for the downstream devices) which identified an IE of < 4 cal/cm^2. The downstream equipment then did not get a label. This resulted in personnel donning inappropriate PPE while working on the MCC feeder compartments. This easily could result in significant injury or death. I feel at least an informational note directing users to apply a label for a device ON THAT DEVICE. Obviously, some conditions such as overhead bus plugs may need alternate labeling methods. This should be addressed but the overall emphasis given that a label identifying a disconnects hazards shall be placed on the disconnect and not elsewhere.

Additionally, the analysis I reviewed resulted in multiple labels on equipment. In several instances multiple labels from their study were applied and dated just a few weeks apart. The information varied on the labels...sometimes significantly. In many more cases, labels from one or two previous studies were left in place. At one switchboard a previous label identifying the IE of just under 20 cal/cm^2 was left in place. The new label identified the IE as being < 2 cal/cm^2. After finding so many other instances of negligence I did not believe the current label. Review of the model proved the hazard to be much greater.

My ultimate request is that wording be added directing users to apply labels which correctly identify electrical hazards on the correct equipment. When I sought clarification from the NFPA 70E representative I was ultimately told "no code says you have to do things right". It says hazards must be identified and also what content is required on the labels. It does not say the correct label has to be placed on a device. I hope this rarely comes into play but feel it is important enough to address.

Finally, please consider somehow commenting on labels from previous studies. I feel the best practice is to remove or cover them up. I feel a devices hazards (as most recently identified) shall be marked and no other similar information left visible. This will result in confusion, unnecessary time, and/or improper selection of PPE.

Related Item

- PI

Submitter Information Verification

Submitter Full Name:	Jason Moore
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Submittal Date:	Mon May 09 10:41:09 EDT 2022
Committee:	EEW-AAA

Public Comment No. 174-NFPA 70E-2022 [Section No. 130.7(C)]

(C) Personal Protective Equipment (PPE).

(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 capacitive test instrument(s) 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.

(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.

(2) Movement and Visibility.

When arc-rated clothing is worn to protect an employee, it shall cover all ignitible clothing and shall allow for movement and visibility.

(3) Head, Face, Neck, and Chin (Head Area) Protection.

Employees shall wear nonconductive head protection wherever there is a danger of head injury from electric shock or burns due to contact with energized electrical conductors or circuit parts or from flying objects resulting from electrical explosion. Employees shall wear nonconductive protective equipment for the face, neck, and chin whenever there is a danger of injury from exposure to electric arcs or flashes or from flying objects resulting from electrical explosion. If employees use hairnets or beard nets, or both, these items shall be arc rated.

Informational Note: See 130.7(C)(10)(b) and (C)(10(c) for arc flash protective requirements.

(4) Eye Protection.

Employees shall wear protective equipment for the eyes whenever there is danger of injury from electric arcs, flashes, or from flying objects resulting from electrical explosion.

(5) Hearing Protection.

Employees inside the arc flash boundary shall wear hearing protection.

(6) Body Protection.

Employees shall wear arc-rated clothing wherever there is possible exposure to an electric arc flash above the threshold incident energy level for a second degree burn [1.2 cal/cm^2 (5 J/cm^2)].

(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 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 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 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 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.

(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 (EH) footwear can provide a secondary source of electric shock protection under dry conditions.

(9) Factors in Selection of Protective Clothing.

Clothing and equipment that provide worker protection from shock and arc flash hazards shall be used. If arc-rated clothing is required, it shall cover associated parts of the body as well as all flammable apparel while allowing movement and visibility.

Clothing and equipment required for the degree of exposure shall be permitted to be worn alone or integrated with flammable, nonmelting apparel. Garments that are not arc rated shall not be permitted to be used to increase the arc rating of a garment or of a clothing system.

Informational Note: Protective clothing includes shirts, pants, coveralls, jackets, and parkas worn routinely by workers who, under normal working conditions, are exposed to momentary electric arc and related thermal hazards. Arc-rated rainwear worn in inclement weather is included in this category of clothing.

(a) *Layering.* Nonmelting, flammable fiber garments shall be permitted to be used as underlayers in conjunction with arc-rated garments in a layered system. If nonmelting, flammable fiber garments are used as underlayers, the system arc rating shall be sufficient to prevent breakopen of the innermost arc-rated layer at the expected arc exposure incident energy level to prevent ignition of flammable underlayers. Garments that are not arc rated shall not be permitted to be used to increase the arc rating of a garment or of a clothing system.

Informational Note: A typical layering system might include cotton underwear, a cotton shirt and trouser, and an arc-rated coverall. Specific tasks might call for additional arc-rated layers to achieve the required protection level.

(b) *Outer Layers.* Garments worn as outer layers over arc-rated clothing, such as jackets, high-visibility apparel, or rainwear, shall also be made from arc-rated material. 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.

(c) *Underlayers.* Meltable fibers such as acetate, nylon, polyester, polypropylene, and spandex shall not be permitted in fabric underlayers.

Exception: An incidental amount of elastic used on nonmelting fabric underwear or socks shall be permitted.

Informational Note No. 1: Arc-rated garments (e.g., shirts, trousers, and coveralls) worn as underlayers that neither ignite nor melt and drip in the course of an exposure to electric arc and related thermal hazards generally provide a higher system arc rating than nonmelting, flammable fiber underlayers.

Informational Note No. 2: Arc-rated underwear or undergarments used as underlayers generally provide a higher system arc rating than nonmelting, flammable fiber underwear or undergarments used as underlayers.

(d) *Coverage.* Clothing shall cover potentially exposed areas as completely as possible. Shirt and coverall sleeves shall be fastened at the wrists, shirts shall be tucked into pants, and shirts, coveralls, and jackets shall be closed at the neck.

(e) *Fit.* Tight-fitting clothing shall be avoided. Loose-fitting clothing provides additional thermal insulation because of air spaces. Arc-rated apparel shall fit properly such that it does not interfere with the work task.

(f) *Interference.* The garment selected shall result in the least interference with the task but still provide the necessary protection. The work method, location, and task could influence the protective equipment selected.

(10) Arc Flash Protective Equipment.

(a) *Arc Flash Suits.* Arc flash suit design shall permit easy and rapid removal by the wearer. The entire arc flash suit, including the hood's face shield, shall have an arc rating that is suitable for the arc flash exposure. When exterior air is supplied into the hood, the air hoses and pump housing shall be either covered by arc-rated materials or constructed of nonmelting and nonflammable materials.

(b) *Head Protection.*

(1) An arc-rated hood or an arc-rated balaclava with an arc-rated face shield shall be used when the back of the head is within the arc flash boundary.

(2) An arc-rated hood shall be used when the anticipated incident energy exposure exceeds 12 cal/cm^2 (50.2 J/cm^2).

(c) *Face Protection.* Face shields shall have an arc rating suitable for the arc flash exposure. Face shields with a wrap-around guarding to protect the face, chin, forehead, ears, and neck area shall be used. Face shields without an arc rating shall not be used. Eye protection (safety glasses or goggles) shall always be worn under face shields or hoods.

Informational Note: Face shields made with energy-absorbing formulations that can provide higher levels of protection from the radiant energy of an arc flash are available, but these shields are tinted and can reduce visual acuity and color perception. Additional illumination of the task area might be necessary when these types of arc-protective face shields are used.

(d) *Hand Protection.*

(1) Heavy-duty leather gloves or arc-rated gloves shall be worn where required for arc flash protection.

Informational Note: Heavy-duty leather gloves are made entirely of leather with minimum thickness of 0.03 in. (0.7 mm) and are unlined or lined with nonflammable, nonmelting fabrics. Heavy-duty leather gloves meeting this requirement have been shown to have ATPV values in excess of 10 cal/cm^2 (41.9 J/cm^2).

(2) Where insulating rubber gloves are used for shock protection, protectors shall be worn over the rubber gloves.

Informational Note: The protectors worn over rubber insulating gloves provide additional arc flash protection for the hands for arc flash protection exposure.

(e) *Foot Protection.* Leather footwear or dielectric footwear or both provide some arc flash protection to the feet and shall be used in all exposures greater than 4 cal/cm^2 (16.75 J/cm^2). 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 or the minimum arc rating for the respective arc flash PPE category.

(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*, for information on test methods used to determine the arc rating of fabrics.

(12) Clothing and Other Apparel Not Permitted.

Clothing and other apparel (such as hard hat liners and hair nets) made from materials that do not meet the requirements of 130.7(C)(11) regarding melting or made from materials that do not meet the flammability requirements shall not be permitted to be worn.

Informational Note: Some flame-resistant fabrics, such as non-flame-resistant modacrylic and nondurable flame-retardant treatments of cotton, are not recommended for industrial electrical or utility applications.

Exception No. 1: Nonmelting, flammable (non-arc-rated) materials shall be permitted to be used as underlayers to arc-rated clothing, as described in 130.7(C)(11).

Exception No. 2: Where the work to be performed inside the arc flash boundary exposes the worker to multiple hazards, such as airborne contaminants, and the risk assessment identifies that the level of protection is adequate to address the arc flash hazard, non-arc-rated PPE shall be permitted.

(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: 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: 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.

(14) Standards for PPE.

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

Informational Note No. 1: See Informational Note Table 130.7(C)(14) 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) for requirements on non-arc-rated or flammable fabrics not covered by any of the standards in Informational Note Table 130.7(C)(14).

(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 of a process for conformity assessment to an appropriate product standard.

Informational Note No. 2: 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) 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
	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:	IEC 61482–2

Subject	Document Title	Document Number
	Requirements	
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
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

Subject	Document Title	Document Number
Sleeves — Insulating	Standard Specification for Rubber Insulating Sleeves	ASTM D1051

(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: 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

(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)

Equipment	Arc Flash PPE Category	Arc Flash Boundary
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)
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): 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).

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 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*, 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*, 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.

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 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-rated flash suit hood or arc-rated face shield[b] and arc-rated balaclava

Arc-Flash PPE Category	PPE
	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 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 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 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]

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 protectors provide arc flash protection in addition to shock protection. Higher class rubber insulating gloves with 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.

Additional Proposed Changes

File Name	Description	Approved
CN_24.pdf	70E_CN24_PC174	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 24 appeared in the First Draft Report on First Revisions No. 108.

The Correlating Committee directs the technical committee to revise Informational Note No. 4 in Table 130.7(C)(15)(a) to "See Informative Annex O .2.4. (9)" to comply with Section 2.1.6 of the NEC Style Manual.

Related Item

• First Revision No. 108

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC
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Submittal Date: Thu Jun 02 16:41:25 EDT 2022
Committee: EEW-AAA

Correlating Committee Note No. 24-NFPA 70E-2022 [Section No. 130.7(C)(15)]

Submitter Information Verification

Committee: NEC-AAC

Submittal Date: Thu Jan 20 11:47:00 EST 2022

Committee Statement

Committee Statement: The Correlating Committee directs the technical committee to revise Informational Note No. 4 in Table 130.7(C)(15)(a) to "See Informative Annex O .2.4. (9)" to comply with Section 2.1.6 of the NEC Style Manual.

First Revision No. 108-NFPA 70E-2021 [Section No. 130.7(C)(15)]

Ballot Results

✔ **This item has passed ballot**

12 Eligible Voters
1 Not Returned
11 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.
Gallo, Ernest J.
Hickman, Palmer L.
Holub, Richard A.
Hunter, Dean C.
Kendall, David H.
Kovacik, John R.
Manche, Alan
Porter, Christine T.
Schultheis, Timothy James
Williams, David A.

Public Comment No. 20-NFPA 70E-2022 [Section No. 130.7(C)(6)]

(6) Body Protection.

Employees shall wear arc-rated clothing wherever there is possible exposure to an electric arc flash equal or above the threshold incident energy level for a second degree burn [1.2 cal/cm^2 (5 J/cm^2)].

Additional Proposed Changes

File Name	Description	Approved
NFPA70E_2021_discrepancy_when_to_use_arc_rated_PPE.JPG	NFPA70E 2021 discrepancy when to use arc rated PPE	

Statement of Problem and Substantiation for Public Comment

The comment will resolve the discrepancy between the Table 130.5(G) and 130.7(C)(6)

Since in the Table 130.5(G) the requirement to wear arc rated clothing are defined when energy exposures are equal to 1.2 cal/cm2' (in fact this is the minimum incident energy required to produce a second-degree burn.) while the 130.7 (C)(6) states that "employees shall wear arc rated clothing wherever there is possible exposure to and electric arc above the threshold energy 1.2 cal/cm2.

This discrepancy leaves room for interpretation when to wear arc rated clothing.

Related Item

- No Public Comments are available

Submitter Information Verification

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Submittal Date: Fri Mar 25 10:23:22 EDT 2022

Committee: EEW-AAA

NFPA 70E 2021 Discrepancy when Arc rated PPE is required

130.5 (G)

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

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

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)[c]
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]

130.7 (C) (6)

(6) Body Protection. Employees shall wear arc-rated clothing wherever there is possible exposure to an electric arc flash above the threshold incident energy level for a second degree burn [1.2 cal/cm² (5 J/cm²)].

Public Comment No. 24-NFPA 70E-2022 [New Section after 130.7(C)(7)]

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

Floor matting   If insulating value is suspect

Additional Proposed Changes

File Name	Description	Approved
New_addition_to_Table_130.7_C_7_b_for_rubber_switchboard_matting.docx	Add rubber switchboard floor matting to Table 130.7(C)(7)(b)	

Statement of Problem and Substantiation for Public Comment

Rubber "switchboard" floor matting is commonly used in many installations to help minimize employee exposure to step and touch hazards.
There is no periodic retesting for rubber floor matting per ASTM D178 just like there is none for rubber covers and line hose which are both listed in Table 130.7(C)(7)(b)

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 23-NFPA 70E-2022 [New Section after 130.7(E)]	Rubber floor matting per ASTM D178

Related Item

- PI

Submitter Information Verification

Submitter Full Name: George Cole
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Submittal Date: Mon Mar 28 21:17:31 EDT 2022
Committee: EEW-AAA

2024 NFPA 70E new addition to Table 130.7(C)(7)(b)
George T. Cole

Add the following to **Table 130.7(C)(7)(b), Rubber Insulating Equipment, Maximum Test Intervals**

Rubber Insulating Equipment	When to Test
Floor matting	If insulating value is suspect

Public Comment No. 57-NFPA 70E-2022 [Section No. 130.7(C)(7)]

(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 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 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 protectors, under the following conditions:

(2) There shall be no activity performed that risks cutting or damaging the glove.

(3) The rubber insulating gloves shall be electrically retested before reuse.

(4) 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.

(e) *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).

(f) *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).

(g) *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 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._

(e) *Thermal Hand Protection* . Hand protection shall, unless justified, be worn where there is possible exposure to a thermal electrical hazard. Light-duty leather gloves, heavy-duty leather gloves, or arc-rated leather gloves shall be worn where required for thermal protection. Shock and arc flash PPE provide protection from thermal hazards.

The employer may justify alternative hand protection or proscription of thermal hand protection based on increased exposure to chemical or other hazards.

Informational note 1: Thermal hazards can be present in electrical systems where the limited and restricted approach boundaries are not defined. Specifically, ac and dc systems below their shock threshold voltage with more than 1000 watts of available short circuit power can still expose a worker to a thermal electrical hazard. Thermal hazards are common in batteries where an accidental short circuit could cause thermal burns. Using insulated tools when working around batteries significantly reduces the risk of short circuit, and therefor thermal burns, but does not prevent short circuits caused by things other than the worker's tools. See Article 320 for more information about safety requirements related to batteries and battery rooms.

Informational note 2: Assembly of small lithium-ion batteries is an example where the fire risks associated with an accidental short circuit are much greater than the thermal burn risks to the worker. The manual dexterity lost by warring thermal hand protection can increase the likelihood of a short circuit leading to greater overall risk to the worker.

Statement of Problem and Substantiation for Public Comment

Changes to article 320 (FR-101 and FR-102) identify a thermal hazard but to not identify proper thermal hand protection. This addition simply corrects that oversight.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 60-NFPA 70E-2022 [Section No. 320.3(A)(2)]	

Related Item

• FR-101 • FR-102

Submitter Information Verification

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Submittal Date:	Fri May 27 12:33:47 EDT 2022
Committee:	EEW-AAA

Public Comment No. 6-NFPA 70E-2022 [Section No. 130.7(C)(7)]

(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 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 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 protectors, under the following conditions:

(2) There shall be no activity performed that risks cutting or damaging the glove.

(3) The rubber insulating gloves shall be electrically retested before reuse.

(4) 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.

(e) *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).

(f) *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).

(g) *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 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*
Matting	If insulating value is suspect

*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.

Statement of Problem and Substantiation for Public Comment

The problem is where do I find out when or if there is a testing interval for rubber insulating matting? This would clarify when or if rubber insulating matting (ASTM D178) should be tested.

Related Item

- Rubber Insulating Matting

Submitter Information Verification

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Committee:	EEW-AAA

Public Comment No. 142-NFPA 70E-2022 [Section No. 130.7(C)(10)]

(10) Arc Flash Protective Equipment.

(a) *Arc Flash Suits.* Arc flash suit design shall permit easy and rapid removal by the wearer. The entire arc flash suit, including the hood's face shield, shall have an arc rating that is suitable for the arc flash exposure. When exterior air is supplied into the hood, the air hoses and pump housing shall be either covered by arc-rated materials or constructed of nonmelting and nonflammable materials.

(b) *Head Protection.*

(3) An arc-rated hood or an arc-rated balaclava with an arc-rated face shield shall be used when the back of the head is within the arc flash boundary.

(4) An arc-rated hood shall be used when the anticipated incident energy exposure exceeds 12 cal/cm^2 (50.2 J/cm^2).

(e) *Face Protection.* Face shields shall have an arc rating suitable for the arc flash exposure. Face shields with a wrap-around guarding to protect the face, chin, forehead, ears, and neck area shall be used. Face shields without an arc rating shall not be used. Eye protection (safety glasses or goggles) shall always be worn under face shields or hoods.

Informational Note: Face shields made with energy-absorbing formulations that can provide higher levels of protection from the radiant energy of an arc flash are available, but these shields are tinted and can reduce visual acuity and color perception. Additional illumination of the task area might be necessary when these types of arc-protective face shields are used.

(f) *Hand Protection.*

(7) Heavy-duty leather gloves or arc-rated gloves shall be worn where required for arc flash protection.

Informational Note: Heavy-duty leather gloves are made entirely of leather with minimum thickness of 0.03 in. (0.7 mm) and are unlined or lined with nonflammable, nonmelting fabrics. Heavy-duty leather gloves meeting this requirement have been shown to have ATPV values in excess of 10 cal/cm^2 (41.9 J/cm^2).

(8) Where insulating rubber gloves are used for shock protection, protectors shall be worn over the rubber gloves.

Informational Note: The protectors worn over rubber insulating gloves provide additional arc flash protection for the hands for arc flash protection exposure.

Informational Note 1: Arc rated protectors with an APTV rating worn over rubber insulating gloves provide a greater level of arc flash protection for the hands than offered by standard leather protectors for arc flash protection exposure.

(i) *Foot Protection.* Leather footwear or dielectric footwear or both provide some arc flash protection to the feet and shall be used in all exposures greater than 4 cal/cm^2 (16.75 J/cm^2). 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 or the minimum arc rating for the respective arc flash PPE category.

Statement of Problem and Substantiation for Public Comment

Leather protectors for rubber insulating gloves are now commercially available with an arc rating and an accompanying APTV designation. Therefore a new informational note #1 should be added to article 130.7(F)(8)(d)(2) informing readers that these new products offer greater protection of the hands from arc flash hazards than traditional leather protectors because of the arc rating provides a known level of protection.
My power plant had a significant arc flash incident during April 2021 in a 480 volt MCC that had an incident energy level of approximately 12 cal/cm2 at 18". The electricians were wearing a 40 cal/cm2 arc flash suit and hood to protect their body. However they were wearing class 0 rubber insulating gloves with a new arc rated leather protectors with an APTV of 36 cal/cm2. When the arc flash occured, the hands of the electricians were directly next to the arc source and well within the working distance. While the AR leather protector suffered a great deal of heat damage, no part of the protector suffered breakopen nor did the threads of the fingers fail. When the protector was turned inside out, there was no visible sign of heat transfer to the interior portion and the rubber glove fingers were totally unaffected by the heat, consequently the worker did not even suffer a first degree burn.

Related Item

- PI

Submitter Information Verification

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Committee:	EEW-AAA

Public Comment No. 38-NFPA 70E-2022 [Section No. 130.7(C)(10)]

(10) Arc Flash Protective Equipment.

(a) *Arc Flash Suits.* Arc flash suit design shall permit easy and rapid removal by the wearer. The entire arc flash suit, including the hood's face shield, shall have an arc rating that is suitable for the arc flash exposure. When exterior air is supplied into the hood, the air hoses and pump housing shall be either covered by arc-rated materials or constructed of nonmelting and nonflammable materials.

(b) *Head Protection.*

(1) An arc-rated hood or an arc-rated balaclava with an arc-rated face shield shall be used when the back of the head is within the arc flash boundary.

(2) An arc-rated hood shall be used when the anticipated incident energy exposure exceeds 12 cal/cm^2 (50.2 J/cm^2).

(c) *Face Protection.* Face shields shall have an arc rating suitable for the arc flash exposure. Face shields with a wrap-around guarding to protect the face, chin, forehead, ears, and neck area shall be used. Face shields without an arc rating shall not be used. Eye protection (safety glasses or goggles) shall always be worn under face shields or hoods.

Informational Note: Face shields made with energy-absorbing formulations that can provide higher levels of protection from the radiant energy of an arc flash are available, but these shields are tinted and can reduce visual acuity and color perception. Additional illumination of the task area might be necessary when these types of arc-protective face shields are used.

(d) *Hand Protection.*

(1) Heavy-duty leather gloves or arc-rated gloves shall be worn where required for arc flash protection.

Informational Note: Heavy-duty leather gloves are made entirely of leather with minimum thickness of 0.03 in. (0.7 mm) and are unlined or lined with nonflammable, nonmelting fabrics. Heavy-duty leather gloves meeting this requirement have been shown to have ATPV values in excess of 10 cal/cm^2 (41.9 J/cm^2).

(2) Where insulating rubber gloves are used for shock protection, protectors shall be worn over the rubber gloves.

Informational Note: The protectors worn over rubber insulating gloves provide additional arc flash protection for the hands for arc flash protection exposure.

(e) *Foot Protection.* Leather footwear or dielectric footwear or both provide some arc flash protection to the feet and shall be used in all exposures greater than 4 cal/cm^2 (16.75 J/cm^2). 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 or the minimum arc rating for the respective arc flash PPE category.

Statement of Problem and Substantiation for Public Comment

Confusion in regards to the required "leather footwear" protection could be resolved somehow?

Firstly, Table 130.5(G)'s Incident energy exposures equal to 1.2 cal/cm2 up to and including 12cal/cm2 is calling for Leather footwear d, that is this table 130.5(G) instructing me, the user to select leather footwear for a ≥ 1.2 cal/cm2 hazard exposure.

Then, 130.7(C) PPE (10) Arc Flash Protective Equipment (e) Foot Protection., states, Leather footwear or dielectric footwear or both provide some arc flash protection to the feet and shall be used in all exposures greater than 4 cal/cm2.

And there is Table 130.7(C)(15)(c) PPE, Arc-Flash PPE Category 1, it has Leather footwear e (AN) as needed or optional. Here, should I understand this "as needed" or "optional" to include just the minimum of 4 cal/cm2 and then any value greater than four, such as 4.1 cal/cm2 and up would require Leather footwear as per 130.7(C)(10)(e), is this interpretation correct, is that what the AN notation is for, only 4 cal/cm2? If this is the case why doesn't Table 130.5(G) include an AN with it's Leather footwear with a AN notation?

Anyhow I feel as if I'm missing something here in my interpretation thereof these combined items and would like to see more clarification and or to see this simplified for end users such as myself? If I have totally missed something here, I do apologize for wasting your time, thank you?

Related Item

• Leather Footwear

Submitter Information Verification

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Committee:	EEW-AAA

Public Comment No. 107-NFPA 70E-2022 [Section No. 130.7(C)(14)]

(14) Standards for PPE.

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

Informational Note No. 1: See Informational Note Table 130.7(C)(14) 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) for requirements on non-arc-rated or flammable fabrics not covered by any of the standards in Informational Note Table 130.7(C)(14).

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

(3) Self-declaration with a Supplier's Declaration of Conformity

(4) Self-declaration under a registered quality management system and product testing by an accredited laboratory and a Supplier's Declaration of Conformity

(5) 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 of a process for conformity assessment to an appropriate product standard.

Informational Note No. 2: 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.

(f) *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:

(7) Name of manufacturer

(8) Product performance standards to which the product conforms

(9) Arc rating where appropriate for the equipment

(10) One or more identifiers such as model, serial number, lot number, or traceability code

(11) Care instructions

~~Table Informational~~ Informational Note Table 130.7(C)(14) 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
	-	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

Subject	Document Title	Document Number
	- 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
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

Subject	Document Title	Document Number
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

Statement of Problem and Substantiation for Public Comment

Terra View error. The only change is to the table title. "Table" is deleted so that the title of the table becomes "Informational Note Table 130.7(C)(14) Standards for PPE" to simplify the table name and to match Informational Note 1 in 130.7(C)(14)(a). The current title of "Table Informational Note Table 130.7(C)(14)" is awkward.

Related Item

- FR-68

Submitter Information Verification

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Public Comment No. 3-NFPA 70E-2022 [New Section after 130.7(C)(15)]

TITLE OF NEW CONTENT

In the table 130.7 (C)(15)(a) Arc-Flash PPE Categories for Alternating Current (ac) System

I would request the team to include the Bolted fault current of 120kA (Range) under Low Voltage which is not defined in the current NFPA 70E 2021.

Also, 120kA range is not defined in IEEE 1584-2018 as well, but some of the systems exist in the market having voltage range of 690V/800V - 120kA/150kA Interrupting capacity.

Example - SIEMENS Fuse - 3NC3242-6U

Where we need to define the Incident energy (PPE Category) and Arc-flash boundary

Statement of Problem and Substantiation for Public Comment

This will include the column for rating of switchgear exist in the market 690/800V - 120/150 kA (Attached)

Related Item

-

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Public Comment No. 51-NFPA 70E-2022 [Section No. 130.7(C)(15)]

(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: 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:

(2) <u>Power systems with greater than the estimated maximum available fault current</u>

(3) <u>Power systems with longer than the maximum fault clearing times</u>

(4) <u>Less than the minimum working distance</u>

(e) *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:

(6) <u>Power systems with greater than the estimated maximum available fault current</u>

(7) <u>Power systems with longer than the maximum arc duration</u>

(8) <u>Less than the minimum working distance</u>

(i) *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

<u>Equipment</u>	**<u>Arc Flash PPE Category</u>**	**<u>Arc Flash Boundary</u>**	
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	-	-	

Equipment	Arc Flash PPE Category	Arc Flash Boundary	
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)	
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.)	-	-	

Equipment	Arc Flash PPE Category	Arc Flash Boundary
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): 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).

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 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*, 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*, 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.

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] and arc-rated balaclava 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 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 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 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-Flash PPE Category	PPE	
	Arc-rated arc flash suit pants (AR)	
	-	Arc-rated arc flash suit hood
	-	Arc-rated gloves or rubber insulating gloves with 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]

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 protectors provide arc flash protection in addition to shock protection. Higher class rubber insulating gloves with 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.

Statement of Problem and Substantiation for Public Comment

As stated in the reason for not requiring the arc-rated balaclava using the PPE Category Method, the arc flash boundary is 19" and therefore the balaclava would not be required.

In keeping with the spirit of electrical safety and safe guarding all employees from the hazards of electricity, the working distance is 18". If the arc-flash boundary is 19", technically a person is in the arc flash boundary and would need all the protection afforded by PPE. Even using the PPE Category Method, there is the possibility that a person would lean forward to attach an amp-clamp, for instance. This would bring the person completely inside the arc-flash boundary and would require the arc-rated balaclava.

As stated in the original PI, not using the PPE Category Method would require the use of an arc-rated balaclava. Let it be added to the Table. It is about safety. It is about not having to decide to wear it or not.

Related Item

- Public Input No. 46-NFPA 70E-2021 [Section No. 130.7(C)(15)]

Submitter Information Verification

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Committee: EEW-AAA

Public Comment No. 7-NFPA 70E-2022 [Section No. 130.7(C)(15)]

(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: 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:

(2) Power systems with greater than the estimated maximum available fault current

(3) Power systems with longer than the maximum fault clearing times

(4) Less than the minimum working distance

(e) *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:

(6) Power systems with greater than the estimated maximum available fault current

(7) Power systems with longer than the maximum arc duration

(8) Less than the minimum working distance

(i) *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	-	-	

Equipment	Arc Flash PPE Category	Arc Flash Boundary	
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)	
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.)	-	-	

Equipment	Arc Flash PPE Category	Arc Flash Boundary
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): 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).

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 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*, 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*, 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.

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-rated arc flash suit ~~hood~~ 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 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 arc 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 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 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-Flash PPE Category	PPE	
	Arc-rated arc flash suit pants (AR)	
	-	Arc-rated arc flash suit hood
	-	Arc-rated gloves or rubber insulating gloves with 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]

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 protectors provide arc flash protection in addition to shock protection. Higher class rubber insulating gloves with 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.

Statement of Problem and Substantiation for Public Comment

It would standardize the nomenclature and eliminate any possible confusion, currently there are three different terms utilized with Table 130.7(C)(15)(c) PPE, Category 1; "arc flash suit hood", Category 2; "Arc-rated flash suit hood" and Categories; 3 & 4 "Arc-rated arc flash suit hood".

Furthermore in 130.7(C)(10)(b)(1 & 2) it's a "arc-rated hood"

Related Item

• Arc-rated arc flash suit hood

Submitter Information Verification

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Submittal Date:	Mon Mar 07 13:21:17 EST 2022
Committee:	EEW-AAA

Public Comment No. 175-NFPA 70E-2022 [Section No. 130.7(D)]

(D) Other Protective Equipment.

(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: 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: See Table Table 130.7(E), Informational Note for a list of standards that contain information on portable ladders.

(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: See Informational Note Table 130.7(E) 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: See Informational Note Table 130.7(E) 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.

Additional Proposed Changes

File Name	Description	Approved
CN_25.pdf	70E_CN25_PC175	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 25 appeared in the First Draft Report on First Revisions No. 69.

The Correlating Committee directs the technical committee to review the standard ASTM F711 referenced in (3)(d) informational note, and how that relates to further information concerning electrical codes and standards dealing with installation requirements. The standard referenced in the informational note to (d) does not appear related to an installation code or standard so that phrase should be deleted.

Related Item

- First Revision No. 69

Submitter Information Verification

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Submittal Date: Thu Jun 02 16:43:09 EDT 2022
Committee: EEW-AAA

Correlating Committee Note No. 25-NFPA 70E-2022 [Section No. 130.7(D)(1)]

Submitter Information Verification

Committee: NEC-AAC

Submittal Date: Thu Jan 20 11:48:15 EST 2022

Committee Statement

Committee Statement: The Correlating Committee directs the technical committee to review the standard ASTM F711 referenced in (3)(d) informational note, and how that relates to further information concerning electrical codes and standards dealing with installation requirements. The standard referenced in the informational note to (d) does not appear related to an installation code or standard so that phrase should be deleted.

First Revision No. 69-NFPA 70E-2021 [Section No. 130.7(D)(1)]

Ballot Results

✔ **This item has passed ballot**

12 Eligible Voters
1 Not Returned
11 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.
Gallo, Ernest J.
Hickman, Palmer L.
Holub, Richard A.
Hunter, Dean C.
Kendall, David H.
Kovacik, John R.
Manche, Alan
Porter, Christine T.
Schultheis, Timothy James
Williams, David A.

Public Comment No. 23-NFPA 70E-2022 [New Section after 130.7(E)]

Table 130.7(G) Informational Note: Standards on Other Protective Equipment

Add the following two ASTM standards to Table 130.7(G)

1. Rubber Floor Matting   Standard Specification for Rubber Insulating Matting   ASTM D178

2. Temporary Protective Grounds – EPZ Bonding Mats   Standard Specification for Temporary Protective Equipotential Bond Mat To Be Used on De-Energized Equipment   ASTM F2715

Additional Proposed Changes

File Name	Description	Approved
New_addition_to_Table_130.7_G_for_ASTM_F2715_and_ASTM_D178.docx	Add ASTM F2715 and ASTM D178 to Table 130.7(G)	

Statement of Problem and Substantiation for Public Comment

Including two additional ASTM standards (ASTM F2715 and ASTM D178) to Table 130.7(G) will help the users of 70E to find the associated standards quickly and easily for commonly used electrical safety other protective equipment.
Rubber "Switchboard matting" per ASTM D178 and Equipotential conductive mats per ASTM F2715 are now commonly used by many companies.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 24-NFPA 70E-2022 [New Section after 130.7(C)(7)]	

Related Item

• PI

Submitter Information Verification

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Committee: EEW-AAA

2024 NFPA 70E new additions to Table 130.7(G)
George T. Cole

Add the following two ASTM standards to Table 130.7(G)

Subject	Document	Document Number
Rubber Floor Matting	Standard Specification for Rubber Insulating Matting	ASTM D178
Temporary Protective Grounds – EPZ Bonding Mats	Standard Specification for Temporary Protective Equipotential Bond Mat To Be Used on De-Energized Equipment	ASTM F2715

Public Comment No. 109-NFPA 70E-2022 [Section No. 130.7(E)]

(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.

Informational Note: See Informational Note Table 130.7(E) for a list of examples of standards that contain information on other protective equipment.

~~Table Informational~~ 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 —	ANSI/ASC A14.5

Subject	Document	Document Number	
		Safety Requirements	
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	
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	

Statement of Problem and Substantiation for Public Comment

The only change is to the table title. "Table" is deleted so that the title of the table becomes "Informational Note Table 130.7(E) Standards for Other Protective Equipment " to simply the table name and to match Informational Note in 130.7(E). The current title of "Table Informational Note Table 130.7(E) Standards for Other Protective Equipment " is awkward.

Related Item

- FR-73

Submitter Information Verification

Submitter Full Name: Louis Barrios

Organization: Shell Global Solutions

Affiliation: API

Street Address:
City:
State:
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Submittal Date: Mon May 30 11:27:22 EDT 2022
Committee: EEW-AAA

Public Comment No. 22-NFPA 70E-2022 [New Section after 130.8(P)]

130.8 (A) CURRENT TRANSFORMERS

130.8(Q) *Current Transformers.* The secondary side of current transformers shall not be open circuited while the transformer's primary side is energized. If the current transformer's primary side cannot be deenergized, then the secondary circuit shall be bridged or shorted to prevent the secondary terminals from experiencing a dangerous open-circuit condition before employees are permitted to perform work on any part of the current transformer.

Additional Proposed Changes

File Name	Description	Approved
New_Article_130.8_Q_Current_Transformers_03-28-2022.docx	New section 130.8(A) Current Transformers safety practices	

Statement of Problem and Substantiation for Public Comment

Current Transformers (CTs) are very common devices in industrial plants and facilities and are used for countless of different applications, such as SCADA, metering, load controllers, protective relaying, etc. However as useful as CTs are in today's electrical equipment, they pose a significant electric shock risk to employees if the secondary side is open circuited while the primary side is still energized, especially if current is flowing.
CT safety is addressed by OSHA regulations for electric generation, transmission and distribution sectors via 29CFR 1910.269(w)(2) subpart R and 1926.967(b) subpart V however the parallel OSHA standards for electric utilization equipment per 1910 subpart S and 1926 subpart K, does not contain any instructions for CT safety.
If the secondary side of a CT is open circuited by removing its burden while the primary is energized, very high hazardous voltages will develop at the secondary terminals and leads which can quickly exceed the insulation rating of the leads which poses an extremely dangerous electric shock risks to employees.
There are countless articles by reputable organizations and authors that validate this position. The following is just one of them.
https://voltage-disturbance.com/power-engineering/open-circuit-current-transformer-characteristics/

Related Item

- PI

Submitter Information Verification

Submitter Full Name: George Cole
Organization: PVNGS/APS
Street Address:
City:
State:
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Submittal Date: Mon Mar 28 20:01:19 EDT 2022
Committee: EEW-AAA

2024 NFPA 70E New Article 130.8(A) *"Current Transformers"*
George T. Cole

130.8(Q) *Current Transformers.* The secondary side of current transformers shall not be open circuited while the transformer's primary side is energized. If the current transformer's primary side cannot be deenergized, then the secondary circuit shall be bridged or shorted to prevent the secondary terminals from experiencing a dangerous open-circuit condition before employees are permitted to perform work on any part of the current transformer.

Public Comment No. 149-NFPA 70E-2022 [Article 205]

Article 205 General Maintenance Requirements

205.1 Scope.

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

205.2 Qualified Persons.

Employees who perform maintenance on electrical equipment and installations shall be qualified persons as required in Chapter 1 and shall be trained in, and familiar with, the specific maintenance procedures and tests required.

205.3 Single-Line Diagram.

A single-line diagram, where provided for the electrical system, shall be maintained in a legible condition and shall be kept current.

205.4 General Maintenance Requirements.

Electrical equipment shall be maintained in accordance with manufacturers' instructions or industry consensus standards to reduce the risk associated with failure. The equipment owner or the owner's designated representative shall be responsible for maintenance of the electrical equipment and documentation.

> Informational Note No. 1: Common industry practice is to apply test or calibration decals to equipment to indicate the test or calibration date and overall condition of equipment that has been tested and maintained in the field. These decals provide the employee immediate indication of last maintenance date and if the tested device or system was found acceptable on the date of test. This local information can assist the employee in the assessment of overall electrical equipment maintenance status.

> Informational Note No. 2: Noncontact diagnostic methods in addition to scheduled maintenance activities of electrical equipment can assist in the identification of electrical anomalies.

205.5 Overcurrent Protective Devices.

Overcurrent protective devices shall be maintained in accordance with the manufacturers' instructions or industry consensus standards. Maintenance, tests, and inspections shall be documented.

205.6 Spaces About Electrical Equipment.

All working space and clearances required by electrical codes and standards shall be maintained.

> Informational Note: See Article 110, Parts II and III, of *NFPA 70*, *National Electrical Code*, for further information concerning spaces about electrical equipment.

205.7 Grounding and Bonding.

Equipment, raceway, cable tray, and enclosure bonding and grounding shall be maintained to ensure electrical continuity.

205.8 Guarding of Energized Conductors and Circuit Parts.

Enclosures shall be maintained to guard against unintentional contact with exposed energized conductors and circuit parts and other electrical hazards. Covers and doors shall be in place with all associated fasteners and latches secured.

205.9 Safety Equipment.

Locks, interlocks, and other safety equipment shall be maintained in proper working condition to accomplish the control purpose.

205.10 Clear Spaces.

Access to working space and escape passages shall be kept clear and unobstructed.

205.11 Identification of Components.

Identification of components, where required, and safety-related instructions (operating or maintenance), if posted, shall be securely attached and maintained in legible condition.

205.12 Warning Signs.

Warning signs, where required, shall be visible, securely attached, and maintained in legible condition.

205.13 Identification of Circuits.

Circuit or voltage identification shall be securely affixed and maintained in updated and legible condition.

205.14 Single and Multiple Conductors and Cables.

Electrical cables and single and multiple conductors shall be maintained free of damage, shorts, and ground that would expose employees to an electrical hazard.

205.15 Flexible Cords and Cables.

Flexible cords and cables shall be maintained to preserve insulation integrity.

(1) Damaged Cords and Cables.

Cords and cables shall not have worn, frayed, or damaged areas that would expose employees to an electrical hazard.

(2) Strain Relief.

Strain relief of cords and cables shall be maintained to prevent pull from being transmitted directly to joints or terminals.

(3) Repair and Replacement.

Cords and cord caps for portable electrical equipment shall be repaired and replaced by qualified personnel and checked for proper polarity, grounding, and continuity prior to returning to service.

205.16 Overhead Line Clearances.

For overhead electric lines under the employer's control, grade elevation shall be maintained to preserve no less than the minimum designed vertical and horizontal clearances necessary to minimize risk of unintentional contact.

Additional Proposed Changes

File Name	Description	Approved
CN_40.pdf	70E_CN40_PC149	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 40 appeared in the First Draft Report on First Revisions No. 92.

The Correlating Committee directs the Technical Committee review the title and scope of the article for clarity and usability. The technical committee is also directed to review the title of Article 205 along with the chapter title for possible conflicts.

Related Item

• First Revision No. 92

Submitter Information Verification

Submitter Full Name:	CC on NEC-AAC
Organization:	NEC Correlating Committee
Street Address:	
City:	
State:	
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Submittal Date:	Thu Jun 02 13:23:16 EDT 2022
Committee:	EEW-AAA

Correlating Committee Note No. 40-NFPA 70E-2022 [Detail]

Submitter Information Verification

Committee: NEC-AAC

Submittal Date: Thu Jan 20 13:02:57 EST 2022

Committee Statement

Committee Statement: The Correlating Committee directs the Technical Committee review the title and scope of the article for clarity and usability. The technical committee is also directed to review the title of Article 205 along with the chapter title for possible conflicts.

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

Ballot Results

This item has passed ballot

12 Eligible Voters
1 Not Returned
11 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.

Gallo, Ernest J.

Hickman, Palmer L.

Holub, Richard A.

Hunter, Dean C.

Kendall, David H.

Kovacik, John R.

Manche, Alan

Porter, Christine T.

Schultheis, Timothy James

Williams, David A.

Public Comment No. 75-NFPA 70E-2022 [Section No. 205.1]

205.1 Scope.

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

Statement of Problem and Substantiation for Public Comment

Changed "practices requirements" to "practices" to align with the other scope statements in Chapter 2.

Related Item

- FR-92

Submitter Information Verification

Submitter Full Name:	Louis Barrios
Organization:	Shell Global Solutions
Affiliation:	API
Street Address:	
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Submittal Date:	Sun May 29 13:18:23 EDT 2022
Committee:	EEW-AAA

Public Comment No. 153-NFPA 70E-2022 [Section No. 210.1]

210.1 Scope.

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

Additional Proposed Changes

File Name	Description	Approved
CN_8.pdf	70E_CN8_PC153	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 8 appeared in the First Draft Report on First Revisions No. 94.

The Correlating Committee advises that article scope statements are the responsibility of the Correlating Committee and directs the technical committee to consider revising the scope statement and remove “specific safety-related maintenance practices for” to match the title of the article.

Related Item

- First Revision No. 94

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC
Organization: NEC Correlating Committee
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jun 02 13:31:09 EDT 2022
Committee: EEW-AAA

Correlating Committee Note No. 8-NFPA 70E-2022 [Detail]

Submitter Information Verification

Committee: NEC-AAC
Submittal Date: Thu Jan 20 10:50:58 EST 2022

Committee Statement

Committee Statement: The Correlating Committee advises that article scope statements are the responsibility of the Correlating Committee and directs the technical committee to consider revising the scope statement and remove "specific safety-related maintenance practices for" to match the title of the article.

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

Ballot Results

✔ **This item has passed ballot**

12 Eligible Voters
1 Not Returned
11 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.
Gallo, Ernest J.
Hickman, Palmer L.
Holub, Richard A.
Hunter, Dean C.
Kendall, David H.
Kovacik, John R.
Manche, Alan
Porter, Christine T.
Schultheis, Timothy James
Williams, David A.

Public Comment No. 147-NFPA 70E-2022 [Article 215]

Article 215 Premises Wiring

215.1 Scope.

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

215.2 Covers for Wiring System Components.

Covers for wiring system components shall be in place with all associated hardware, and there shall be no unprotected openings.

215.3 Open Wiring Protection.

Open wiring protection, such as location or barriers, shall be maintained to prevent unintentional contact.

215.4 Raceways and Cable Trays.

Raceways and cable trays shall be maintained to provide physical protection and support for conductors.

Additional Proposed Changes

File Name	Description	Approved
CN_3.pdf	70E_CN3_PC147	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 3 appeared in the First Draft Report on First Revisions No. 113.

The Correlating Committee advises that article scope statements are the responsibility of the Correlating Committee and directs the technical committee to consider removing “specific" per 200.1(2) and the need to restate the title of Chapter 2 in the scope.

Related Item

- First Revision No. 113

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC
Organization: NEC Correlating Committee
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jun 02 13:19:09 EDT 2022
Committee: EEW-AAA

Correlating Committee Note No. 3-NFPA 70E-2022 [Detail]

Submitter Information Verification

Committee: NEC-AAC

Submittal Date: Thu Jan 20 10:30:16 EST 2022

Committee Statement

Committee Statement: The Correlating Committee advises that article scope statements are the responsibility of the Correlating Committee and directs the technical committee to consider removing “specific" per 200.1(2) and the need to restate the title of Chapter 2 in the scope.

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

Ballot Results

✔ **This item has passed ballot**

12 Eligible Voters
1 Not Returned
11 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.
Gallo, Ernest J.
Hickman, Palmer L.
Holub, Richard A.
Hunter, Dean C.
Kendall, David H.
Kovacik, John R.
Manche, Alan
Porter, Christine T.
Schultheis, Timothy James
Williams, David A.

Public Comment No. 176-NFPA 70E-2022 [Section No. 220.1]

220.1 Scope.

This article covers specific safety-related maintenance practices for controllers, 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.

Additional Proposed Changes

File Name	Description	Approved
CN_26.pdf	70E_CN26_PC176	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 26 appeared in the First Draft Report on First Revisions No. 95.

The Correlating Committee advises that article scope statements are the responsibility of the Correlating Committee and directs the technical committee to consider revising the scope statement and remove "specific safety-related maintenance practices for" to match the title of the article.

Related Item

- First Revision No. 95

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC
Organization: NEC Correlating Committee
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jun 02 16:44:45 EDT 2022
Committee: EEW-AAA

Correlating Committee Note No. 26-NFPA 70E-2022 [Section No. 220.1]

Submitter Information Verification

Committee: NEC-AAC
Submittal Date: Thu Jan 20 12:12:22 EST 2022

Committee Statement

Committee Statement: The Correlating Committee advises that article scope statements are the responsibility of the Correlating Committee and directs the technical committee to consider revising the scope statement and remove “specific safety-related maintenance practices for” to match the title of the article.

First Revision No. 95-NFPA 70E-2021 [Section No. 220.1]

Ballot Results

This item has passed ballot

12 Eligible Voters
1 Not Returned
11 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.
Gallo, Ernest J.
Hickman, Palmer L.
Holub, Richard A.
Hunter, Dean C.
Kendall, David H.
Kovacik, John R.
Manche, Alan
Porter, Christine T.
Schultheis, Timothy James
Williams, David A.

Public Comment No. 154-NFPA 70E-2022 [Section No. 225.1]

225.1 Scope.

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

Additional Proposed Changes

File Name	Description	Approved
CN_9.pdf	70E_CN9_PC154	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 9 appeared in the First Draft Report on First Revisions No. 96.

The Correlating Committee advises that article scope statements are the responsibility of the Correlating Committee and directs the technical committee to consider removing "specific" per 200.1(2) and the need to restate the title of Chapter 2 in the scope.

Related Item

- First Revision No. 96

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC
Organization: NEC Correlating Committee
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jun 02 13:32:52 EDT 2022
Committee: EEW-AAA

Correlating Committee Note No. 9-NFPA 70E-2022 [Detail]

Submitter Information Verification

Committee: NEC-AAC
Submittal Date: Thu Jan 20 10:51:47 EST 2022

Committee Statement

Committee Statement: The Correlating Committee advises that article scope statements are the responsibility of the Correlating Committee and directs the technical committee to consider removing "specific" per 200.1(2) and the need to restate the title of Chapter 2 in the scope.

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

Ballot Results

✔ **This item has passed ballot**

12 Eligible Voters
1 Not Returned
11 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.
Gallo, Ernest J.
Hickman, Palmer L.
Holub, Richard A.
Hunter, Dean C.
Kendall, David H.
Kovacik, John R.
Manche, Alan
Porter, Christine T.
Schultheis, Timothy James
Williams, David A.

Public Comment No. 148-NFPA 70E-2022 [Article 230]

Article 230 Rotating Equipment

230.1 Scope.

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

230.2 Terminal Boxes.

Terminal chambers, enclosures, and terminal boxes shall be maintained to guard against unintentional contact with exposed energized conductors and circuit parts and other electrical hazards.

230.3 Guards, Barriers, and Access Plates.

Guards, barriers, and access plates shall be maintained to prevent employees from contacting moving or energized parts.

Additional Proposed Changes

File Name	Description	Approved
CN_4.pdf	70E_CN4_PC148	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 4 appeared in the First Draft Report on First Revisions No. 114.

The Correlating Committee advises that article scope statements are the responsibility of the Correlating Committee and directs the technical committee to consider removing “specific" per 200.1(2) and the need to restate the title of Chapter 2 in the scope.

Related Item

- First Revision No. 114

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC
Organization: NEC Correlating Committee
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City:
State:
Zip:
Submittal Date: Thu Jun 02 13:21:13 EDT 2022
Committee: EEW-AAA

Correlating Committee Note No. 4-NFPA 70E-2022 [Detail]

Submitter Information Verification

Committee: NEC-AAC

Submittal Date: Thu Jan 20 10:31:16 EST 2022

Committee Statement

Committee Statement: The Correlating Committee advises that article scope statements are the responsibility of the Correlating Committee and directs the technical committee to consider removing “specific" per 200.1(2) and the need to restate the title of Chapter 2 in the scope.

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

Ballot Results

This item has passed ballot

12 Eligible Voters
1 Not Returned
11 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.

Gallo, Ernest J.

Hickman, Palmer L.

Holub, Richard A.

Hunter, Dean C.

Kendall, David H.

Kovacik, John R.

Manche, Alan

Porter, Christine T.

Schultheis, Timothy James

Williams, David A.

Public Comment No. 177-NFPA 70E-2022 [Section No. 235.1]

235.1 Scope.

This article covers specific safety-related maintenance 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.

Additional Proposed Changes

File Name	Description	Approved
CN_27.pdf	70E_CN27_PC177	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 27 appeared in the First Draft Report on First Revisions No. 97.

The Correlating Committee advises that article scope statements are the responsibility of the Correlating Committee and directs the technical committee to consider revising the scope statement and remove “specific safety-related maintenance practices for” to match the title of the article.

Related Item

- First Revision No. 97

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC
Organization: NEC Correlating Committee
Street Address:
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Submittal Date: Thu Jun 02 16:46:07 EDT 2022
Committee: EEW-AAA

Correlating Committee Note No. 27-NFPA 70E-2022 [Section No. 235.1]

Submitter Information Verification

Committee: NEC-AAC

Submittal Date: Thu Jan 20 12:13:02 EST 2022

Committee Statement

Committee Statement: The Correlating Committee advises that article scope statements are the responsibility of the Correlating Committee and directs the technical committee to consider revising the scope statement and remove “specific safety-related maintenance practices for” to match the title of the article.

First Revision No. 97-NFPA 70E-2021 [Section No. 235.1]

Ballot Results

This item has passed ballot

12 Eligible Voters
1 Not Returned
11 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.
Gallo, Ernest J.
Hickman, Palmer L.
Holub, Richard A.
Hunter, Dean C.
Kendall, David H.
Kovacik, John R.
Manche, Alan
Porter, Christine T.
Schultheis, Timothy James
Williams, David A.

Public Comment No. 150-NFPA 70E-2022 [Article 240]

Article 240 Batteries and Battery Rooms

240.1 Scope.

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

240.2 Ventilation.

When forced or natural ventilation systems are required by the battery system design and are present, they shall be examined and maintained to prevent buildup of explosive mixtures. This maintenance shall include a functional test of any associated detection and alarm systems.

> Informational Note: “Natural ventilation” implies there are no mechanical mechanisms. Maintenance includes activities such as inspection and removal of any obstructions to natural air flow.

240.3 Eye and Body Wash Apparatus.

Eye and body wash apparatus shall be maintained in operable condition.

Additional Proposed Changes

File Name	Description	Approved
CN_5.pdf	70E_CN5_PC150	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 5 appeared in the First Draft Report on First Revisions No. 116.

The Correlating Committee advises that article scope statements are the responsibility of the Correlating Committee and directs the technical committee to consider removing “specific" per 200.1(2) and the need to restate the title of Chapter 2 in the scope.

Related Item

- First Revision No. 116

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC
Organization: NEC Correlating Committee
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jun 02 13:26:06 EDT 2022
Committee: EEW-AAA

Correlating Committee Note No. 5-NFPA 70E-2022 [Detail]

Submitter Information Verification

Committee: NEC-AAC

Submittal Date: Thu Jan 20 10:32:04 EST 2022

Committee Statement

Committee Statement: The Correlating Committee advises that article scope statements are the responsibility of the Correlating Committee and directs the technical committee to consider removing “specific" per 200.1(2) and the need to restate the title of Chapter 2 in the scope.

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

Ballot Results

✔ **This item has passed ballot**

12 Eligible Voters
1 Not Returned
11 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.
Gallo, Ernest J.
Hickman, Palmer L.
Holub, Richard A.
Hunter, Dean C.
Kendall, David H.
Kovacik, John R.
Manche, Alan
Porter, Christine T.
Schultheis, Timothy James
Williams, David A.

Public Comment No. 151-NFPA 70E-2022 [Article 245]

Article 245 Portable Electric Tools and Equipment

245.1 Scope.

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

245.2 Maintenance Requirements for Portable Electric Tools and Equipment.

Attachment plugs, receptacles, cover plates, and cord connectors shall be maintained such that the following criteria are met:

(1) There are no breaks, damage, or cracks exposing energized conductors and circuit parts.

(2) There are no missing cover plates.

(3) Terminations have no stray strands or loose terminals.

(4) There are no missing, loose, altered, or damaged blades, pins, or contacts.

(5) Polarity is correct.

Additional Proposed Changes

File Name	Description	Approved
CN_6.pdf	70E_CN6_PC151	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 6 appeared in the First Draft Report on First Revisions No. 117.

The Correlating Committee advises that article scope statements are the responsibility of the Correlating Committee and directs the technical committee to consider removing “specific" per 200.1(2) and the need to restate the title of Chapter 2 in the scope.

Related Item

• First Revision No. 117

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC
Organization: NEC Correlating Committee
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jun 02 13:27:47 EDT 2022
Committee: EEW-AAA

Correlating Committee Note No. 6-NFPA 70E-2022 [Detail]

Submitter Information Verification

Committee: NEC-AAC
Submittal Date: Thu Jan 20 10:33:27 EST 2022

Committee Statement

Committee Statement: The Correlating Committee advises that article scope statements are the responsibility of the Correlating Committee and directs the technical committee to consider removing “specific" per 200.1(2) and the need to restate the title of Chapter 2 in the scope.

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

Ballot Results

✔ **This item has passed ballot**

12 Eligible Voters
1 Not Returned
11 Affirmative All
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0 Negative with Comments
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Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.
Gallo, Ernest J.
Hickman, Palmer L.
Holub, Richard A.
Hunter, Dean C.
Kendall, David H.
Kovacik, John R.
Manche, Alan
Porter, Christine T.
Schultheis, Timothy James
Williams, David A.

Public Comment No. 152-NFPA 70E-2022 [Article 250]

Article 250 Personal Safety and Protective Equipment

250.1 Scope.

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

250.2 Maintenance Requirements for Personal Safety and Protective Equipment.

Personal safety and protective equipment such as the following shall be maintained in a safe working condition:

(1) Grounding equipment

(2) Hot sticks

(3) Rubber gloves, sleeves, and protectors

(4) Test instruments

(5) Blanket and similar insulating equipment

(6) Insulating mats and similar insulating equipment

(7) Protective barriers

(8) External circuit breaker rack-out devices

(9) Portable lighting units

(10) Temporary protective grounding equipment

(11) Dielectric footwear

(12) Protective clothing

(13) Bypass jumpers

(14) Insulated and insulating hand tools

250.3 Inspection and Testing of Protective Equipment and Protective Tools.

(A) Visual.

Safety and protective equipment and protective tools shall be visually inspected for damage and defects before initial use and at intervals thereafter, as service conditions require, but in no case shall the interval exceed 1 year, unless specified otherwise by the applicable state, federal, or local codes and standards.

(B) Testing.

The insulation of protective equipment and protective tools, such as items specified in 250.2(1) through 250.2(14), that is used as primary protection from shock hazards and requires an insulation system to ensure protection of personnel, shall be verified by the appropriate test and visual inspection to ascertain that insulating capability has been retained before initial use, and at intervals thereafter, as service conditions and applicable standards and instructions require, but in no case shall the interval exceed 3 years.

250.4 Safety Grounding Equipment.

(A) Inspection.

Personal protective ground cable sets shall be inspected for cuts in the protective sheath and damage to the conductors. Clamps and connector strain relief devices shall be checked for tightness. These inspections shall be made at intervals thereafter as service conditions require, but in no case shall the interval exceed 1 year.

(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: 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.

(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: 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.

250.5 Test Instruments.

Test instruments and associated test leads used to verify the absence or presence of voltage shall be maintained to assure functional integrity. The maintenance program shall include functional verification as described in 110.6(E).

Additional Proposed Changes

File Name	Description	Approved
CN_7.pdf	70E_CN7_PC152	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 7 appeared in the First Draft Report on First Revisions No. 118.

The Correlating Committee advises that article scope statements are the responsibility of the Correlating Committee and directs the technical committee to consider removing “specific" per 200.1(2) and the need to restate the title of Chapter 2 in the scope.

Related Item

- First Revision No. 118

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC
Organization: NEC Correlating Committee
Street Address:
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State:
Zip:
Submittal Date: Thu Jun 02 13:29:20 EDT 2022
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Submitter Information Verification

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Ballot Results

✔ **This item has passed ballot**

12 Eligible Voters
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11 Affirmative All
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Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.
Gallo, Ernest J.
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Holub, Richard A.
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Kendall, David H.
Kovacik, John R.
Manche, Alan
Porter, Christine T.
Schultheis, Timothy James
Williams, David A.

Public Comment No. 54-NFPA 70E-2022 [Section No. 250.2]

250.2 Maintenance Requirements for Personal Safety and Protective Equipment.

Personal safety and protective equipment such as the following shall be maintained in a safe working condition:

(1) Grounding equipment

(2) Hot sticks (Live-Line-Tools)

(3) Rubber gloves, sleeves, and protectors

(4) Test instruments

(5) Blanket and similar insulating equipment

(6) Insulating mats and similar insulating equipment

(7) Protective barriers

(8) External circuit breaker rack-out devices

(9) Portable lighting units

(10) Temporary protective grounding equipment

(11) Dielectric footwear

(12) Protective clothing

(13) Bypass jumpers

(14) Insulated and insulating hand tools

Statement of Problem and Substantiation for Public Comment

"Hotsticks" is a slang used by electricians and linemen the correct technical term is "Live-Line-Tools" which is used throughout NFPA 70E therefore it should be added.

Related Item

• pi

Submitter Information Verification

Submitter Full Name: George Cole
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City:
State:
Zip:
Submittal Date: Tue May 24 14:20:02 EDT 2022
Committee: EEW-AAA

Public Comment No. 178-NFPA 70E-2022 [Section No. 250.4]

250.4 Safety Grounding Equipment.

(A) Inspection.

Personal protective ground cable sets shall be inspected for cuts in the protective sheath and damage to the conductors. Clamps and connector strain relief devices shall be checked for tightness. These inspections shall be made at intervals thereafter as service conditions require, but in no case shall the interval exceed 1 year.

(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: 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.

(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: 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.

Additional Proposed Changes

File Name	Description	Approved
CN_29.pdf	70E_CN29_PC178	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 29 appeared in the First Draft Report on First Revisions No. 119.

The Correlating Committee directs the technical committee to review the term safety grounds in the informational note and in the title of 250.4. The term is not used in the requirement, or the standard being referenced.

Related Item

- First Revision No. 119

Submitter Information Verification

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Organization: NEC Correlating Committee
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State:
Zip:
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Submitter Information Verification

Committee: NEC-AAC

Submittal Date: Thu Jan 20 12:19:43 EST 2022

Committee Statement

Committee Statement: The Correlating Committee directs the technical committee to review the term safety grounds in the informational note and in the title of 250.4. The term is not used in the requirement, or the standard being referenced.

First Revision No. 119-NFPA 70E-2021 [Section No. 250.3(B)]

Ballot Results

✔ **This item has passed ballot**

12 Eligible Voters
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11 Affirmative All
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0 Abstention

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.

Gallo, Ernest J.

Hickman, Palmer L.

Holub, Richard A.

Hunter, Dean C.

Kendall, David H.

Kovacik, John R.

Manche, Alan

Porter, Christine T.

Schultheis, Timothy James

Williams, David A.

Public Comment No. 179-NFPA 70E-2022 [Section No. 250.4(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: 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.

Additional Proposed Changes

File Name	Description	Approved
CN_30.pdf	70E_CN30_PC179	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 30 appeared in the First Draft Report on First Revisions No. 120.

The Correlating Committee directs the technical committee to review the structure of the informational note in respect to the order in which section numbers and the title of the referenced standard are presented.

Related Item

- First Revision No. 120

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State:
Zip:
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Committee: EEW-AAA

Correlating Committee Note No. 30-NFPA 70E-2022 [Section No. 250.3(C)]

Submitter Information Verification

Committee: NEC-AAC

Submittal Date: Thu Jan 20 12:22:15 EST 2022

Committee Statement

Committee Statement: The Correlating Committee directs the technical committee to review the structure of the informational note in respect to the order in which section numbers and the title of the referenced standard are presented.

First Revision No. 120-NFPA 70E-2021 [Section No. 250.3(C)]

Ballot Results

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11 Affirmative All
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McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.
Gallo, Ernest J.
Hickman, Palmer L.
Holub, Richard A.
Hunter, Dean C.
Kendall, David H.
Kovacik, John R.
Manche, Alan
Porter, Christine T.
Schultheis, Timothy James
Williams, David A.

Public Comment No. 128-NFPA 70E-2022 [Chapter 3]

~~Chapter 3~~

Chapter 3 Safety Requirements for Special Equipment

~~Article 300 Introduction~~

ARTICLE 300 Introduction

300.

~~1 Scope~~

1 Scope .

~~Chapter 3 covers~~

Chapter 3 covers special electrical equipment in the workplace , and modifies the general requirements of Chapter 1.

300.

~~2 Responsibility~~

2 Responsibility .

The employer shall provide safety-related work practices and employee training on the material covered in this Chapter, in addition to those in Chapter 1 . The employee shall follow those work practices.

300.

~~3 Organization~~

3 Organization .

~~Chapter 3 of~~

Chapter 3 of this standard is divided into articles. Article

~~300~~

305 applies generally. Article 310 applies to

~~electrolytic cells~~

dc electrical hazards . Article 320 applies to capacitor electrical hazards. Article 330 covers electrical hazards from 1 Hz to 100 MHz, other than 50/60 Hz. Article 350 applies to electrolytic cells. Article 360 applies to batteries and battery rooms.

~~Article 330 applies to lasers. Article 340 applies to power electronic equipment. Article 350 applies to research and development (R&D) laboratories. Article 360 applies to safety-related requirements for capacitors. Article 310 Safety-~~

ARTICLE 305 General Requirements

305.1 Applications of Other Articles.

The special electrical equipment covered by this chapter shall meet the requirements of the remainder of this document, except as amended by this chapter.

> *Informational Note: Examples of these applications covered in this chapter include low-voltage–high-current power systems; high-voltage–low-current power systems; dc power supplies; capacitors; cable trays for signal; and, custom-made electronic equipment. Examples of specialized equipment include energy conversion (ac to dc, dc to ac), energy storage systems, accelerators, all sub RF and RF systems, lasers, medical and laboratory diagnostic equipment, and process equipment using dc and RF (e.g., induction).*

305.2 Electrical Safety Authority (ESA).

A laboratory or specialized industry shall be permitted to assign an ESA to ensure the use of appropriate electrical safety-related work practices and controls covered in this chapter. The ESA shall be permitted to be an electrical safety committee, engineer, or equivalent qualified individual. The ESA shall be permitted to delegate authority to an individual or organization within their control.

305.2(A) Responsibility.

The ESA shall act in a manner similar to an authority having jurisdiction for specialized electrical systems and electrical safe work practices.

305.2(B) Qualifications.

The ESA shall be competent in the following:

(1) The requirements of this standard

(2) Electrical system requirements applicable to the special electrical hazards and equipment covered by this chapter, including nonionizing and ionizing radiation.

305.3 Specific Measures and Controls for Personnel Safety.

Each laboratory or specialized industry shall designate a competent person as defined in this article to ensure the use of appropriate electrical safety-related work practices and controls covered in this article.

305.3(A) Job Briefings.

Job briefings shall be performed in accordance with 110.5(I) .

Exception: Prior to starting work, a brief discussion shall be permitted if the task and hazards are documented and the employee has reviewed applicable documentation and is qualified for the task.

305.3(B) Personnel Protection.

Safety-related work practices shall be used to safeguard employees from injury while they are exposed to electrical hazards from exposed electrical conductors or circuit parts that are or can become energized. The specific safety-related work practices shall be consistent with the electrical hazard(s) and the associated risk. For calibration and adjustment of equipment as it pertains to sensors, motor controllers, control hardware, and other devices that need to be installed inside equipment or control cabinet, surrounded by electrical hazards, the ESA shall define the required PPE based on the risk and exposure.

Use of electrical insulating blankets, covers, or barriers shall be permitted to prevent inadvertent contact to exposed terminals and conductors. Insulated/nonconductive adjustment and alignment tools shall be used where feasible.

305.4 Approval Requirements.

The equipment or systems used in the laboratory or specialized industry shall be listed or field evaluated prior to use.

> *Informational Note: Laboratory and specialized electrical equipment or systems can pose unique electrical hazards that might require mitigation. Such hazards include ac and dc, low voltage and high amperage, high voltage and low current, large electromagnetic fields, induced voltages, pulsed power, multiple frequencies, and similar exposures.*

305.5 Custom Built, Non-Listed Specialized Electrical Equipment, 1000 Volts or less AC or DC.

305.5(A) Equipment Marking and Documentation.

305.5(A)(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 ANSI Z535, Series of Standards for Safety Signs and Tags, for more information on precautionary marking of electrical systems or equipment.*

305.5(A)(2) Documentation.

Sufficient documentation shall be provided and readily available to personnel that install, operate, and maintain equipment that describes operation, shutdown, safety concerns, and nonstandard installations.

Schematics, drawings, and bill of materials describing power feeds, voltages, currents, and parts used for construction, maintenance, and operation of the equipment shall be provided.

305.5(A)(3) Shutdown Procedures.

Safety requirements and emergency shutdown procedures of equipment shall include lockout/tagout (LOTO) requirements. If equipment-specific LOTO is required, then documentation outlining this procedure and PPE requirements shall be made readily available.

305.5(A)(4) Specific Hazards.

Specific hazards, other than electrical, associated with research and specialized electrical equipment shall be documented and readily available.

305.5(A)(5) Approvals.

Drawings, standard operational procedures, and equipment shall be approved by the ESA on site before initial startup. Assembly of equipment shall comply with national standards where applicable unless research or industrial application requires exceptions. Equipment that does not meet the applicable standards shall be required to be approved by the ESA. Proper safety shutdown procedures and PPE requirements shall be considered in the absence of grounding and/or bonding.

305.5(B) Tools, Training, and Maintenance.

Documentation shall be provided if special tools, unusual PPE, or other equipment is necessary for proper maintenance and operation of equipment. The ESA shall make the determination of appropriate training and qualifications required to perform specific tasks.

305.6 Custom Built, Unlisted Electrical Equipment, >1000 V AC or DC.

Installations shall comply with all requirements of 305.5

In the event that specialized electrical equipment requires PPE beyond what is commercially available, the ESA shall determine safe work practices and PPE to be used.

305.7 Establishing an Electrically Safe Work Condition.

Energized electrical conductors and circuit parts shall be put into an electrically safe work condition before an employee performs work.

Exception: At the discretion of the ESA, alternative methods of ensuring worker safety shall be permitted to be employed for the following conditions:

(1) *Minor tool changes and adjustments, and other normal production operations that are routine, repetitive, or sequential and integral to the use of the equipment for production*

(2) *Minor changes to the unit under test and other minor servicing activities, to include the activities listed under 3 05.7 Exception condition (1), that take place during research and development*

(3) *Work on cord-and-plug-connected equipment for which exposure to the hazards of unexpected energization or start up is controlled by the following:*

(4) *Unplugging the equipment from the energy source*

(5) *The employee performing the work maintaining exclusive control of the plug*

ARTICLE 310 DC Electrical Hazards

310.1 Scope.

This article covers the electrical safety-related requirements for the practical safeguarding of employees while working with direct current (dc) that present an electrical hazard.

310.2 DC Electrical Hazard Thresholds

310.2(A) Electrical Thermal Hazard Thresholds

For dc systems, hazardous power is considered greater than or equal to 1000 W.

310.2(B) Electrical Shock Hazard Thresholds.

For dc systems, hazardous voltage is considered greater than or equal to 100 volts dc and 40 mA.

310.2(C) Electrical Arc Flash Hazard Thresholds.

For dc systems, hazardous arc flash is considered for systems greater than or equal to 150 volts dc and 17,000 amps dc.

ARTICLE 320 Capacitor Electrical Hazards

320.1 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: For more information on working safely with capacitors, see Informative Annex R, Working with Capacitors.

320.2 Stored Energy Hazard Thresholds.

Appropriate controls shall be applied where any of the following hazard thresholds are exceeded:

(1) Less than 100 volts and greater than 100 joules of stored energy

(2) Greater than or equal to 100 volts and greater than 1.0 joule of stored energy

(3) Greater than or equal to 400 volts and greater than 0.25 joules of stored energy

320.4 Specific Measures for Personnel Safety.

320.4(A) Qualification and Training.

The following qualifications and training shall be required for personnel safety:

(1) Employees who perform work on electrical equipment with capacitors that exceed the energy thresholds in 360.3 shall be qualified and shall be trained in, and familiar with, the specific hazards and controls required for safe work.

(2) Unqualified persons who perform work on electrical equipment with capacitors shall be trained in, and familiar with, any electrical safety-related work practices necessary for their safety.

320.4(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 110.5(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:

  (5) 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.

  (6) Hearing protection shall be required where the stored energy exceeds 100 joules.

  (7) The lung protection boundary shall be determined if stored energy is above 122 kJ. Employees shall not enter the lung protection boundary.

  (8) Alerting techniques in accordance with 130.7(E) shall be used to warn employees of the hazards.

(9) 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.

(10) 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: 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.

320.5 Establishing an Electrically Safe Work Condition for a Capacitor(s).

360.5(A) Written Procedure.

Where a conductor or circuit part is connected to a capacitor(s) operating at or above the thresholds in 360.3 , a written procedure shall be used to document the necessary steps and sequence to discharge the capacitor(s) and place the equipment into an electrically safe work condition. The written procedure shall incorporate the results of the risk assessment performed in 360.5(B) and specify the following at a minimum:

320.5(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) 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.

320.6 Ground Sticks.

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 ground sticks shall be designed, constructed, installed, and periodically inspected so that the full energy and voltage of the capacitors can be safely discharged.

320.6(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 ground 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.

320.6(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.

(1) Soft grounding (High-Z) ground sticks with resistors shall be measured and compared to the specified value before each use.

320.6(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.

ARTICLE 330 Electrical Hazards 1 Hz to 100 MHz (not including 50/60 Hz)

330.1 Scope

This article shall apply to safety-related work practices around electrical equipment that includes ac waveforms from 1 Hz to 3 kHz (sub RF) and 3 kHz to 110 MHz (RF), 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) Equipment that includes rectifiers and inverters such as the following:

- (6) Motor drives
- (7) Uninterruptible power supply systems
- (8) Lighting controllers

(9) Generators producing sub-RF (1 kHz to 3 kHz) and (3 kHz to 100 MHz) fields

(10) Ionizing radiation field generators including X-rays, magnetrons, klystrons, thyratrons, vacuum tubes, and similar high-voltage vacuum devices

(11) Nonionizing radiation field generating equipment, including:

  (12) Antennas and RF transmission lines

  (13) Radar equipment

  (14) Industrial scientific and medical equipment

  (15) RF induction and dielectric heaters

  (16) Industrial microwave heaters and diathermy radiators

  (17) Magnetic resonance imagers (MRIs)

  (18) Large electromagnets

Informational Note: See the following standards for specific guidance 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*

(3) International Commission on Radiological Protection (ICRP) Publication 33, *Protection Against Ionizing Radiation from External Sources Used in Medicine*

340.2 Application.

The purpose of this article is to provide guidance for safety personnel in preparing specific safety-related work practices for sub RF and RF electrical hazards within their industry or laboratory.

340.3 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)* $^{0.3}$, f in MHz

(7) AC (30 MHz to 110 MHz): 200 mA

ARTICLE 350 Safety- Related Work Practices for Electrolytic Cells

310.

~~1 Scope~~

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~~

See Informative

~~Annex L for~~

Annex L for a typical application of safeguards in the cell line working zone.

Informational Note No. 2:

~~See~~

For further information about electrolytic cells, see NFPA 70,

~~National~~

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.

310.

~~3 Safety~~

3 Safety Training.

310.3 (A)

~~General~~

General.

The training requirements of this chapter shall apply to employees exposed to electrical hazards in the cell line working zone

~~and~~

defined in 110.6 and shall supplement or modify the requirements

~~of~~

of 110.

~~2~~

3,

~~110~~

120.

~~4~~

5, 130.1,

~~and~~

and 130.9.

310.3 (B)

~~Training~~

Training Requirements.

Employees shall be trained to understand the specific electrical hazards associated with electrical energy on the cell line. Employees shall be trained in safety-related work practices and procedural requirements to provide protection from the electrical hazards associated with their respective job or task assignment.

310.

~~4 Employee~~

4 Employee Training.

310.4 (A)

~~Qualified~~

Qualified Persons.

310.4 (A)(1)

~~Training~~

Training .

Qualified persons shall be trained and knowledgeable in the operation of cell line working zone equipment and specific work methods and shall be trained to avoid the electrical hazards that are present. Such persons shall be familiar with the proper use of precautionary techniques and PPE. Training for a qualified person shall include the following:

(1) Skills and techniques to avoid a shock hazard:

  (2) Between exposed energized surfaces, which might include temporarily insulating or guarding parts to permit the employee to work on exposed energized parts

  (3) Between exposed energized surfaces and grounded equipment, other grounded objects, or the earth itself, that might include temporarily insulating or guarding parts to permit the employee to work on exposed energized parts

(4) Method of determining the cell line working zone area boundaries

310.4 (A)(2)

~~Qualified~~

Qualified Persons.

Qualified persons shall be permitted to work within the cell line working zone.

310.4 (B)

~~Unqualified~~

Unqualified Persons.

310.4 (B)(1)

~~Training~~

Training .

Unqualified persons shall be trained to identify electrical hazards to which they could be exposed and the proper methods of avoiding the hazards.

310.4 (B)(2)

~~In~~

In Cell Line Working Zone.

When there is a need for an unqualified person to enter the cell line working zone to perform a specific task, that person shall be advised of the electrical hazards by the designated qualified person in charge to ensure that the unqualified person is safeguarded.

310.

~~5 Safeguarding~~

5 Safeguarding of Employees in the Cell Line Working Zone.

310.5 (A)

~~General~~

General .

Operation and maintenance of electrolytic cell lines might require contact by employees with exposed energized surfaces such as buses, electrolytic cells, and their attachments. The approach distances referred to

~~in~~

in Table 130.4(E)(a)

~~and~~

and Table 130.4(E)(b)

~~shall~~

shall not apply to work performed by qualified persons in the cell line working zone. Safeguards such as safety-related work practices and other safeguards shall be used to protect employees from injury while working in the cell line working zone. These safeguards shall be consistent with the nature and extent of the related electrical hazards. Safeguards might be different for energized cell lines and de-energized cell lines. Hazardous battery effect voltages shall be dissipated to consider a cell line de-energized.

Informational Note No. 1:

~~Exposed~~

Exposed energized surfaces might not present an electrical hazard. Shock hazards are related to current through the body, producing possible injury or damage to health. Shock severity is a function of many factors, including skin and body resistance, current path through the body, paths in parallel with the body, and system voltage. Arc flash burns and arc blasts are a function of the arcing current and the duration of arc exposure.

Informational Note No. 2:

~~A~~

A cell line or group of cell lines operated as a unit for the production of a particular metal, gas, or chemical compound might differ from other cell lines producing the same product because of variations in the particular raw materials used, output capacity, use of proprietary methods or process practices, or other modifying factors. Detailed standard electrical safety-related work practice requirements could become overly restrictive without accomplishing the stated purpose of Chapter 1.

310.5 (B)

~~Signs~~

Signs .

Permanent signs shall clearly designate electrolytic cell areas.

310.5 (C)

~~Arc~~

Arc Flash Risk Assessment.

The requirements

~~of~~

of 130.5 , Arc Flash Risk Assessment, shall not be required for electrolytic cell line working zones.

310.5 (C)(1)

~~General~~

General .

Each task performed in the electrolytic cell line working zone shall be analyzed for the likelihood of arc flash injury. If there is a likelihood of personal injury, appropriate measures shall be taken to protect persons exposed to the arc flash hazards, including one or more of the following:

(1) Providing appropriate

~~PPE~~

(1) PPE *[*

~~see~~

(1) *see 310.5(D)(2)]*

~~to~~

(1) to prevent injury from the arc flash hazard

(2) Altering work procedures to reduce the likelihood of occurrence of an arc flash incident

(3) Scheduling the task so that work can be performed when the cell line is de-energized

310.5 (C)(2)

~~Routine~~

Routine Tasks.

Arc flash risk assessment shall be done for all routine tasks performed in the cell line work zone. The results of the arc flash risk assessment shall be used in training employees in job procedures that minimize the possibility of arc flash hazards. The training shall be included in the requirements

~~of~~

of 310.3 .

310.5 (C)(3)

~~Nonroutine~~

Nonroutine Tasks.

Before a nonroutine task is performed in the cell line working zone, an arc flash risk assessment shall be done. If an arc flash hazard is a possibility during nonroutine work, appropriate instructions shall be given to employees involved on how to minimize the risk associated with arc flash.

310.5 (C)(4)

~~Arc~~

Arc Flash Hazards.

If the likelihood of occurrence of an arc flash hazard exists for either routine or nonroutine tasks, employees shall use appropriate safeguards.

310.5 (D)

~~Safeguards~~

Safeguards .

Safeguards shall include one or a combination of the following means.

310.5 (D)(1)

~~Insulation~~

Insulation .

Insulation shall be suitable for the specific conditions, and its components shall be permitted to include glass, porcelain, epoxy coating, rubber, fiberglass, and plastic and, when dry, such materials as concrete, tile, brick, and wood. Insulation shall be permitted to be applied to energized or grounded surfaces.

310.5 (D)(2)

~~Personal~~

Personal Protective Equipment (PPE).

PPE shall provide protection from electrical hazards. PPE shall include one or more of the following, as determined by authorized management:

(1) Footwear for wet service

(2) Gloves for wet service

(3) Sleeves for wet service

(4) Footwear for dry service

(5) Gloves for dry service

(6) Sleeves for dry service

(7) Electrically insulated head protection

(8) Protective clothing

(9) Eye protection with nonconductive frames

(10) Face shield (polycarbonate or similar nonmelting type)

(1) *PPE.*

~~Personal~~

(1) Personal and other protective equipment shall be appropriate for conditions, as determined by authorized management.

(2) *Testing of PPE.*

~~PPE~~

(1) PPE shall be verified with regularity and by methods that are consistent with the exposure of employees to electrical hazards.

310.5 (D)(3)

~~Barriers~~

Barriers .

Barriers shall be devices that prevent contact with energized or grounded surfaces that could present an electrical hazard.

310.5 (D)(4)

~~Voltage~~

Voltage Equalization.

Voltage equalization shall be permitted by bonding a conductive surface to an exposed energized surface, either directly or through a resistance, so that there is insufficient voltage to create an electrical hazard.

310.5 (D)(5)

~~Isolation~~

Isolation .

Isolation shall be established by placing equipment or other items in locations such that employees are unable to simultaneously contact exposed conductive surfaces that could present an electrical hazard.

310.5 (D)(6)

~~Safe~~

Safe Work Practices.

Employees shall be trained in safe work practices. The training shall include why the work practices in a cell line working zone are different from similar work situations in other areas of the plant. Employees shall comply with established safe work practices and the safe use of protective equipment.

(1) *Attitude Awareness.*

~~Safe~~

(1) Safe work practice training shall include attitude awareness instruction. Simultaneous contact with energized parts and ground can cause serious electrical shock. Of special importance is the need to be aware of body position where contact may be made with energized parts of the electrolytic cell line and grounded surfaces.

(2) *Bypassing of Safety Equipment.*

~~Safe~~

(1) Safe work practice training shall include techniques to prevent bypassing the protection of safety equipment. Clothing may bypass protective equipment if the clothing is wet. Trouser legs should be kept at appropriate length, and shirt sleeves should be a good fit so as not to drape while reaching. Jewelry and other metal accessories that may bypass protective equipment shall not be worn while working in the cell line working zone.

310.5 (D)(7)

~~Tools~~

Tools .

Tools and other devices used in the energized cell line work zone shall be selected to prevent bridging between surfaces at hazardous potential difference.

Informational Note:

~~Tools~~

Tools and other devices of magnetic material could be difficult to handle in the area of energized cells due to their strong dc magnetic fields.

310.5 (D)(8)

~~Portable~~

Portable Cutout-Type Switches.

Portable cell cutout switches that are connected shall be considered as energized and as an extension of the cell line working zone. Appropriate procedures shall be used to ensure proper cutout switch connection and operation.

310.5 (D)(9)

~~Cranes~~

Cranes and Hoists.

Cranes and hoists shall meet the requirements of applicable codes and standards to safeguard employees. Insulation required for safeguarding employees, such as insulated crane hooks, shall be periodically tested.

310.5 (D)(10)

~~Attachments~~

Attachments .

Attachments that extend the cell line electrical hazards beyond the cell line working zone shall use one or more of the following:

(1) Temporary or permanent extension of the cell line working zone

(2) Barriers

(3) Insulating breaks

(4) Isolation

310.5 (D)(11)

~~Pacemakers~~

Pacemakers and Metallic Implants.

Employees with implanted pacemakers, ferromagnetic medical devices, or other electronic devices vital to life shall not be permitted in cell areas unless written permission is obtained from the employee's physician.

Informational Note:

~~The~~

The American Conference of Governmental Industrial Hygienists (ACGIH) and IEEE 463, *Electrical Safety Practices in Electrolytic Cell Line Working Zones* , recommend that persons with implanted pacemakers should not be exposed to magnetic flux densities above 5 gauss.

310.5 (D)(12)

~~Testing~~

Testing .

Equipment safeguards for employee protection shall be tested to ensure they are in a safe working condition.

310.

~~6 Portable~~

6 Portable Tools and Equipment.

Informational Note:

~~The~~

The order of preference for the energy source for portable hand-held equipment is considered to be as follows:

(1) Battery power

(2) Pneumatic power

(3) Portable generator

(4) Nongrounded-type receptacle connected to an ungrounded source

310.6 (A)

~~Portable~~

Portable Electrical Equipment.

The grounding requirements

~~of~~

of 110.

~~7~~
9 (B)

~~shall~~
shall not be permitted within an energized cell line working zone. Portable electrical equipment and associated power supplies shall meet the requirements of applicable codes and standards.

310.6 (B)

~~Auxiliary~~
Auxiliary Nonelectric Connections.

Auxiliary nonelectric connections such as air, water, and gas hoses shall meet the requirements of applicable codes and standards. Pneumatic-powered tools and equipment shall be supplied with nonconductive air hoses in the cell line working zone.

310.6 (C)

~~Welding~~
Welding Machines.

Welding machine frames shall be considered at cell potential when within the cell line working zone. Safety-related work practices shall require that the cell line not be grounded through the welding machine or its power supply. Welding machines located outside the cell line working zone shall be barricaded to prevent employees from touching the welding machine and ground simultaneously where the welding cables are in the cell line working zone.

310.6 (D)

~~Portable~~
Portable Test Equipment.

Test equipment in the cell line working zone shall be suitable for use in areas of large magnetic fields and orientation.

Informational Note:

~~Test~~

Test equipment that is not suitable for use in such magnetic fields could result in an incorrect response. When such test equipment is removed from the cell line working zone, its performance might return to normal, giving the false impression that the results were correct.

~~Article 320 Safety~~
ARTICLE 360 Safety Requirements Related to Batteries and Battery Rooms

320.

~~1 Scope~~
1 Scope .

This article covers electrical safety requirements for the practical safeguarding of employees while working with exposed stationary storage batteries that exceed 100 volts, nominal, or exceed a short-circuit power of 1000 watts.

Informational Note:

~~See the following documents for~~

For additional information on best practices for safely working on stationary batteries , see the following documents :

(1) NFPA 1 ,

~~Fire~~

(1) Fire Code , Chapter 52, Stationary Storage Battery Systems,

~~2021~~

(1) 2015

(2) NFPA 70 ,

~~National~~

(1) National Electrical Code , Article 480, Storage Batteries,

~~2020~~

(1) 2014

(2) IEEE 450,

~~IEEE~~

(1) IEEE Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications ,

~~2020~~

(1) 2010

(2) IEEE 937,

~~Recommended~~

(1) Recommended Practice for Installation and Maintenance of Lead-Acid Batteries for Photovoltaic Systems ,

~~2019~~

(1) 2007

(2) IEEE 1106,

~~IEEE~~

(1) IEEE Recommended Practice for Installation, Maintenance, Testing, and Replacement of Vented Nickel-Cadmium Batteries for Stationary Applications , 2005 (R 2011)

(2) IEEE 1184,

~~IEEE~~

(1) IEEE Guide for Batteries for Uninterruptible Power Supply Systems ,

~~2015~~

(1) 2006 (R 2011)

(2) IEEE 1188,

~~IEEE~~

(1) IEEE Recommended Practice for Maintenance, Testing, and Replacement of Valve-Regulated Lead-Acid (VRLA) Batteries for Stationary Applications , 1188a-2014

(2) IEEE 1657,

~~Recommended~~

(1) Recommended Practice for Personnel Qualifications for Installation and Maintenance of Stationary

Batteries,

~~2018~~

(1) *2009*

(2) *OSHA 29 CFR 1910.305(j)(7), "Storage batteries"*

(3) *OSHA 29 CFR 1926.441, "Batteries and battery charging"*

(4) *DHHS (NIOSH) Publication No. 94-110,*

~~Applications~~

(1) *Applications Manual for the Revised NIOSH Lifting Equation,*

~~1994~~

(1) *1994*

(2) *IEEE/ASHRAE 1635,*

~~Guide~~

(1) *Guide for the Ventilation and Thermal Management of Batteries for Stationary Applications*

~~2018~~

- ~~NFPA 855, *Standard for the Installation of Stationary Energy Storage Systems* , 2020~~
- ~~UL 9540, *Energy Storage Systems and Equipment* , 2020~~
- ~~UL 9540A, *Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems* , 2019~~

~~**320.3** Safety Procedures.~~

~~(A) General~~

(1) *, 2012*

320.3 Safety Procedures.

320.3(A) General Safety Hazards.

320.3 (

~~1) 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) ~~Thermal: 1000 watts short-circuit power~~

~~Informational Note: See Department of Energy, *DOE Electrical Safety Handbook* , DOE-HDBK-1092, for electrical hazard thresholds.~~

~~(2) Battery~~

~~**A)(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.*~~

~~**320.3 (A)(3)**~~

~~Battery~~

~~**Battery Room or Enclosure Requirements.**~~

(1) ~~*Personnel Access to Energized Batteries.*~~

~~Each~~

(1) ~~Each battery room or battery enclosure shall be accessible only to authorized personnel.~~

(2) ~~*Illumination.*~~

~~Employees~~

(1) ~~Employees shall not enter spaces containing batteries unless illumination is provided that enables the employees to perform the work safely.~~

~~*Informational Note:*~~

~~Battery~~

~~*Battery terminals are normally exposed and pose possible shock hazard. Batteries are also installed in steps or tiers that can cause obstructions.*~~

~~**320.3 (A)(4)**~~

~~Apparel~~

~~**Apparel .**~~

~~Personnel shall not wear electrically conductive objects such as jewelry while working on a battery system.~~

~~**320.3 (A)(5)**~~

~~Abnormal~~

~~**Abnormal Battery Conditions.**~~

~~Instrumentation that provides alarms for early warning of abnormal conditions of battery operation, if present, shall be tested annually.~~

~~*Informational Note:*~~

~~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~~

~~*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 .*~~

~~**320.3 (A)(6)**~~

~~Warning~~

~~**Warning Signs.**~~

~~The following warning signs or labels shall be posted in appropriate locations:~~

(1) ~~Electrical hazard warnings indicating the shock hazard due to the battery voltage and the arc flash hazard due to the prospective short-circuit current, and the thermal hazard.~~

~~*Informational Note No.1:*~~

~~Because~~

~~Because internal resistance, prospective short-circuit current, or both are not always provided on battery container labels or data sheets, and because many variables can be introduced into a battery layout, the battery manufacturer should be consulted for accurate data. Variables can include, but are not limited to, the following:~~

(1)

- (a) *~~Series connections~~*
- (b) *~~Parallel connections~~*
- (c) *~~Charging methodology~~*
- (d) *~~Temperature~~*
- (e) *~~Charge status~~*
- (f) *~~Dc distribution cable size and length~~*

~~Informational Note No. 2:~~

~~See~~

~~See~~ *~~130.5(~~*

~~H~~

~~D)~~

~~for~~

~~for requirements for equipment labeling.~~

(1) ~~Chemical hazard warnings, applicable to the worst case when multiple battery types are installed in the same space, indicating the following:~~

- (2) ~~Potential presence of explosive gas (when applicable to the battery type)~~
- (3) ~~Prohibition of open flame and smoking~~
- (4) ~~Danger of chemical burns from the electrolyte (when applicable to the battery type)~~

(5) ~~Notice for personnel to use and wear protective equipment and apparel appropriate to the hazard for the battery~~

(6) ~~Notice prohibiting access to unauthorized personnel~~

~~320.3 (B)~~

~~Electrolyte~~

~~Electrolyte Hazards.~~

~~320.3 (B)(1)~~

~~Battery~~

~~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:~~

~~See~~

~~*Guidelines for the use and maintenance of eye wash facilities for vented batteries in nontelecom environments can be found in ANSI/ISEA Z358.1,*~~

~~American~~

~~*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~~

~~.~~

~~**320.3 (B)(2)**~~

~~Activities~~

~~**Activities That Do Not Include Handling of Electrolyte.**~~

~~Employees performing any activity not involving the handling of electrolyte shall wear safety glasses.~~

~~*Informational Note:*~~

~~Battery~~

~~*Battery maintenance activities usually do not involve handling electrolyte. Batteries that are hermetically sealed (such as most lithium batteries) or immobilized electrolyte (such as valve-regulated lead acid batteries) present little or no electrolyte hazard. Most modern density meters expose a worker to a quantity of electrolyte too minute to be considered hazardous, if at all. Such work would not be considered handling electrolyte. However, if specific gravity readings are taken using a bulb hydrometer, the risk of exposure is higher — this could be considered to be handling electrolyte, and the requirements*~~

~~of~~

~~*of 320.3(B)(1)*~~

~~would~~

~~*would apply.*~~

~~**320.3 (C)**~~

~~Tools~~

~~**Tools and Equipment.**~~

~~**320.3 (C)(1)**~~

~~Handles~~

~~**Handles .**~~

~~Tools and equipment for work on batteries shall be equipped with insulated handles rated for the voltage on which they are used. The length and insulation of tools for work on batteries shall be selected to minimize the risk of inadvertent~~

~~contact~~

~~short circuit .~~

~~**320.3 (C)(2)**~~

~~Contact~~

~~**Contact .**~~

~~Battery terminals and all electrical conductors shall be kept clear of unintended contact with tools, test equipment, liquid containers, and other foreign objects.~~

~~**320.3 (C)(3)**~~

~~Nonsparking~~

~~**Nonsparking Tools.**~~

~~Nonsparking tools shall be required when the risk assessment required~~

~~by~~

~~by~~ ~~110.~~

~~3~~

~~5 (H)~~

~~justifies~~

~~justifies their use.~~

~~320.3 (D)~~

~~Cell~~

~~Cell Flame Arresters and Cell Ventilation.~~

~~When present, battery cell ventilation openings shall be unobstructed. Cell flame arresters shall be inspected for proper installation and unobstructed ventilation and shall be replaced when necessary in accordance with the manufacturer's instructions.~~

~~**Article 330** Safety-Related Work Practices: Lasers~~

~~**330.1** Scope.~~

~~This article covers safety-related work practices for maintaining lasers and their associated equipment.~~

~~Informational Note No. 1:~~

~~See ANSI Z136.1, *Standard for Safe Use of Lasers* , for recommendations on laser safety requirements for laser use.~~

> ~~Informational Note No. 2: 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.~~

~~**330.3** 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:~~

  (4) ~~Less than 100 volts and greater than 100 joules of stored energy~~

  (5) ~~Greater than or equal to 100 volts and greater than 1.0 joule of stored energy~~

  (6) ~~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.~~

~~**330.4** Electrical Safety Training.~~

~~**(A)** Personnel to Be Trained.~~

~~Employers shall provide training for all personnel who work on or are near lasers or laser systems with user-accessible hazardous voltage, current, or stored energy (e.g., flashlamp-pumped lasers).~~

~~**(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~~

(4) ~~Ionizing radiation, including X-rays at voltages greater than 5 kV in a vacuum~~

(5) ~~Assessing the listing status of electrical equipment and the need for field evaluation of nonlisted equipment~~

~~**330.5** Safeguarding of Persons from Electrical Hazards Associated with Lasers and Laser Systems.~~

~~**(A)** Temporary Guarding.~~

~~Temporary guarding (e.g., covers, protective insulating barriers) shall be used to limit exposure to any electrical hazard when the permanent laser enclosure covers are removed for maintenance and testing.~~

~~**(B)** Work Requiring an Electrically Safe Work Condition.~~

~~Work that might expose employees to electrical hazards shall be performed with the equipment in an electrically safe work condition in accordance with 120.2 , 120.3 , and 110.2(C) .~~

~~**(C)** Energized Electrical Testing.~~

~~Energized electrical testing, troubleshooting, and voltage testing shall not require an energized work permit in accordance with 130.2(C) .~~

~~**(D)** Warning Signs and Labels.~~

~~Electrical safety warning signs and labels shall be posted as applicable on electrical equipment doors, covers, and protective barriers. The warning signs and labels shall adequately warn of the hazard using effective words, colors, and symbols. These signs and labels shall be permanently affixed to the equipment and shall be of sufficient durability to withstand the environment involved.~~

~~**(E)** Listing.~~

~~Laser system electrical equipment presenting electrical hazards shall be listed or field evaluated prior to use.~~

~~**330.6** Responsibility for Electrical Safety.~~

~~All persons with access to hazardous voltage, current, or stored energy shall be responsible for the following:~~

(1) ~~Obtaining authorization for work with or on hazardous electrical equipment in lasers and laser systems~~

(2) ~~Use of Chapter 1 safety-related work practices~~

(3) ~~Reporting laser equipment failures, accidents, inadequate barriers, and inadequate signage to the employer~~

~~**Article 340** Safety-Related Work Practices: Power Electronic Equipment~~

~~340.1~~ ~~Scope.~~

~~This article 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) ~~Equipment that includes rectifiers and inverters such as the following:~~

  (6) ~~Motor drives~~

  (7) ~~Uninterruptible power supply systems~~

  (8) ~~Lighting controllers~~

(9) ~~Generators producing sub RF (1 kHz to 3 kHz) and (3 kHz to 100 MHz) fields~~

(10) ~~Ionizing radiation field generators including X-rays, magnetrons, klystrons, thyratrons, vacuum tubes, and similar high-voltage vacuum devices~~

(11) ~~Nonionizing radiation field generating equipment, including:~~

  (12) ~~Antennas and RF transmission lines~~

  (13) ~~Radar equipment~~

  (14) ~~Industrial scientific and medical equipment~~

  (15) ~~RF induction and dielectric heaters~~

  (16) ~~Industrial microwave heaters and diathermy radiators~~

  (17) ~~Magnetic resonance imagers (MRIs)~~

  (18) ~~Large electromagnets~~

~~Informational Note: See the following standards for specific guidance 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*~~

(3) ~~International Commission on Radiological Protection (ICRP) Publication 33,~~ ~~*Protection Against Ionizing Radiation from External Sources Used in Medicine*~~

~~340.3~~ ~~Application.~~

~~The purpose of this article is to provide guidance for safety personnel in preparing specific safety-related work practices within their industry.~~

~~**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)*~~ $\cancel{^{0.3}}$ ~~, f in MHz~~

(7) ~~AC (30 MHz to 110 MHz): 200 mA~~

~~**340.5** Specific Measures for Personnel Safety.~~

~~**(A)** Employer Responsibility.~~

~~The employer shall be responsible for the following:~~

(1) ~~Proper training and supervision by properly qualified personnel, including the following:~~

 (2) ~~Identification of associated hazards~~

 (3) ~~Strategies to reduce the risk associated with the hazards~~

 (4) ~~Methods of avoiding or protecting against the hazard~~

 (5) ~~Necessity of reporting any incident that resulted in, or could have resulted in, injury or damage to health~~

(6) ~~Properly installed equipment~~

(7) ~~Proper access to the equipment~~

(8) ~~Availability of the correct tools for operation and maintenance~~

(9) ~~Proper identification and guarding of dangerous equipment~~

(10) ~~Provision of complete and accurate circuit diagrams and other published information to the employee prior to the employee starting work (The circuit diagrams should be marked to indicate the components that present an electrical hazard.)~~

(11) ~~Maintenance of clear and clean work areas around the equipment to be worked on~~

(12) ~~Provision of adequate and proper illumination of the work area~~

~~**(B)** Employee Responsibility.~~

~~The employee shall be responsible for the following:~~

(1) ~~Understanding the hazards associated with the work~~

(2) ~~Being continuously alert and aware of the possible hazards~~

(3) ~~Using the proper tools and procedures for the work~~

(4) ~~Informing the employer of malfunctioning protective measures, such as faulty or inoperable enclosures and locking schemes~~

(5) ~~Examining all documents provided by the employer relevant to the work to identify the location of components that present an electrical hazard~~

(6) ~~Maintaining good housekeeping around the equipment and work space~~

(7) ~~Reporting any incident that resulted in, or could have resulted in, injury or damage to health~~

(8) ~~Using and appropriately maintaining the PPE and tools required to perform the work safely~~

~~**Article 350** Safety-Related Work Requirements: Research and Development Laboratories~~

~~**350.1** Scope.~~

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

~~**350.3** Applications of Other Articles.~~

~~The electrical system for R&D and laboratory applications shall meet the requirements of the remainder of this document, except as amended by Article 350.~~

> ~~Informational Note: Examples of these applications include low-voltage–high-current power systems; high-voltage–low-current power systems; dc power supplies; capacitors; cable trays for signal cables and other systems, such as steam, water, air, gas, or drainage; and custom-made electronic equipment.~~

~~**350.4** Electrical Safety Authority (ESA).~~

~~Each laboratory or R&D system application shall be permitted to assign an ESA to ensure the use of appropriate electrical safety-related work practices and controls. The ESA shall be permitted to be an electrical safety committee, engineer, or equivalent qualified individual. The ESA shall be permitted to delegate authority to an individual or organization within their control.~~

~~**(A)** Responsibility.~~

~~The ESA shall act in a manner similar to an authority having jurisdiction for R&D electrical systems and electrical safe work practices.~~

~~**(B)** Qualifications.~~

~~The ESA shall be competent in the following:~~

(1) ~~The requirements of this standard~~

(2) ~~Electrical system requirements applicable to the R&D laboratories~~

~~**350.5** Specific Measures and Controls for Personnel Safety.~~

~~Each laboratory or R&D system application shall designate a competent person as defined in this article to ensure the use of appropriate electrical safety-related work practices and controls.~~

~~**(A)** Job Briefings.~~

~~Job briefings shall be performed in accordance with 110.3(I) .~~

~~*Exception: Prior to starting work, a brief discussion shall be permitted if the task and hazards are documented and the employee has reviewed applicable documentation and is qualified for the task.*~~

~~**(B)** Personnel Protection.~~

~~Safety-related work practices shall be used to safeguard employees from injury while they are exposed to electrical hazards from exposed electrical conductors or circuit parts that are or can become energized. The specific safety-related work practices shall be consistent with the electrical hazard(s) and the associated risk. For calibration and adjustment of equipment as it pertains to sensors, motor controllers, control hardware, and other devices that need to be installed inside equipment or control cabinet, surrounded by electrical hazards, the ESA shall define the required PPE based on the risk and exposure.~~

~~Use of electrical insulating blankets, covers, or barriers shall be permitted to prevent inadvertent contact to exposed terminals and conductors. Insulated/nonconductive adjustment and alignment tools shall be used where feasible.~~

~~**350.6** Approval Requirements.~~

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

> ~~Informational Note: Laboratory and R&D equipment or systems can pose unique electrical hazards that might require mitigation. Such hazards include ac and dc, low voltage and high amperage, high voltage and low current, large electromagnetic fields, induced voltages, pulsed power, multiple frequencies, and similar exposures.~~

~~**350.7** Custom Built, Non-Listed Research Equipment, 1000 Volts or less AC or DC.~~

~~**(A)** Equipment Marking and Documentation.~~

~~**(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: See ANSI Z535, *Series of Standards for Safety Signs and Tags* , for more information on precautionary marking of electrical systems or equipment.~~

~~**(2)** Documentation.~~

~~Sufficient documentation shall be provided and readily available to personnel that install, operate, and maintain equipment that describes operation, shutdown, safety concerns, and nonstandard installations.~~

~~Schematics, drawings, and bill of materials describing power feeds, voltages, currents, and parts used for construction, maintenance, and operation of the equipment shall be provided.~~

~~**(3)** Shutdown Procedures.~~

~~Safety requirements and emergency shutdown procedures of equipment shall include lockout/tagout (LOTO) requirements. If equipment-specific LOTO is required, then documentation outlining this procedure and PPE requirements shall be made readily available.~~

~~**(4)** Specific Hazards.~~

~~Specific hazards, other than electrical, associated with research equipment shall be documented and readily available.~~

~~**(5)** Approvals.~~

~~Drawings, standard operational procedures, and equipment shall be approved by the ESA on site before initial startup. Assembly of equipment shall comply with national standards where applicable unless research application requires exceptions. Equipment that does not meet the applicable standards shall be required to be approved by the ESA. Proper safety shutdown procedures and PPE requirements shall be considered in the absence of grounding and/or bonding.~~

~~**(B)** Tools, Training, and Maintenance.~~

~~Documentation shall be provided if special tools, unusual PPE, or other equipment is necessary for proper maintenance and operation of equipment. The ESA shall make the determination of appropriate training and qualifications required to perform specific tasks.~~

~~**350.8** Custom Built, Unlisted Research Equipment, >1000 V AC or DC.~~

~~Installations shall comply with all requirements of 350.7 .~~

~~In the event that research equipment requires PPE beyond what is commercially available, the ESA shall determine safe work practices and PPE to be used.~~

~~**350.9** 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: 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.~~

~~**350.10** Establishing an Electrically Safe Work Condition.~~

~~Energized electrical conductors and circuit parts shall be put into an electrically safe work condition before an employee performs work.~~

~~*Exception: At the discretion of the ESA, alternative methods of ensuring worker safety shall be permitted to be employed for the following conditions:*~~

~~*(1) Minor tool changes and adjustments, and other normal production operations that are routine, repetitive, or sequential and integral to the use of the equipment for production*~~

~~*(2) Minor changes to the unit under test and other minor servicing activities, to include the activities listed under 350.10 Exception condition (1), that take place during research and development*~~

~~*(3) Work on cord-and-plug-connected equipment for which exposure to the hazards of unexpected energization or start up is controlled by the following:*~~

~~*(4) Unplugging the equipment from the energy source*~~

~~*(5) The employee performing the work maintaining exclusive control of the plug*~~

~~**Article 360** Safety-Related Requirements for Capacitors~~

~~**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 more information on working safely with capacitors.~~

~~**360.3** Stored Energy Hazard Thresholds.~~

~~Appropriate controls shall be applied where any of the following hazard thresholds are exceeded:~~

~~(1) Less than 100 volts and greater than 100 joules of stored energy~~

~~(2) Greater than or equal to 100 volts and greater than 1.0 joule of stored energy~~

~~(3) Greater than or equal to 400 volts and greater than 0.25 joules of stored energy~~

~~**360.4** Specific Measures for Personnel Safety.~~

~~**(A)** Qualification and Training.~~

~~The following qualifications and training shall be required for personnel safety:~~

~~(1) Employees who perform work on electrical equipment with capacitors that exceed the energy thresholds in 360.3 shall be qualified and shall be trained in, and familiar with, the specific hazards and controls required for safe work.~~

~~(2) Unqualified persons who perform work on electrical equipment with capacitors shall be trained in, and familiar with, any electrical safety-related work practices necessary for their safety.~~

~~**(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:~~

  (5) ~~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.~~

  (6) ~~Hearing protection shall be required where the stored energy exceeds 100 joules.~~

  (7) ~~The lung protection boundary shall be determined if stored energy is above 122 kJ. Employees shall not enter the lung protection boundary.~~

  (8) ~~Alerting techniques in accordance with 130.8(O) shall be used to warn employees of the hazards.~~

(9) ~~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.~~

(10) ~~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 more information on calculating capacitor stored energy, arc flash, and arc blast boundaries.~~

~~Informational Note No. 2: Heavy duty leather with a minimum thickness of 0.03 in. (0.7 mm) provides protection from thermal hazards.~~

~~**360.5** Establishing an Electrically Safe Work Condition for a Capacitor(s).~~

~~**(A)** Written Procedure.~~

~~Where a conductor or circuit part is connected to a capacitor(s) operating at or above the thresholds in 360.3 , a written procedure shall be used to document the necessary steps and sequence to discharge the capacitor(s) and place the equipment into an electrically safe work condition. The written procedure shall incorporate the results of the risk assessment performed in 360.5(B) and specify the following at a minimum:~~

~~**(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) ~~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.*~~

~~**360.6** Ground Sticks.~~

~~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 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.~~

Additional Proposed Changes

File Name	Description	Approved
Chapter3_70E-2021.LBGdraft.05.30.22CleanCopy.docx	Clean copy of Chapter 3 rewrite, no track changes	
Chapter3_70E-2021.LBGdraft.05.30.22TrackChanges.docx	Rewrite of Chapter 3 with Track Changes	
Reorganization_SummarywJustification.05.30.22.docx	Justification of Reorganization	
Additional_Justifications_-_Ch_3.05.30.22.docx	Additional Justifications to consolidation	
Chapter3_Reog.GraphicalView.05.30.22.docx	Graphical View of Ch 3 Reorg	
70E_Chapter_3_Proposal_for_2024.pptx	Overall Benefit to Reorganization	

Statement of Problem and Substantiation for Public Comment

Chapter 3 has evolved over 20 years in a piecemeal fashion. Due to the independent evolution of Articles 310, 320, 330, 340, 350, and 360, there were multiple inconsistencies, contradictions, duplication, and material no longer relevant. Recent and rapid improvements in the understanding and establishment of hazard thresholds for dc, capacitor, sub RF and RF make this an opportune time to reorganize Chapter 3 to be useful to all users of specialized electrical equipment, in industry, government, universities, and all research laboratories.

This concept was presented at the 2021 First Meeting for discussion. There was enthusiasm, but some mixed reviews. This new work cleans up and clarifies the plan.

Important to note is that NO NEW TECHNICAL REQUIREMENTS were added that were not already an approved PI (except for the morphing of "R&D" into industrial and research).

The elimination of Articles 330 (lasers) and 340 (Power Electronics) seems like a dramatic step, but not really. All of the hazards previously covered by 330 and 340 are now covered in the new Articles 310 (DC), 320 (Capacitors, previously 360), and 330 (RF). There is no longer a reason to highlight lasers, or power electronics. Otherwise, we would need to add new articles on RF linear accelerators, energy storage systems, medical diagnostic equipment, induction furnaces, etc. These are just a few of the applications that use unique forms of electricity, dc, capacitor, batteries, sub RF and RF.

Please review the 6 documents included for clarification and justification.

It is the submitters' opinion that this would be a great step forward to make Chapter 3 a tool for all work places, not previously covered by Chapter 1, and the historical NFPA 70E.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 98-NFPA 70E-2022 [Section No. 340.4]	
Public Comment No. 99-NFPA 70E-2022 [Section No. 350.9]	
Public Comment No. 112-NFPA 70E-2022 [Article 350]	

Related Item

- PI No. 304

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Chapter 3 Safety Requirements for Special Equipment

ARTICLE 300 Introduction

300.1 Scope.

Chapter 3 covers special electrical equipment in the workplace, and modifies the general requirements of Chapter 1.

300.2 Responsibility.

The employer shall provide safety-related work practices and employee training on the material covered in this Chapter, in addition to those in Chapter 1. The employee shall follow those work practices.

300.3 Organization.

Chapter 3 of this standard is divided into articles. Article 305 applies generally. Article 310 applies to dc electrical hazards. Article 320 applies to capacitor electrical hazards. Article 330 covers electrical hazards from 1 Hz to 100 MHz, other than 50/60 Hz. Article 350 applies to electrolytic cells. Article 360 applies to batteries and battery rooms.

ARTICLE 305 General Requirements

305.1 Applications of Other Articles.

The special electrical equipment covered by this chapter shall meet the requirements of the remainder of this document, except as amended by this chapter.

> *Informational Note: Examples of these applications covered in this chapter include low-voltage–high-current power systems; high-voltage–low-current power systems; dc power supplies; capacitors; cable trays for signal; and, custom-made electronic equipment. Examples of specialized equipment include energy conversion (ac to dc, dc to ac), energy storage systems, accelerators, all sub RF and RF systems, lasers, medical and laboratory diagnostic equipment, and process equipment using dc and RF (e.g., induction).*

305.2 Electrical Safety Authority (ESA).

A laboratory or specialized industry shall be permitted to assign an ESA to ensure the use of appropriate electrical safety-related work practices and controls covered in this chapter. The ESA shall be permitted to be an electrical safety committee, engineer, or equivalent qualified individual. The ESA shall be permitted to delegate authority to an individual or organization within their control.

305.2(A) Responsibility.

The ESA shall act in a manner similar to an authority having jurisdiction for specialized electrical systems and electrical safe work practices.

305.2(B) Qualifications.

The ESA shall be competent in the following:

1) The requirements of this standard
2) Electrical system requirements applicable to the special electrical hazards and equipment covered by this chapter, including nonionizing and ionizing radiation.

305.3 Specific Measures and Controls for Personnel Safety.

Each laboratory or specialized industry shall designate a competent person as defined in this article to ensure the use of appropriate electrical safety-related work practices and controls covered in this article.

305.3(A) Job Briefings.

Job briefings shall be performed in accordance with 110.5(I).

Exception: Prior to starting work, a brief discussion shall be permitted if the task and hazards are documented and the employee has reviewed applicable documentation and is qualified for the task.

305.3(B) Personnel Protection.

Safety-related work practices shall be used to safeguard employees from injury while they are exposed to electrical hazards from exposed electrical conductors or circuit parts that are or can become energized. The specific safety-related work practices shall be consistent with the electrical hazard(s) and the associated risk. For calibration and adjustment of equipment as it pertains to sensors, motor controllers, control hardware, and other devices that need to be installed inside equipment or control cabinet, surrounded by electrical hazards, the ESA shall define the required PPE based on the risk and exposure.

Use of electrical insulating blankets, covers, or barriers shall be permitted to prevent inadvertent contact to exposed terminals and conductors. Insulated/nonconductive adjustment and alignment tools shall be used where feasible.

305.4 Approval Requirements.
The equipment or systems used in the laboratory or specialized industry shall be listed or field evaluated prior to use.

> *Informational Note: Laboratory and specialized electrical equipment or systems can pose unique electrical hazards that might require mitigation. Such hazards include ac and dc, low voltage and high amperage, high voltage and low current, large electromagnetic fields, induced voltages, pulsed power, multiple frequencies, and similar exposures.*

305.5 Custom Built, Non-Listed Specialized Electrical Equipment, 1000 Volts or less AC or DC.
305.5(A) Equipment Marking and Documentation.
305.5(A)(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 ANSI Z535, Series of Standards for Safety Signs and Tags, for more information on precautionary marking of electrical systems or equipment.*

305.5(A)(2) Documentation.
Sufficient documentation shall be provided and readily available to personnel that install, operate, and maintain equipment that describes operation, shutdown, safety concerns, and nonstandard installations.

Schematics, drawings, and bill of materials describing power feeds, voltages, currents, and parts used for construction, maintenance, and operation of the equipment shall be provided.

305.5(A)(3) Shutdown Procedures.
Safety requirements and emergency shutdown procedures of equipment shall include lockout/tagout (LOTO) requirements. If equipment-specific LOTO is required, then documentation outlining this procedure and PPE requirements shall be made readily available.

305.5(A)(4) Specific Hazards.
Specific hazards, other than electrical, associated with research and specialized electrical equipment shall be documented and readily available.

305.5(A)(5) Approvals.
Drawings, standard operational procedures, and equipment shall be approved by the ESA on site before initial startup. Assembly of equipment shall comply with national standards where applicable unless research or industrial application requires exceptions. Equipment that does not meet the applicable standards shall be required to be approved by the ESA. Proper safety shutdown procedures and PPE requirements shall be considered in the absence of grounding and/or bonding.

305.5(B) Tools, Training, and Maintenance.

Documentation shall be provided if special tools, unusual PPE, or other equipment is necessary for proper maintenance and operation of equipment. The ESA shall make the determination of appropriate training and qualifications required to perform specific tasks.

305.6 Custom Built, Unlisted Electrical Equipment, >1000 V AC or DC.

Installations shall comply with all requirements of 305.5

In the event that specialized electrical equipment requires PPE beyond what is commercially available, the ESA shall determine safe work practices and PPE to be used.

305.7 Establishing an Electrically Safe Work Condition.

Energized electrical conductors and circuit parts shall be put into an electrically safe work condition before an employee performs work.

Exception: At the discretion of the ESA, alternative methods of ensuring worker safety shall be permitted to be employed for the following conditions:

1) *Minor tool changes and adjustments, and other normal production operations that are routine, repetitive, or sequential and integral to the use of the equipment for production*
2) *Minor changes to the unit under test and other minor servicing activities, to include the activities listed under 305.7 Exception condition (1), that take place during research and development*
3) *Work on cord-and-plug-connected equipment for which exposure to the hazards of unexpected energization or start up is controlled by the following:*
    a) *Unplugging the equipment from the energy source*
    b) *The employee performing the work maintaining exclusive control of the plug*

ARTICLE 310 DC Electrical Hazards

310.1 Scope.

This article covers the electrical safety-related requirements for the practical safeguarding of employees while working with direct current (dc) that present an electrical hazard.

310.2 DC Electrical Hazard Thresholds

310.2(A) Electrical Thermal Hazard Thresholds

For dc systems, hazardous power is considered greater than or equal to 1000 W.

310.2(B) Electrical Shock Hazard Thresholds.

For dc systems, hazardous voltage is considered greater than or equal to 100 volts dc and 40 mA.

310.2(C) Electrical Arc Flash Hazard Thresholds.

For dc systems, hazardous arc flash is considered for systems greater than or equal to 150 volts dc and 17,000 amps dc.

ARTICLE 320 Capacitor Electrical Hazards

320.1 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: For more information on working safely with capacitors, see Informative Annex R, Working with Capacitors.

320.2 Stored Energy Hazard Thresholds.

Appropriate controls shall be applied where any of the following hazard thresholds are exceeded:

1) Less than 100 volts and greater than 100 joules of stored energy
2) Greater than or equal to 100 volts and greater than 1.0 joule of stored energy
3) Greater than or equal to 400 volts and greater than 0.25 joules of stored energy

320.4 Specific Measures for Personnel Safety.
320.4(A) Qualification and Training.
The following qualifications and training shall be required for personnel safety:

1) Employees who perform work on electrical equipment with capacitors that exceed the energy thresholds in 360.3 shall be qualified and shall be trained in, and familiar with, the specific hazards and controls required for safe work.
2) Unqualified persons who perform work on electrical equipment with capacitors shall be trained in, and familiar with, any electrical safety-related work practices necessary for their safety.

320.4(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 110.5(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 130.7(E) 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: 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.

320.5 Establishing an Electrically Safe Work Condition for a Capacitor(s).
360.5(A) Written Procedure.
Where a conductor or circuit part is connected to a capacitor(s) operating at or above the thresholds in 360.3, a written procedure shall be used to document the necessary steps and sequence to discharge the capacitor(s) and place the equipment into an electrically safe work condition. The written procedure shall incorporate the results of the risk assessment performed in 360.5(B) and specify the following at a minimum:

320.5(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) 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.

320.6 Ground Sticks.

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 ground sticks shall be designed, constructed, installed, and periodically inspected so that the full energy and voltage of the capacitors can be safely discharged.

320.6(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 ground 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.

320.6(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.

320.6(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.

ARTICLE 330 Electrical Hazards 1 Hz to 100 MHz (not including 50/60 Hz)

330.1 Scope

This article shall apply to safety-related work practices around electrical equipment that includes ac waveforms from 1 Hz to 3 kHz (sub RF) and 3 kHz to 110 MHz (RF), 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. Equipment that includes rectifiers and inverters such as the following:
    0. Motor drives
    1. Uninterruptible power supply systems
    2. 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:
    0. Antennas and RF transmission lines
    1. Radar equipment
    2. Industrial scientific and medical equipment
    3. RF induction and dielectric heaters
    4. Industrial microwave heaters and diathermy radiators
    5. Magnetic resonance imagers (MRIs)
    6. Large electromagnets

Informational Note: See the following standards for specific guidance 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*
3. International Commission on Radiological Protection (ICRP) Publication 33, *Protection Against Ionizing Radiation from External Sources Used in Medicine*

340.2 Application.
The purpose of this article is to provide guidance for safety personnel in preparing specific safety-related work practices for sub RF and RF electrical hazards within their industry or laboratory.

340.3 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 $(f/3)^{*0.3}$, f in MHz
7. AC (30 MHz to 110 MHz): 200 mA

ARTICLE 350 Safety-Related Work Practices for Electrolytic Cells

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 NFPA 70, National Electrical Code, Article 668.*

> *Informational Note No. 3: 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.*

310.3 Safety Training.

310.3(A) General.

The training requirements of this chapter shall apply to employees exposed to electrical hazards in the cell line working zone defined in 110.6 and shall supplement or modify the requirements of 110.3, 120.5, 130.1, and 130.9.

310.3(B) Training Requirements.

Employees shall be trained to understand the specific electrical hazards associated with electrical energy on the cell line. Employees shall be trained in safety-related work practices and procedural requirements to provide protection from the electrical hazards associated with their respective job or task assignment.

310.4 Employee Training.

310.4(A) Qualified Persons.

310.4(A)(1) Training.

Qualified persons shall be trained and knowledgeable in the operation of cell line working zone equipment and specific work methods and shall be trained to avoid the electrical hazards that are present. Such persons shall be familiar with the proper use of precautionary techniques and PPE. Training for a qualified person shall include the following:

1) Skills and techniques to avoid a shock hazard:
    a. Between exposed energized surfaces, which might include temporarily insulating or guarding parts to permit the employee to work on exposed energized parts
    b. Between exposed energized surfaces and grounded equipment, other grounded objects, or the earth itself, that might include temporarily insulating or guarding parts to permit the employee to work on exposed energized parts
2) Method of determining the cell line working zone area boundaries

310.4(A)(2) Qualified Persons.

Qualified persons shall be permitted to work within the cell line working zone.

310.4(B) Unqualified Persons.

310.4(B)(1) Training.

Unqualified persons shall be trained to identify electrical hazards to which they could be exposed and the proper methods of avoiding the hazards.

310.4(B)(2) In Cell Line Working Zone.

When there is a need for an unqualified person to enter the cell line working zone to perform a specific task, that person shall be advised of the electrical hazards by the designated qualified person in charge to ensure that the unqualified person is safeguarded.

310.5 Safeguarding of Employees in the Cell Line Working Zone.

310.5(A) General.

Operation and maintenance of electrolytic cell lines might require contact by employees with exposed energized surfaces such as buses, electrolytic cells, and their attachments. The approach distances referred to in Table 130.4(E)(a) and Table 130.4(E)(b) shall not apply to work performed by qualified persons in the cell line working zone. Safeguards such as safety-related work practices and other safeguards shall be used to protect employees from injury while working in the cell line working zone. These safeguards shall be consistent with the nature and extent of the related electrical hazards. Safeguards might be different for energized cell lines and de-energized cell lines. Hazardous battery effect voltages shall be dissipated to consider a cell line de-energized.

> *Informational Note No. 1: Exposed energized surfaces might not present an electrical hazard. Shock hazards are related to current through the body, producing possible injury or damage to health. Shock severity is a function of many factors, including skin and body resistance, current path through the body, paths in parallel with the body, and system voltage. Arc flash burns and arc blasts are a function of the arcing current and the duration of arc exposure.*

> *Informational Note No. 2: A cell line or group of cell lines operated as a unit for the production of a particular metal, gas, or chemical compound might differ from other cell lines producing the same product because of variations in the particular raw materials used, output capacity, use of proprietary methods or process practices, or other modifying factors. Detailed standard electrical safety-related work practice requirements could become overly restrictive without accomplishing the stated purpose of Chapter 1.*

310.5(B) Signs.

Permanent signs shall clearly designate electrolytic cell areas.

310.5(C) Arc Flash Risk Assessment.

The requirements of 130.5, Arc Flash Risk Assessment, shall not be required for electrolytic cell line working zones.

310.5(C)(1) General.

Each task performed in the electrolytic cell line working zone shall be analyzed for the likelihood of arc flash injury. If there is a likelihood of personal injury, appropriate measures shall be taken to protect persons exposed to the arc flash hazards, including one or more of the following:

1) Providing appropriate PPE *[see 310.5(D)(2)]* to prevent injury from the arc flash hazard
2) Altering work procedures to reduce the likelihood of occurrence of an arc flash incident
3) Scheduling the task so that work can be performed when the cell line is de-energized

310.5(C)(2) Routine Tasks.

Arc flash risk assessment shall be done for all routine tasks performed in the cell line work zone. The results of the arc flash risk assessment shall be used in training employees in job procedures that minimize the possibility of arc flash hazards. The training shall be included in the requirements of 310.3.

310.5(C)(3) Nonroutine Tasks.

Before a nonroutine task is performed in the cell line working zone, an arc flash risk assessment shall be done. If an arc flash hazard is a possibility during nonroutine work, appropriate instructions shall be given to employees involved on how to minimize the risk associated with arc flash.

310.5(C)(4) Arc Flash Hazards.

If the likelihood of occurrence of an arc flash hazard exists for either routine or nonroutine tasks, employees shall use appropriate safeguards.

310.5(D) Safeguards.

Safeguards shall include one or a combination of the following means.

310.5(D)(1) Insulation.

Insulation shall be suitable for the specific conditions, and its components shall be permitted to include glass, porcelain, epoxy coating, rubber, fiberglass, and plastic and, when dry, such materials as concrete, tile, brick, and wood. Insulation shall be permitted to be applied to energized or grounded surfaces.

310.5(D)(2) Personal Protective Equipment (PPE).

PPE shall provide protection from electrical hazards. PPE shall include one or more of the following, as determined by authorized management:

1) Footwear for wet service
2) Gloves for wet service
3) Sleeves for wet service
4) Footwear for dry service
5) Gloves for dry service
6) Sleeves for dry service
7) Electrically insulated head protection
8) Protective clothing
9) Eye protection with nonconductive frames
10) Face shield (polycarbonate or similar nonmelting type)

    a) *PPE.* Personal and other protective equipment shall be appropriate for conditions, as determined by authorized management.
    b) *Testing of PPE.* PPE shall be verified with regularity and by methods that are consistent with the exposure of employees to electrical hazards.

310.5(D)(3) Barriers.

Barriers shall be devices that prevent contact with energized or grounded surfaces that could present an electrical hazard.

310.5(D)(4) Voltage Equalization.

Voltage equalization shall be permitted by bonding a conductive surface to an exposed energized surface, either directly or through a resistance, so that there is insufficient voltage to create an electrical hazard.

310.5(D)(5) Isolation.

Isolation shall be established by placing equipment or other items in locations such that employees are unable to simultaneously contact exposed conductive surfaces that could present an electrical hazard.

310.5(D)(6) Safe Work Practices.

Employees shall be trained in safe work practices. The training shall include why the work practices in a cell line working zone are different from similar work situations in other areas of the plant. Employees shall comply with established safe work practices and the safe use of protective equipment.

a) *Attitude Awareness.* Safe work practice training shall include attitude awareness instruction. Simultaneous contact with energized parts and ground can cause serious electrical shock. Of special importance is the need to be aware of body position where contact may be made with energized parts of the electrolytic cell line and grounded surfaces.

b) *Bypassing of Safety Equipment.* Safe work practice training shall include techniques to prevent bypassing the protection of safety equipment. Clothing may bypass protective equipment if the clothing is wet. Trouser legs should be kept at appropriate length, and shirt sleeves should be a good fit so as not to drape while reaching. Jewelry and other metal accessories that may bypass protective equipment shall not be worn while working in the cell line working zone.

310.5(D)(7) Tools.

Tools and other devices used in the energized cell line work zone shall be selected to prevent bridging between surfaces at hazardous potential difference.

Informational Note: Tools and other devices of magnetic material could be difficult to handle in the area of energized cells due to their strong dc magnetic fields.

310.5(D)(8) Portable Cutout-Type Switches.

Portable cell cutout switches that are connected shall be considered as energized and as an extension of the cell line working zone. Appropriate procedures shall be used to ensure proper cutout switch connection and operation.

310.5(D)(9) Cranes and Hoists.

Cranes and hoists shall meet the requirements of applicable codes and standards to safeguard employees. Insulation required for safeguarding employees, such as insulated crane hooks, shall be periodically tested.

310.5(D)(10) Attachments.

Attachments that extend the cell line electrical hazards beyond the cell line working zone shall use one or more of the following:

1) Temporary or permanent extension of the cell line working zone
2) Barriers
3) Insulating breaks
4) Isolation

310.5(D)(11) Pacemakers and Metallic Implants.

Employees with implanted pacemakers, ferromagnetic medical devices, or other electronic devices vital to life shall not be permitted in cell areas unless written permission is obtained from the employee's physician.

Informational Note: The American Conference of Governmental Industrial Hygienists (ACGIH) and IEEE 463, *Electrical Safety Practices in Electrolytic Cell Line Working Zones*, recommend that persons with implanted pacemakers should not be exposed to magnetic flux densities above 5 gauss.

310.5(D)(12) Testing.

Equipment safeguards for employee protection shall be tested to ensure they are in a safe working condition.

310.6 Portable Tools and Equipment.

Informational Note: The order of preference for the energy source for portable hand-held equipment is considered to be as follows:

1) Battery power
2) Pneumatic power
3) Portable generator
4) Nongrounded-type receptacle connected to an ungrounded source

310.6(A) Portable Electrical Equipment.

The grounding requirements of 110.9(B) shall not be permitted within an energized cell line working zone. Portable electrical equipment and associated power supplies shall meet the requirements of applicable codes and standards.

310.6(B) Auxiliary Nonelectric Connections.

Auxiliary nonelectric connections such as air, water, and gas hoses shall meet the requirements of applicable codes and standards. Pneumatic-powered tools and equipment shall be supplied with nonconductive air hoses in the cell line working zone.

310.6(C) Welding Machines.

Welding machine frames shall be considered at cell potential when within the cell line working zone. Safety-related work practices shall require that the cell line not be grounded through the welding machine or its power supply. Welding machines located outside the cell line working zone shall be barricaded to prevent employees from touching the welding machine and ground simultaneously where the welding cables are in the cell line working zone.

310.6(D) Portable Test Equipment.

Test equipment in the cell line working zone shall be suitable for use in areas of large magnetic fields and orientation.

> *Informational Note: Test equipment that is not suitable for use in such magnetic fields could result in an incorrect response. When such test equipment is removed from the cell line working zone, its performance might return to normal, giving the false impression that the results were correct.*

ARTICLE 360 Safety Requirements Related to Batteries and Battery Rooms

320.1 Scope.

This article covers electrical safety requirements for the practical safeguarding of employees while working with exposed stationary storage batteries that exceed 100 volts, nominal, or exceed a short-circuit power of 1000 watts.

Informational Note: 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*
2) *NFPA 70, National Electrical Code, Article 480, Storage Batteries, 2014*
3) *IEEE 450, IEEE Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications, 2010*
4) *IEEE 937, Recommended Practice for Installation and Maintenance of Lead-Acid Batteries for Photovoltaic Systems, 2007*
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)*
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*
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*

320.3 Safety Procedures.

320.3(A) General Safety Hazards.

320.3(A)(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: For an example of a risk assessment method for work on batteries, see F.7 and Figure F.7 in Informative Annex F.*

320.3(A)(3) Battery Room or Enclosure Requirements.

a) *Personnel Access to Energized Batteries.* Each battery room or battery enclosure shall be accessible only to authorized personnel.
b) *Illumination.* Employees shall not enter spaces containing batteries unless illumination is provided that enables the employees to perform the work safely.

Informational Note: Battery terminals are normally exposed and pose possible shock hazard. Batteries are also installed in steps or tiers that can cause obstructions.

320.3(A)(4) Apparel.
Personnel shall not wear electrically conductive objects such as jewelry while working on a battery system.

320.3(A)(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 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.

320.3(A)(6) Warning Signs.
The following warning signs or labels shall be posted in appropriate locations:

1) Electrical hazard warnings indicating the shock hazard due to the battery voltage and the arc flash hazard due to the prospective short-circuit current, and the thermal hazard.

   Informational Note No.1: Because internal resistance, prospective short-circuit current, or both are not always provided on battery container labels or data sheets, and because many variables can be introduced into a battery layout, the battery manufacturer should be consulted for accurate data. Variables can include, but are not limited to, the following:

   a) Series connections
   b) Parallel connections
   c) Charging methodology
   d) Temperature
   e) Charge status
   f) Dc distribution cable size and length

   Informational Note No. 2: See 130.5(D) for requirements for equipment labeling.

2) Chemical hazard warnings, applicable to the worst case when multiple battery types are installed in the same space, indicating the following:
   a) Potential presence of explosive gas (when applicable to the battery type)
   b) Prohibition of open flame and smoking
   c) Danger of chemical burns from the electrolyte (when applicable to the battery type)
3) Notice for personnel to use and wear protective equipment and apparel appropriate to the hazard for the battery
4) Notice prohibiting access to unauthorized personnel

320.3(B) Electrolyte Hazards.
320.3(B)(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 ANSI/ISEA Z358.1, American National Standard for Emergency Eye Wash and Shower Equipment.

320.3(B)(2) Activities That Do Not Include Handling of Electrolyte.

Employees performing any activity not involving the handling of electrolyte shall wear safety glasses.

Informational Note: Battery maintenance activities usually do not involve handling electrolyte. Batteries that are hermetically sealed (such as most lithium batteries) or immobilized electrolyte (such as valve-regulated lead acid batteries) present little or no electrolyte hazard. Most modern density meters expose a worker to a quantity of electrolyte too minute to be considered hazardous, if at all. Such work would not be considered handling electrolyte. However, if specific gravity readings are taken using a bulb hydrometer, the risk of exposure is higher — this could be considered to be handling electrolyte, and the requirements of 320.3(B)(1) would apply.

320.3(C) Tools and Equipment.

320.3(C)(1) Handles.

Tools and equipment for work on batteries shall be equipped with insulated handles rated for the voltage on which they are used. The length and insulation of tools for work on batteries shall be selected to minimize the risk of inadvertent short circuit.

320.3(C)(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.

320.3(C)(3) Nonsparking Tools.

Nonsparking tools shall be required when the risk assessment required by 110.5(H) justifies their use.

320.3(D) Cell Flame Arresters and Cell Ventilation.

When present, battery cell ventilation openings shall be unobstructed. Cell flame arresters shall be inspected for proper installation and unobstructed ventilation and shall be replaced when necessary in accordance with the manufacturer's instructions.

Chapter 3 Safety Requirements for Special Equipment

ARTICLE 300 Introduction

300.1 Scope.

Chapter 3 covers special electrical equipment in the workplace, and modifies the general requirements of Chapter 1.

300.2 Responsibility.

The employer shall provide safety-related work practices and employee training on the material covered in this Chapter, in addition to those in Chapter 1. The employee shall follow those work practices.

300.3 Organization.

Chapter 3 of this standard is divided into articles. Article 300 applies generally. Article 310 applies to dc electrical hazards. Article 320 applies to capacitor electrical hazards. Article 330 covers electrical hazards from 1 Hz to 100 MHz, other than 50/60 Hz. Article 350~~310~~ applies to electrolytic cells. Article 360 ~~320~~ applies to batteries and battery rooms. ~~Article 330 applies to lasers. Article 340 applies to power electronic equipment. Article 350 applies to research and development (R&D) laboratories. Article 360 applies to safety-related requirements for capacitors.~~

ARTICLE 305 General Requirements

See below, modified previous Article 350.

ARTICLE 310 DC Electrical Hazards

310.1 Scope.

This article covers the electrical safety-related requirements for the practical safeguarding of employees while working with direct current (dc) that present an electrical hazard.

310.2 DC Electrical Hazard Thresholds

310.2(A) Electrical Thermal Hazard Thresholds

For dc systems, hazardous ~~current~~power is considered greater than or equal to 1000 W.

310.2(B) Electrical Shock Hazard Thresholds.

For dc systems, hazardous voltage is considered greater than or equal to 100 volts dc and 40 mA.

310.2(C) Electrical Arc Flash Hazard Thresholds.

For dc systems, hazardous arc flash is considered for systems greater than or equal to 150 volts dc and 17,000 amps dc.

ARTICLE 320 Capacitor Electrical Hazards

See below, no changes except for 2024 PIs.

ARTICLE 330 Electrical Hazards 1 Hz to 100 MHz (not including 50/60 Hz)

330.1 Scope

This article shall apply to safety-related work practices around electrical equipment that includes ac waveforms from 1 Hz to 3 kHz (sub RF) and 3 kHz to 110 MHz (RF), 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. Equipment that includes rectifiers and inverters such as the following:
    0. Motor drives
    1. Uninterruptible power supply systems
    2. 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:
    0. Antennas and RF transmission lines
    1. Radar equipment
    2. Industrial scientific and medical equipment
    3. RF induction and dielectric heaters
    4. Industrial microwave heaters and diathermy radiators
    5. Magnetic resonance imagers (MRIs)
    6. Large electromagnets

Informational Note: See the following standards for specific guidance 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*
3. International Commission on Radiological Protection (ICRP) Publication 33, *Protection Against Ionizing Radiation from External Sources Used in Medicine*

340.~~3~~ 2 Application.
The purpose of this article is to provide guidance for safety personnel in preparing specific safety-related work practices for sub RF and RF electrical hazards within their industry or laboratory.

340.3 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 $(f/3)*^{0.3}$, f in MHz
7. AC (30 MHz to 110 MHz): 200 mA

ARTICLE 35~~1~~0 Safety-Related Work Practices for Electrolytic Cells
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 NFPA 70, National Electrical Code, Article 668.

Informational Note No. 3: 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.

~~310.2 Definitions.~~
~~For the purposes of this article, the definitions that follow shall apply.~~

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~~Battery Effect.~~
~~A voltage that exists on the cell line after the power supply is disconnected.~~

~~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.~~

~~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.~~

310.3 Safety Training.
310.3(A) General.
The training requirements of this chapter shall apply to employees exposed to electrical hazards in the cell line working zone defined in 110.6 and shall supplement or modify the requirements of 110.3, 120.5, 130.1, and 130.9.

310.3(B) Training Requirements.
Employees shall be trained to understand the specific electrical hazards associated with electrical energy on the cell line. Employees shall be trained in safety-related work practices and procedural requirements to provide protection from the electrical hazards associated with their respective job or task assignment.

310.4 Employee Training.
310.4(A) Qualified Persons.
310.4(A)(1) Training.
Qualified persons shall be trained and knowledgeable in the operation of cell line working zone equipment and specific work methods and shall be trained to avoid the electrical hazards that are present. Such persons shall be familiar with the proper use of precautionary techniques and PPE. Training for a qualified person shall include the following:

1) Skills and techniques to avoid a shock hazard:
    a. Between exposed energized surfaces, which might include temporarily insulating or guarding parts to permit the employee to work on exposed energized parts
    b. Between exposed energized surfaces and grounded equipment, other grounded objects, or the earth itself, that might include temporarily insulating or guarding parts to permit the employee to work on exposed energized parts
2) Method of determining the cell line working zone area boundaries

310.4(A)(2) Qualified Persons.
Qualified persons shall be permitted to work within the cell line working zone.

310.4(B) Unqualified Persons.

310.4(B)(1) Training.
Unqualified persons shall be trained to identify electrical hazards to which they could be exposed and the proper methods of avoiding the hazards.

310.4(B)(2) In Cell Line Working Zone.
When there is a need for an unqualified person to enter the cell line working zone to perform a specific task, that person shall be advised of the electrical hazards by the designated qualified person in charge to ensure that the unqualified person is safeguarded.

310.5 Safeguarding of Employees in the Cell Line Working Zone.
310.5(A) General.
Operation and maintenance of electrolytic cell lines might require contact by employees with exposed energized surfaces such as buses, electrolytic cells, and their attachments. The approach distances referred to in Table 130.4(E)(a) and Table 130.4(E)(b) shall not apply to work performed by qualified persons in the cell line working zone. Safeguards such as safety-related work practices and other safeguards shall be used to protect employees from injury while working in the cell line working zone. These safeguards shall be consistent with the nature and extent of the related electrical hazards. Safeguards might be different for energized cell lines and de-energized cell lines. Hazardous battery effect voltages shall be dissipated to consider a cell line de-energized.

Informational Note No. 1: Exposed energized surfaces might not present an electrical hazard. Shock hazards are related to current through the body, producing possible injury or damage to health. Shock severity is a function of many factors, including skin and body resistance, current path through the body, paths in parallel with the body, and system voltage. Arc flash burns and arc blasts are a function of the arcing current and the duration of arc exposure.

Informational Note No. 2: A cell line or group of cell lines operated as a unit for the production of a particular metal, gas, or chemical compound might differ from other cell lines producing the same product because of variations in the particular raw materials used, output capacity, use of proprietary methods or process practices, or other modifying factors. Detailed standard electrical safety-related work practice requirements could become overly restrictive without accomplishing the stated purpose of Chapter 1.

310.5(B) Signs.
Permanent signs shall clearly designate electrolytic cell areas.

310.5(C) Arc Flash Risk Assessment.
The requirements of 130.5, Arc Flash Risk Assessment, shall not be required for electrolytic cell line working zones.

310.5(C)(1) General.
Each task performed in the electrolytic cell line working zone shall be analyzed for the likelihood of arc flash injury. If there is a likelihood of personal injury, appropriate measures shall be taken to protect persons exposed to the arc flash hazards, including one or more of the following:

1) Providing appropriate PPE *[see 310.5(D)(2)]* to prevent injury from the arc flash hazard
2) Altering work procedures to reduce the likelihood of occurrence of an arc flash incident
3) Scheduling the task so that work can be performed when the cell line is de-energized

310.5(C)(2) Routine Tasks.
Arc flash risk assessment shall be done for all routine tasks performed in the cell line work zone. The results of the arc flash risk assessment shall be used in training employees in job procedures that minimize the possibility of arc flash hazards. The training shall be included in the requirements of 310.3.

310.5(C)(3) Nonroutine Tasks.
Before a nonroutine task is performed in the cell line working zone, an arc flash risk assessment shall be done. If an arc flash hazard is a possibility during nonroutine work, appropriate instructions shall be given to employees involved on how to minimize the risk associated with arc flash.

310.5(C)(4) Arc Flash Hazards.

If the likelihood of occurrence of an arc flash hazard exists for either routine or nonroutine tasks, employees shall use appropriate safeguards.

310.5(D) Safeguards.
Safeguards shall include one or a combination of the following means.

310.5(D)(1) Insulation.
Insulation shall be suitable for the specific conditions, and its components shall be permitted to include glass, porcelain, epoxy coating, rubber, fiberglass, and plastic and, when dry, such materials as concrete, tile, brick, and wood. Insulation shall be permitted to be applied to energized or grounded surfaces.

310.5(D)(2) Personal Protective Equipment (PPE).
PPE shall provide protection from electrical hazards. PPE shall include one or more of the following, as determined by authorized management:

1) Footwear for wet service
2) Gloves for wet service
3) Sleeves for wet service
4) Footwear for dry service
5) Gloves for dry service
6) Sleeves for dry service
7) Electrically insulated head protection
8) Protective clothing
9) Eye protection with nonconductive frames
10) Face shield (polycarbonate or similar nonmelting type)

    a) *PPE.* Personal and other protective equipment shall be appropriate for conditions, as determined by authorized management.
    b) *Testing of PPE.* PPE shall be verified with regularity and by methods that are consistent with the exposure of employees to electrical hazards.

310.5(D)(3) Barriers.
Barriers shall be devices that prevent contact with energized or grounded surfaces that could present an electrical hazard.

310.5(D)(4) Voltage Equalization.
Voltage equalization shall be permitted by bonding a conductive surface to an exposed energized surface, either directly or through a resistance, so that there is insufficient voltage to create an electrical hazard.

310.5(D)(5) Isolation.
Isolation shall be established by placing equipment or other items in locations such that employees are unable to simultaneously contact exposed conductive surfaces that could present an electrical hazard.

310.5(D)(6) Safe Work Practices.
Employees shall be trained in safe work practices. The training shall include why the work practices in a cell line working zone are different from similar work situations in other areas of the plant. Employees shall comply with established safe work practices and the safe use of protective equipment.

a) *Attitude Awareness.* Safe work practice training shall include attitude awareness instruction. Simultaneous contact with energized parts and ground can cause serious electrical shock. Of special importance is the need to be aware of body position where contact may be made with energized parts of the electrolytic cell line and grounded surfaces.
b) *Bypassing of Safety Equipment.* Safe work practice training shall include techniques to prevent bypassing the protection of safety equipment. Clothing may bypass protective equipment if the clothing is wet. Trouser legs should be kept at appropriate length, and shirt sleeves should be a good fit so as not to drape while reaching. Jewelry and other metal accessories that may bypass protective equipment shall not be worn while working in the cell line working zone.

310.5(D)(7) Tools.
Tools and other devices used in the energized cell line work zone shall be selected to prevent bridging between surfaces at hazardous potential difference.

Informational Note: Tools and other devices of magnetic material could be difficult to handle in the area of energized cells due to their strong dc magnetic fields.

310.5(D)(8) Portable Cutout-Type Switches.
Portable cell cutout switches that are connected shall be considered as energized and as an extension of the cell line working zone. Appropriate procedures shall be used to ensure proper cutout switch connection and operation.

310.5(D)(9) Cranes and Hoists.
Cranes and hoists shall meet the requirements of applicable codes and standards to safeguard employees. Insulation required for safeguarding employees, such as insulated crane hooks, shall be periodically tested.

310.5(D)(10) Attachments.
Attachments that extend the cell line electrical hazards beyond the cell line working zone shall use one or more of the following:

1) Temporary or permanent extension of the cell line working zone
2) Barriers
3) Insulating breaks
4) Isolation

310.5(D)(11) Pacemakers and Metallic Implants.
Employees with implanted pacemakers, ferromagnetic medical devices, or other electronic devices vital to life shall not be permitted in cell areas unless written permission is obtained from the employee's physician.

Informational Note: The American Conference of Governmental Industrial Hygienists (ACGIH) and IEEE 463, *Electrical Safety Practices in Electrolytic Cell Line Working Zones*, recommend that persons with implanted pacemakers should not be exposed to magnetic flux densities above 5 gauss.

310.5(D)(12) Testing.
Equipment safeguards for employee protection shall be tested to ensure they are in a safe working condition.

310.6 Portable Tools and Equipment.
Informational Note: The order of preference for the energy source for portable hand-held equipment is considered to be as follows:

1) Battery power
2) Pneumatic power
3) Portable generator
4) Nongrounded-type receptacle connected to an ungrounded source

310.6(A) Portable Electrical Equipment.
The grounding requirements of 110.9(B) shall not be permitted within an energized cell line working zone. Portable electrical equipment and associated power supplies shall meet the requirements of applicable codes and standards.

310.6(B) Auxiliary Nonelectric Connections.
Auxiliary nonelectric connections such as air, water, and gas hoses shall meet the requirements of applicable codes and standards. Pneumatic-powered tools and equipment shall be supplied with nonconductive air hoses in the cell line working zone.

310.6(C) Welding Machines.
Welding machine frames shall be considered at cell potential when within the cell line working zone. Safety-related work practices shall require that the cell line not be grounded through the welding machine or its power supply.

Welding machines located outside the cell line working zone shall be barricaded to prevent employees from touching the welding machine and ground simultaneously where the welding cables are in the cell line working zone.

310.6(D) Portable Test Equipment.
Test equipment in the cell line working zone shall be suitable for use in areas of large magnetic fields and orientation.

> *Informational Note: Test equipment that is not suitable for use in such magnetic fields could result in an incorrect response. When such test equipment is removed from the cell line working zone, its performance might return to normal, giving the false impression that the results were correct.*

ARTICLE 36~~2~~0 Safety Requirements Related to Batteries and Battery Rooms

320.1 Scope.
This article covers electrical safety requirements for the practical safeguarding of employees while working with exposed stationary storage batteries that exceed 10~~5~~0 volts, nominal, or exceed a short-circuit power of 1000 watts.~~.~~

> *Informational Note: 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*
2) *NFPA 70, National Electrical Code, Article 480, Storage Batteries, 2014*
3) *IEEE 450, IEEE Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications, 2010*
4) *IEEE 937, Recommended Practice for Installation and Maintenance of Lead-Acid Batteries for Photovoltaic Systems, 2007*
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)*
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*
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*

~~320.2 Definitions.~~
~~For the purposes of this article definitions that follow shall apply.~~

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~~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.~~

~~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.~~

~~Battery Room.~~
~~A room specifically intended for the installation of batteries that have no other protective enclosure.~~

~~Cell.~~
~~The basic electrochemical unit, characterized by an anode and a cathode used to receive, store, and deliver electrical energy.~~

~~**Electrolyte.**~~
~~A solid, liquid, or aqueous immobilized liquid medium that provides the ion transport mechanism between the positive and negative electrodes of a cell.~~

~~**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.~~

~~**Pilot Cell.**~~
~~One or more cells chosen to represent the operating parameters of the entire battery (sometimes called "temperature reference" cell).~~

~~**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.~~

> ~~*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.*~~

~~**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.~~

~~**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.")~~

320.3 Safety Procedures.
320.3(A) General Safety Hazards.
320.3(A)(1) Energy Thresholds.
Energy exposure levels shall not exceed those identified in the following list unless appropriate controls are implemented:

1) AC: 50 volts and 5 milliamperes
2) DC: 100 volts

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

320.3(A)(2) Battery Risk Assessment.
Prior to any work on a battery system, a risk assessment shall be performed to identify the chemical, electrical shock, and arc flash hazards and assess the risks associated with the type of tasks to be performed.

Informational Note: For an example of a risk assessment method for work on batteries, see F.7 and Figure F.7 in Informative Annex F.

320.3(A)(3) Battery Room or Enclosure Requirements.

a) *Personnel Access to Energized Batteries.* Each battery room or battery enclosure shall be accessible only to authorized personnel.
b) *Illumination.* Employees shall not enter spaces containing batteries unless illumination is provided that enables the employees to perform the work safely.

Informational Note: Battery terminals are normally exposed and pose possible shock hazard. Batteries are also installed in steps or tiers that can cause obstructions.

320.3(A)(4) Apparel.
Personnel shall not wear electrically conductive objects such as jewelry while working on a battery system.

320.3(A)(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 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.

320.3(A)(6) Warning Signs.
The following warning signs or labels shall be posted in appropriate locations:

1) Electrical hazard warnings indicating the shock hazard due to the battery voltage and the arc flash hazard due to the prospective short-circuit current, and the thermal hazard.

   Informational Note No.1: Because internal resistance, prospective short-circuit current, or both are not always provided on battery container labels or data sheets, and because many variables can be introduced into a battery layout, the battery manufacturer should be consulted for accurate data. Variables can include, but are not limited to, the following:

   a) Series connections
   b) Parallel connections
   c) Charging methodology
   d) Temperature
   e) Charge status
   f) Dc distribution cable size and length

   Informational Note No. 2: See 130.5(D) for requirements for equipment labeling.

2) Chemical hazard warnings, applicable to the worst case when multiple battery types are installed in the same space, indicating the following:
   a) Potential presence of explosive gas (when applicable to the battery type)
   b) Prohibition of open flame and smoking
   c) Danger of chemical burns from the electrolyte (when applicable to the battery type)
3) Notice for personnel to use and wear protective equipment and apparel appropriate to the hazard for the battery
4) Notice prohibiting access to unauthorized personnel

320.3(B) Electrolyte Hazards.
320.3(B)(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 ANSI/ISEA Z358.1, American National Standard for Emergency Eye Wash and Shower Equipment.

320.3(B)(2) Activities That Do Not Include Handling of Electrolyte.
Employees performing any activity not involving the handling of electrolyte shall wear safety glasses.

> *Informational Note: Battery maintenance activities usually do not involve handling electrolyte. Batteries that are hermetically sealed (such as most lithium batteries) or immobilized electrolyte (such as valve-regulated lead acid batteries) present little or no electrolyte hazard. Most modern density meters expose a worker to a quantity of electrolyte too minute to be considered hazardous, if at all. Such work would not be considered handling electrolyte. However, if specific gravity readings are taken using a bulb hydrometer, the risk of exposure is higher — this could be considered to be handling electrolyte, and the requirements of 320.3(B)(1) would apply.*

320.3(C) Tools and Equipment.
320.3(C)(1) Handles.
Tools and equipment for work on batteries shall be equipped with handles listed as insulated for the maximum working voltage.

320.3(C)(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.

320.3(C)(3) Nonsparking Tools.
Nonsparking tools shall be required when the risk assessment required by 110.5(H) justifies their use.

320.3(D) Cell Flame Arresters and Cell Ventilation.
When present, battery cell ventilation openings shall be unobstructed. Cell flame arresters shall be inspected for proper installation and unobstructed ventilation and shall be replaced when necessary in accordance with the manufacturer's instructions.

~~ARTICLE 330 Safety-Related Work Practices: Lasers~~
~~330.1 Scope.~~
~~This article applies to 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 ANSI Z136.1, Standard for Safe Use of Lasers.*~~

> ~~*Informational Note No. 2: For laser product requirements for laser manufacturers, see 21 CFR Part 1040, "Performance Standards for Light-Emitting Products," Sections 1040.10 "Laser products" and 1040.11, "Specific purpose laser products."*~~

~~330.2 Definitions.~~
~~For the purposes of this article, the following definitions shall apply.~~

~~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: The evaluation approval ensures that the equipment meets appropriate codes and standards or is similarly found suitable for a specified purpose.*~~

~~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.~~

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~~**Laser Energy Source.**~~
~~Any device intended for use in conjunction with a laser to supply energy for the excitation of electrons, ions, or molecules.~~

~~**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.~~

~~**Laser System.**~~
~~A laser in combination with an appropriate laser energy source with or without additional incorporated components.~~

~~**Protective Barrier.**~~
~~Prevents user access to a hazardous voltage, current, or stored energy area.~~

~~**330.3 Hazardous Energy.**~~
~~**330.3(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.~~

~~**330.3(B) 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.~~

~~**330.4 Electrical Safety Training.**~~
~~**330.4(A) Personnel to Be Trained.**~~
~~Employers shall provide training for all personnel who work on or are near lasers or laser systems with user-accessible hazardous voltage, current, or stored energy (e.g., flashlamp-pumped lasers).~~

~~**330.4(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 bank explosion potential~~
4) ~~Ionizing radiation~~
5) ~~X-ray hazards from high-voltage equipment (>5 kV)~~
6) ~~Assessing the listing status of electrical equipment and the need for field evaluation of nonlisted equipment~~

~~**330.5 Safeguarding of Persons from Electrical Hazards Associated with Lasers and Laser Systems.**~~
~~**330.5(A) Temporary Guarding.**~~
~~Temporary guarding (e.g., covers, protective insulating barriers) shall be used to limit exposure to any electrical hazard when the permanent laser enclosure covers are removed for maintenance and testing.~~

~~**330.5(B) Work Requiring an Electrically Safe Work Condition.**~~
~~Work that might expose employees to electrical hazards shall be performed with the equipment in an electrically safe work condition in accordance with 120.1, 120.2, and 110.3.~~

~~**330.5(C) Energized Electrical Testing.**~~
~~Energized electrical testing, troubleshooting, and voltage testing shall not require an energized work permit in accordance with 130.2(C).~~

~~**330.5(D) Warning Signs and Labels.**~~
~~Electrical safety warning signs and labels shall be posted as applicable on electrical equipment doors, covers, and protective barriers. The warning signs and labels shall adequately warn of the hazard using effective words, colors,~~

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~~and symbols. These signs and labels shall be permanently affixed to the equipment and shall be of sufficient durability to withstand the environment involved.~~

~~330.5(E) Listing.~~
~~Laser system electrical equipment shall be listed or field evaluated prior to use.~~

~~330.6 Responsibility for Electrical Safety.~~
~~All persons with access to hazardous voltage, current, or stored energy shall be responsible for the following:~~

1) ~~Obtaining authorization for work with or on hazardous electrical equipment in lasers and laser systems~~
2) ~~Use of Chapter 1 safety-related work practices~~
3) ~~Reporting laser equipment failures, accidents, inadequate barriers, and inadequate signage to the employer~~

~~ARTICLE 340 Safety-Related Work Practices: Power Electronic Equipment~~

~~340.1 Scope.~~
~~This article shall apply to 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 that includes rectifiers and inverters such as the following:~~
    a) ~~Motor drives~~
    b) ~~Uninterruptible power supply systems~~
    c) ~~Lighting controllers~~

~~Informational Note: The following standards provide specific guidance for safety-related work practices around power electronic equipment: International Electrotechnical Commission IEC 60479-1, Effects of Current on Human Beings and Livestock, Part 1: General Aspects, and the International Commission on Radiological Protection (ICRP) Publication 33, Protection Against Ionizing Radiation from External Sources Used in Medicine.~~

~~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.~~

~~340.3 Application.~~
~~The purpose of this article is to provide guidance for safety personnel in preparing specific safety-related work practices within their industry.~~

~~340.4 Hazards Associated with Power Electronic Equipment.~~
~~The employer and employees shall be aware of the hazards associated with the following:~~

1) ~~High voltages within the power supplies~~
2) ~~Radio frequency energy–induced high voltages~~
3) ~~Effects of RF fields in the vicinity of antennas and antenna transmission lines, which can introduce electrical shock and burns~~
4) ~~Ionizing (X-radiation) hazards from magnetrons, klystrons, thyratrons, cathode-ray tubes, and similar devices~~
5) ~~Nonionizing RF radiation hazards from the following:~~
    a) ~~Radar equipment~~
    b) ~~Radio communication equipment, including broadcast transmitters~~
    c) ~~Satellite–earth-transmitters~~

~~d) Industrial scientific and medical equipment~~
~~e) RF induction heaters and dielectric heaters~~
~~f) Industrial microwave heaters and diathermy radiators~~

~~340.5 Specific Measures for Personnel Safety.~~
~~340.5(A) Employer Responsibility.~~
~~The employer shall be responsible for the following:~~

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

~~340.5(B) Employee Responsibility.~~
~~The employee shall be responsible for the following:~~

1) ~~Understanding the hazards associated with the work~~
2) ~~Being continuously alert and aware of the possible hazards~~
3) ~~Using the proper tools and procedures for the work~~
4) ~~Informing the employer of malfunctioning protective measures, such as faulty or inoperable enclosures and locking schemes~~
5) ~~Examining all documents provided by the employer relevant to the work to identify the location of components that present an electrical hazard~~
6) ~~Maintaining good housekeeping around the equipment and work space~~
7) ~~Reporting any incident that resulted in, or could have resulted in, injury or damage to health~~
8) ~~Using and appropriately maintaining the PPE and tools required to perform the work safely~~

ARTICLE 305~~50~~ ~~Safety-Related Work Requirements: Research and Development Laboratories~~General Requirements

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

~~350.2 Definitions.~~
~~For the purposes of this article, the definitions that follow shall apply.~~

~~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.~~

~~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. The evaluation approval ensures that the equipment meets appropriate codes and standards, or is similarly found suitable for a specified purpose.~~

~~Informational Note: For additional information on recommended practices and procedures for the field evaluation of nonlisted equipment, see NFPA 791, *Recommended Practice and Procedures for Unlabeled Electrical Equipment Evaluation*. For help in evaluating whether third-party entities are acceptable to an authority having jurisdiction, see NFPA 790, *Standard for Competency of Third-Party, Field Evaluation Bodies*.~~

~~**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.~~

~~**Research and Development (R&D).**~~
~~An activity in an installation specifically designated for research or development conducted with custom or special electrical equipment.~~

305.1~~50.3~~ Applications of Other Articles.

The special electrical equipment~~system for R&D and laboratory applications~~covered by this chapter shall meet the requirements of the remainder of this document, except as amended by ~~Article 350~~this chapter.

> *Informational Note: Examples of these applications include low-voltage–high-current power systems; high-voltage–low-current power systems; dc power supplies; capacitors; cable trays for signal; and, custom-made electronic equipment. Examples of specialized equipment include energy conversion (ac to dc, dc to ac), energy storage systems, accelerators, all sub RF and RF systems, lasers, medical and laboratory diagnostic equipment, and process equipment using dc and RF (e.g., induction).*

305~~50~~.2~~4~~ Electrical Safety Authority (ESA).

~~Each~~ A laboratory or ~~R&D system application~~specialized industry shall be permitted to assign an ESA to ensure the use of appropriate electrical safety-related work practices and controls covered in this chapter. The ESA shall be permitted to be an electrical safety committee, engineer, or equivalent qualified individual. The ESA shall be permitted to delegate authority to an individual or organization within their control.

305.2~~50.4~~(A) Responsibility.

The ESA shall act in a manner similar to an authority having jurisdiction for ~~R&D~~specialized electrical systems and electrical safe work practices.

305.2~~50.4~~(B) Qualifications.

The ESA shall be competent in the following:

1) The requirements of this standard
2) Electrical system requirements applicable to the ~~R&D laboratories~~special electrical hazards and equipment covered by this chapter, including nonionizing and ionizing radiation.

305.3~~50.5~~ Specific Measures and Controls for Personnel Safety.

Each laboratory or ~~R&D system application~~specialized industry shall designate a competent person as defined in this article to ensure the use of appropriate electrical safety-related work practices and controls.

305.3~~50.5~~(A) Job Briefings.

Job briefings shall be performed in accordance with 110.5(I).

Exception: Prior to starting work, a brief discussion shall be permitted if the task and hazards are documented and the employee has reviewed applicable documentation and is qualified for the task.

305.3~~50.5~~(B) Personnel Protection.

Safety-related work practices shall be used to safeguard employees from injury while they are exposed to electrical hazards from exposed electrical conductors or circuit parts that are or can become energized. The specific safety-related work practices shall be consistent with the electrical hazard(s) and the associated risk. For calibration and adjustment of equipment as it pertains to sensors, motor controllers, control hardware, and other devices that need to be installed inside equipment or control cabinet, surrounded by electrical hazards, the ESA shall define the required PPE based on the risk and exposure.

Use of electrical insulating blankets, covers, or barriers shall be permitted to prevent inadvertent contact to exposed terminals and conductors. Insulated/nonconductive adjustment and alignment tools shall be used where feasible.

305.4~~50.6~~ Approval Requirements.
The equipment or systems used in the ~~R&D area or in the~~ laboratory or specialized industry shall be listed or field evaluated prior to use.

> *Informational Note: Laboratory and ~~R&D~~specialized electrical equipment or systems can pose unique electrical hazards that might require mitigation. Such hazards include ac and dc, low voltage and high amperage, high voltage and low current, large electromagnetic fields, induced voltages, pulsed power, multiple frequencies, and similar exposures.*

305.5~~50.7~~ Custom Built, Non-Listed Specialized Electrical~~Research~~ Equipment, 1000 Volts or less AC or DC.
305.5~~50.7~~(A) Equipment Marking and Documentation.
305.5~~50.7~~(A)(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 ANSI Z535, Series of Standards for Safety Signs and Tags, for more information on precautionary marking of electrical systems or equipment.*

305.5~~50.7~~(A)(2) Documentation.
Sufficient documentation shall be provided and readily available to personnel that install, operate, and maintain equipment that describes operation, shutdown, safety concerns, and nonstandard installations.

Schematics, drawings, and bill of materials describing power feeds, voltages, currents, and parts used for construction, maintenance, and operation of the equipment shall be provided.

305.5~~50.7~~(A)(3) Shutdown Procedures.
Safety requirements and emergency shutdown procedures of equipment shall include lockout/tagout (LOTO) requirements. If equipment-specific LOTO is required, then documentation outlining this procedure and PPE requirements shall be made readily available.

305.5~~50.7~~(A)(4) Specific Hazards.
Specific hazards, other than electrical, associated with research and specialized electrical equipment shall be documented and readily available.

305.5~~50.7~~(A)(5) Approvals.
Drawings, standard operational procedures, and equipment shall be approved by the ESA on site before initial startup. Assembly of equipment shall comply with national standards where applicable unless research or industrial application requires exceptions. Equipment that does not meet the applicable standards shall be required to be approved by the ESA. Proper safety shutdown procedures and PPE requirements shall be considered in the absence of grounding and/or bonding.

305.5~~50.7~~(B) Tools, Training, and Maintenance.
Documentation shall be provided if special tools, unusual PPE, or other equipment is necessary for proper maintenance and operation of equipment. The ESA shall make the determination of appropriate training and qualifications required to perform specific tasks.

305.6~~50.8~~ Custom Built, Unlisted Electrical~~Research~~ Equipment, >1000 V AC or DC.

Installations shall comply with all requirements of ~~3~~ 305.5~~50.7.~~

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In the event that ~~research~~ specialized electrical equipment requires PPE beyond what is commercially available, the ESA shall determine safe work practices and PPE to be used.

~~350.9 Energy Thresholds.~~

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~~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 Department of Energy, DOE Electrical Safety Handbook, DOE-HDBK-1092.*~~

~~*Informational Note No. 2: See 360.3 and Informative Annex R for information on capacitor hazards and controls.*~~

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305.7~~50.10~~ Establishing an Electrically Safe Work Condition.

Energized electrical conductors and circuit parts shall be put into an electrically safe work condition before an employee performs work.

Exception: At the discretion of the ESA, alternative methods of ensuring worker safety shall be permitted to be employed for the following conditions:

1) *Minor tool changes and adjustments, and other normal production operations that are routine, repetitive, or sequential and integral to the use of the equipment for production*
2) *Minor changes to the unit under test and other minor servicing activities, to include the activities listed under 305.7 ~~50.10~~ Exception condition (1), that take place during research and development*
3) *Work on cord-and-plug-connected equipment for which exposure to the hazards of unexpected energization or start up is controlled by the following:*
    a) *Unplugging the equipment from the energy source*
    b) *The employee performing the work maintaining exclusive control of the plug*

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ARTICLE 32~~6~~0 ~~Safety-Related Requirements for~~ Capacitors Electrical Hazards

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: For more information on working safely with capacitors, see Informative Annex R, Working with Capacitors.

360.2 Definitions.

Arc Blast Hazard.
A source of possible injury or damage to health from the energy deposited into acoustical shock-wave and high-velocity shrapnel.

Bleed Resistor.
A resistor network connected in parallel with a capacitor's terminals that drains the charge after power has been disconnected.

Charge Transfer.

Improper discharging of capacitor networks that results in transferring from one capacitor to another charge instead of fully discharging the stored energy.

Dielectric Absorption.
The property of certain capacitors to recharge after being discharged.

Informational Note: A voltage recharge of up to 10 percent can occur a few minutes after the grounding or shorting device has been removed.

Discharge Time.
The time required to discharge a capacitor to below a stored energy hazard threshold.

Ground Stick.
A device that is used to ensure that the capacitor is discharged by applying it to all terminals of the capacitor element.

Informational Note: This is also called a ground hook and could incorporate power-rated discharge resistors for high-energy applications.

Hard Grounding (Low-Z).
The practice of discharging a capacitor through a low impedance, also called Low-Z (impedance) grounding.

Hearing Protection Boundary.
Worker distance at which a 1 percent probability of ear damage exists from a 20 kPa (3.0 psi) shock wave.

Lung Protection Boundary.
Worker distance at which a 1 percent probability of lung damage exists from a 70 kPa (10 psi) shock wave.

Soft Grounding (High-Z).
The practice of connecting a capacitor to ground through a power resistor to avoid the hazards related with hard grounding.

Time Constant.
The time it takes for voltage to drop by ~63 percent (1/e) during discharge.

360.3 Stored Energy Hazard Thresholds.
Appropriate controls shall be applied where any of the following hazard thresholds are exceeded:

1) Less than 100 volts and greater than 100 joules of stored energy
2) Greater than or equal to 100 volts and greater than 1.0 joule of stored energy
3) Greater than or equal to 400 volts and greater than 0.25 joules of stored energy

360.4 Specific Measures for Personnel Safety.
360.4(A) Qualification and Training.
The following qualifications and training shall be required for personnel safety:

1) Employees who perform work on electrical equipment with capacitors that exceed the energy thresholds in 360.3 shall be qualified and shall be trained in, and familiar with, the specific hazards and controls required for safe work.
2) Unqualified persons who perform work on electrical equipment with capacitors shall be trained in, and familiar with, any electrical safety-related work practices necessary for their safety.

360.4(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 110.5(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 130.7(E) 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: 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.

360.5 Establishing an Electrically Safe Work Condition for a Capacitor(s).
360.5(A) Written Procedure.
Where a conductor or circuit part is connected to a capacitor(s) operating at or above the thresholds in 360.3, a written procedure shall be used to document the necessary steps and sequence to discharge the capacitor(s) and place the equipment into an electrically safe work condition. The written procedure shall incorporate the results of the risk assessment performed in 360.5(B) and specify the following at a minimum:

360.5(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 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 on a known dc voltage source. 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.

360.6 Grounding Sticks.
Grounding 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 sticks shall be designed, constructed, installed, and periodically inspected so that the full energy and voltage of the capacitors can be safely discharged.

360.6(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.

360.6(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.

360.6(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.*

Summary of Reorganization of Chapter 3

Order was changed from

ARTICLE 300 Introduction	
ARTICLE 310 Safety-Related Work Practices for Electrolytic Cells	
ARTICLE 320 Safety Requirements Related to Batteries and Battery Rooms	
ARTICLE 330 Safety-Related Work Practices: Lasers	eliminate article
ARTICLE 340 Safety-Related Work Practices: Power Electronic Equipment	eliminate article
ARTICLE 350 Safety-Related Work Requirements: Research and Development Laboratories.	
ARTICLE 360 Safety-Related Requirements for Capacitors	

TO

ARTICLE 300 Introduction	similar
ARTICLE 305 General Requirements	all of 350 was absorbed
ARTICLE 310 DC Electrical Hazards	pulls in 320, 330, 340, 350
ARTICLE 320 Capacitor Electrical Hazards	no changes to content
ARTICLE 330 RF and SubRF Electrical Hazards	from 340 and PI 328
ARTICLE 340 Reserved for Mixed Waveform Hazards	
ARTICLE 350 Safety-Related Work Practices for Electrolytic Cells	no changes to content
ARTICLE 360 Safety Requirements Related to Batteries and Battery Rooms	no changes to content

Some Justifications

<u>Article 330 – Lasers elimination</u>

We don't need to define lasers. We don't define accelerators, induction furnaces, VFDs, transformers, etc.
Thresholds (330) now covered in 310 and 320.
All safe work procedures are covered in Chapter 1, or Article 305.
Equipment listing is covered in 305.

<u>Article 340 – Power Electronics elimination</u>

There is no need to list examples, it is an incomplete list. We don't do this elsewhere.
All hazards now defined in 310, 320, and 330.
Responsibilities are redundant with Chapter 1.

Additional Justifications for Reorganization to Chapter 3, 70E

Definitions – 310, 320, 330, 340, 350, 360 – some contradictory
Move all to Article 100, and assure consistency.

Training section – 310, 330
All training requirements should be combined and cover the hazards and the specifics of the equipment.
320, 340, 350, 360 – don't have training sections, inconsistent
Combine into one section.

Hazard Sections
310 – missing
320 – missing
330 – ac, dc, and capacitor, missing RF
340 – thresholds missing, especially for RF, which the article tries to cover
350 – ac, dc only
360 – capacitor only

Sections are inconsistent. RF hazards are found in all equipment.
The above sections were redundant and NOT in agreement.
Combine into one section on hazards, with three parts: DC, capacitor, RF.

What is common about ALL sections – 310, 320, 330, 340, and 350 is AC, DC, and Capacitors.
And, most all have some form of subRF and RF.

Special Work Practices – 310, 320, 330, 340, 350, and 360
These may be justified as unique for each section.
At least combine those in common, and state once, up front, and leave only practices unique to the equipment.

Electrical Safety Authority – applies to whole chapter
Unlisted electrical equipment – applies to whole chapter – 330 and 350
Establishing an Electrically Safe work condition – applies to whole chapter – 350 and 360

ELIMINATE Article 330 – Lasers
Once we removed the laser safety material (not the purpose of 70E), all that was left were the electrical hazards, AC, DC, and capacitors, occasionally RF. The electrical hazards of lasers are no different than accelerators, capacitors banks, etc. DC and capacitors are now covered elsewhere. Note that this article was written before 70E had DC and capacitors.

ELIMINATE Article 340 – Power Electronics
There are power electronics everywhere, lasers, UPSs, VFDs, telecommunications, lighting, hand tools, etc. This article was written before 70E included DC and capacitors. Thus, the only new material is RF and subRF shock and EM fields. This should be covered for all electrical equipment, not just Power Electronics.

Titles were inconsistent

ARTICLE 310 **Safety-Related Work Practices** for Electrolytic Cells
ARTICLE 320 **Safety Requirements Related** to Batteries and Battery Rooms
ARTICLE 330 **Safety-Related Work Practices**: Lasers
ARTICLE 340 **Safety-Related Work Practices**: Power Electronic Equipment
ARTICLE 350 **Safety-Related Work Requirements**: Research and Development Laboratories.
ARTICLE 360 **Safety-Related Requirements** for Capacitors

SUMMARY

(A) Move definitions
(B) Combine training
(C) Mention ESA up front
(D) Combine hazards
(E) Combine common work practices
(F) De-emphasize R&D and emphasize “special hazards and equipment”
(G) Eliminate Article 330 – Lasers
(H) Eliminate Article 340 – Power Electronics

To article 100

ARTICLE 300 Introduction
300.1 Scope.
300.2 Responsibility.
300.3 Organization.

ARTICLE 310 Safety-Related Work Practices for Electrolytic Cells
310.1 Scope.
310.2 Definitions.
310.3 Safety Training.
310.4 Employee Training
310.5 Safeguarding of Employees in the Cell Line Working Zone.
310.6 Portable Tools and Equipment.

ARTICLE 320 Safety Requirements Related to Batteries and Battery Rooms
320.1 Scope.
320.2 Definitions
320.3 Safety Procedures

ARTICLE 330 Safety-Related Work Practices: Lasers
330.1 Scope.
330.2 Definitions
330.3 Hazardous Energy
330.4 Electrical Safety Training
330.5 Safeguarding of Persons from Electrical Hazards ~~Associated with Lasers and Laser Systems.~~
~~330.6 Responsibility for Electrical Safety.~~

ARTICLE 340 Safety-Related Work Practices: Power Electronic Equipment
340.1 Scope
340.2 Definition
340.3 Application.
340.4 Hazards Associated with Power Electronic Equipment
~~340.5 Specific Measure for Personnel Safety~~

ARTICLE 350 Safety-Related Work Requirements: Research and Development Laboratories.
350.1 Scope.
350.2 Definitions
350.3 Application of Other Articles
350.4 Electrical Safety Authority
350.5 Specific Measures and Controls for Personnel Safety
350.6 Approval Requirements.
350.7 Custom Built, Non-Listed Research Equipment, 1000 Volts or less AC or DC.
350.8 Custom Built, Unlisted Research Equipment, >1000 V AC or DC.
350.9 Energy Thresholds.
350.10 Establishing an Electrically Safe Work Condition.

ARTICLE 360 Safety-Related Requirements for Capacitors
360.1 Scope
360.2 Definitions.
360.3 Stored Energy Hazard Thresholds
360.4 Specific Measures for Personnel Safety
360.5 Establishing an Electrically Safe Work Condition for……
360.6 Grounding Sticks

ARTICLE 300 Introduction
300.1 Scope.
300.2 Responsibility.
300.3 Organization.

ARTICLE 305 General Requirements
305.1 Training
305.2 Application of Other Articles
305.3 Unlisted Electrical Equipment Approval
305.4 Electrical Safety Authority
305.6 Custom Built, Non-Listed Research Equipment, 1000 Volts or less AC or DC.
305.7 Custom Built, Unlisted Research Equipment, >1000 V AC or DC.

ARTICLE 310 DC Electrical Hazards
310.1 Scope
310.2 DC Hazard Thresholds

ARTICLE 320 Capacitor Electrical Hazards
360.1 Scope
360.3 Stored Energy Hazard Thresholds
360.4 Specific Measures for Personnel Safety
360.5 Establishing an Electrically Safe Work Condition for……
360.6 Grounding Sticks

ARTICLE 330 RF and SubRF Electrical Hazards
310.1 Scope
310.2 RF and SubRF Hazard Thresholds

ARTICLE 340 Reserved for Mixed Waveform Hazards

ARTICLE 350 Safety-Related Work Practices for Electrolytic Cells
360.1 Scope.
360.3 Safety Training.
360.4 Employee Training
360.5 Safeguarding of Employees in the Cell Line Working Zone.
360.6 Portable Tools and Equipment.

ARTICLE 360 Safety Requirements Related to Batteries and Battery Rooms
320.1 Scope.
320.3 Safety Procedures

Proposal to 2024 NFPA 70E Committee Reorganization of Chapter 3

Chapter 3 Task Group

Presented by Lloyd B. Gordon

August 2021

Update May 2022

Chapter 3 Task Group

- Bobby Gray
- Ray Crow
- Bill Cantor
- Lloyd Gordon
- Ernest Gallo
- Heath Garrison
- Larry Perkins
- Mark McNellis
- Jim Dollard

Evolution of NFPA 70E

- 1979
  - Part I – Installation Safety Requirements
- 1981
  - Part I – Installation Safety Requirements
  - Part II – Safety Related Work Practices
- 1983, 1988, 1995
  - Part I – Installation Safety Requirements
  - Part II – Safety Related Work Practices
  - Part III – Safety Related Maintenance Requirements
- 2000
  - Part I – Installation Safety Requirements
  - Part II – Safety Related Work Practices
  - Part III – Safety Related Maintenance Requirements
  - Part IV – Safety Requirements for Special Equipment
- 2004
  - Chapter 1 – Safety Related Work Practices
  - Chapter 2 – Safety Related Maintenance Requirements
  - **Chapter 3 – Safety Requirements for Special Equipment**
  - Chapter 4 – Installation Safety Requirements
- 2009, 2012, 2015, 2018, 2021
  - Chapter 1 – Safety Related Work Practices
  - Chapter 2 – Safety Related Maintenance Requirements
  - **Chapter 3 – Safety Requirements for Special Equipment**

Evolution of Chapter 3 – Special Equipment

2000/2004 – Part/Chapter III/3

- 300 – Introduction
- 310 – Electrolytic Cells
- 320 – Batteries and Battery Rooms
- 330 – Lasers
- 340 – Power Electronic Equipment

2009, 2012 (added DC), 2015

- 300 – Introduction
- 310 – Electrolytic Cells
- 320 – Batteries and Battery Rooms
- 330 – Lasers
- 340 – Power Electronic Equipment
- 350 – Research and Development Laboratories

2018

- 330 – Lasers – eliminated sections
- 340 – Power Electronic Equipment – cut in half
- 350 – Research and Development Laboratories
  - added ESA, increased equipment, thresholds

- 2021
  - 300 – Introduction
  - 310 – Electrolytic Cells
  - 320 – Batteries and Battery Rooms
  - 330 – Lasers
  - 340 – Power Electronic Equipment
  - 350 – Research and Development Laboratories
  - 360 – Capacitors (plus Annex R)
- 2024
  - 300 – Introduction
  - 305 – General (previously 350)
  - 310 – DC
  - 320 – Capacitors (previously 360)
  - 330 – RF and subRF (previously in 340)
  - 350 – Electrolytic Cells
  - 360 – Batteries and Battery Rooms
  - ~~330 – Lasers~~
  - ~~340 – Power Electronic Equipment~~

Observations – what happened over 21 years?

- Cells and Batteries were maintained and are in excellent form.
- Lasers and Power Electronics were full of errors, not maintained, redundant (some corrections in 2018).
- Concepts of AHJ (ESA) approval of special equipment and procedures added in 2009/2018 (350).
- Hazards formally added DC (2012), capacitors (2021), and RF (2024 PIs)
- Hazard thresholds were found in 310, 320, 330, 340, 350 and 360. Were not consistent.
- Equipment approval was found in 330, 340, and 350.
- Some material was redundant with Chapter 1.

Conclusions and Justifications

- Keep Cells and Batteries intact
  - Maintained and excellent
- Eliminate Lasers and Power Electronics
  - Hazards, controls, and special equipment now covered elsewhere
  - These two Articles no longer contain unique information
- Reorder to flow
  - Overall processes (applying to all special equipment)
    - Equipment approval, special authority to approve unique processes (ESA)
  - Unique Hazards (non 60 Hz)
    - DC, capacitor, RF
  - Article on special equipment
    - Cells, Batteries

Proposed Revision for 2024

300 – Introduction	
305 – General Requirements	(previously 350)
310 – DC Electrical Hazards	
320 – Capacitor Electrical Hazards	(previously 360, a few PIs)
330 – RF and subRF Electrical Hazards	(previously in 340, PIs)
350 – Electrolytic Cells	very few changes (some from PIs)
360 – Batteries and Battery Rooms	very few changes (some from PIs)

Additional Points

- NO new technical changes are introduced in the reorder that were not submitted as PIs.
- NO requirements are eliminated with the deletion of Lasers and Power Electronics, all previous requirements are covered in 305 through 330.
- Redundancy is eliminated (e.g., equipment approval, hazard thresholds).
- Focus on Research and Development Laboratories is replaced with Special Industrial and R&D Equipment, broadens scope to embrace all industry.

Details on "new" Articles (not really new, consolidated from other locations in Chapter 3 and new PIs)

- Article 300 – Introduction — essentially unchanged
- Article 305 – General Requirements — taken from 350, remove focus on R&D
  - 305.1 Training
  - 305.2 Application of Other Articles
  - 305.3 Unlisted Electrical Equipment Approval
  - 305.4 Electrical Safety Authority
  - 305.6 Custom Built, Non-Listed Research Equipment, 1000 Volts or less AC or DC.
  - 305.7 Custom Built, Unlisted Research Equipment, >1000 V AC or DC.
- Article 310 – DC Electrical Hazards — consolidated from many sections
  - 310.1 – Scope
  - 310.2 - DC Hazard Thresholds (thermal, shock, and arc flash)
- Article 320 – Capacitor Electrical Hazards — unchanged except for PIs
- Article 330 – RF and SubRF Electrical Hazards — from new PI and old 340
  - 330.1 – Scope
  - 330.2 – RF and SubRF Hazard Thresholds
- Article350 – Safety-Related Work Practices for Electrolytic Cells (unchanged)
- Article 360 – Safety Requirements Related to Batteries and Battery Rooms (unchanged except for PIs)

Public Comment No. 180-NFPA 70E-2022 [Section No. 300.3]

300.3 Organization.

Chapter 3 of this standard is divided into articles. Article 300 applies generally. Article 310 applies to electrolytic cells. Article 320 applies to batteries and battery rooms. Article 330 applies to lasers. Article 340 applies to power electronic equipment. Article 350 applies to research and development (R&D) laboratories. Article 360 applies to safety-related requirements for capacitors.

Additional Proposed Changes

File Name	Description	Approved
CN_41.pdf	70E_CN41_PC180	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 41 appeared in the First Draft Report as Correlating Note No. 41.

The Correlating Committee direct the technical committee to review this section in respect to references to entire articles and possibly converting this information into an informational note to 300.1.

Related Item

- Correlating Note No. 41

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC
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Submittal Date: Thu Jun 02 16:51:47 EDT 2022
Committee: EEW-AAA

Correlating Committee Note No. 41-NFPA 70E-2022 [Section No. 300.3]

Submitter Information Verification

Committee: NEC-AAC

Submittal Date: Thu Jan 20 13:25:43 EST 2022

Committee Statement

Committee Statement: The Correlating Committee direct the technical committee to review this section in respect to references to entire articles and possibly converting this information into an informational note to 300.1.

Ballot Results

✔ **This item has passed ballot**

12 Eligible Voters
1 Not Returned
11 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.
Gallo, Ernest J.
Hickman, Palmer L.
Holub, Richard A.
Hunter, Dean C.
Kendall, David H.
Kovacik, John R.
Manche, Alan
Porter, Christine T.
Schultheis, Timothy James
Williams, David A.

Public Comment No. 63-NFPA 70E-2022 [New Section after 320.3]

Electrical Work on Batteries

320.4(A) General.

Batteries shall not be required to be de-energized. The limited and restricted approach boundaries of a battery shall be not specified below 100 V, 3 ft 6 in and avoid contact respectively from 100 V to 300 V, 3 ft 6 in and 1 ft respectively from 300 V to 1000 V, and 5 ft and 1 ft 5 in respectively for batteries from 1000 V to 5000 V.

The battery's dc voltage for shock hazard is the maximum voltage difference within a distance of twice the limited approach boundary calculated from the nominal battery voltage. If the battery's isolation from ground is less than 25 Ohms per Volt (40 milliamperes through a short-circuit to ground) then the voltage from exposed battery terminals to the grounded enclosure or rack shall be used to calculate the battery's dc voltage for shock hazard. A ground fault identification device used to verify isolation from ground shall be listed, properly installed, and tested regularly.

Employees performing any activity, except handling of liquid electrolyte, on or within 18" of a battery that exceeds any of the energy thresholds defined in 320.3(A)(1), shall wear safety glasses. See 320.3(B)(1) for activities involving handling liquid electrolyte. Employees performing any activity that involves direct contact with the positive or negative terminals of a battery with 1000 watts or more of short circuit power shall ware hand protection in accordance with 130.7(C)(7)(e). Employers shall base the selection of the appropriate hand protection on an evaluation of the performance characteristics of the hand protection relative to the task(s) to be performed, conditions present, duration of use, and the short circuit power of the battery.

Informational Note 1: Discharging or disassembling batteries to a 'de-energized' state is damaging to the battery, hazardous to the worker, or both. Over discharge can cause excessive heat generation or fire in batteries and should not be performed as a means of shock or arc flash mitigation. In general, reducing the charge of a battery does not significantly reduce its electrical hazard for the purposed of electrical work. Some battery types are required to be shipped at a reduced state of charge based on their chemical or potential fire hazards. Some flow batteries, batteries with tanks of liquid electrolyte, are designed to be safely discharged to close to zero energy, though doing so can require specialized equipment and an extended, planned outage.

Informational Note 2: In ungrounded battery systems, dc voltage that could cause shock is often physically separated farther than twice the limited approach boundary. For example, a string of vented lead-acid cells connected in series to build a 125 V battery can require 30' or more of length. This means that the maximum voltage within 7' (twice the limited approach boundary of 3' 6") is approximately 28 V dc. Using 28 V dc in Table 130.4(E)(b) yields limited and restricted approach boundaries of 'not specified.' There is not a shock hazard because the maximum voltage that the worker could be exposed to is below the dc shock threshold. There is still a thermal hazard associated with accidental short circuit.

Informational Note 3: I solation from ground is common in battery circuits over 100 V dc. However, ground faults are also common and can occur gradually over time. A ground fault in dc systems can result from water leaks, condensation buildup, vermin (e.g., rats, squirrels, snakes), chemical leaks from the batteries, material fatigue or damage, rusting or corrosion, and many other factors. A ground fault identification device can detect the breakdown in isolation between the battery and a grounded and bonded enclosure or rack. These devices must be properly installed and regularly tested to account for them when assessing risk. An ungrounded system without a properly installed and tested ground fault identification device should be treated as grounded.

Informational Note 4: Tasks that involve contact with the positive or negative terminals of a battery often require high manual dexterity to perform safely. Unbolting a conductor from a terminal of a battery can require the employee to manipulate nuts, washers, and busbars delicately and dropping them on the exposed conductors could cause a short circuit. For this reason, light-duty leather gloves are recommended wherever there is no shock or arc flash hazard as heavy-duty leather gloves can be too restrictive.

Statement of Problem and Substantiation for Public Comment

This section clarifies how the hazardous voltage of a battery is identified relating to TR-101 and TR-102 and how the 40 milliamp threshold added in TR-102 is to be identified.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 64-NFPA 70E-2022 [New Section after 320.3]	

Related Item

• Tr-101 • TR-102

Submitter Information Verification

Submitter Full Name: David Rosewater
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Submittal Date: Fri May 27 13:46:45 EDT 2022
Committee: EEW-AAA

Public Comment No. 64-NFPA 70E-2022 [New Section after 320.3]

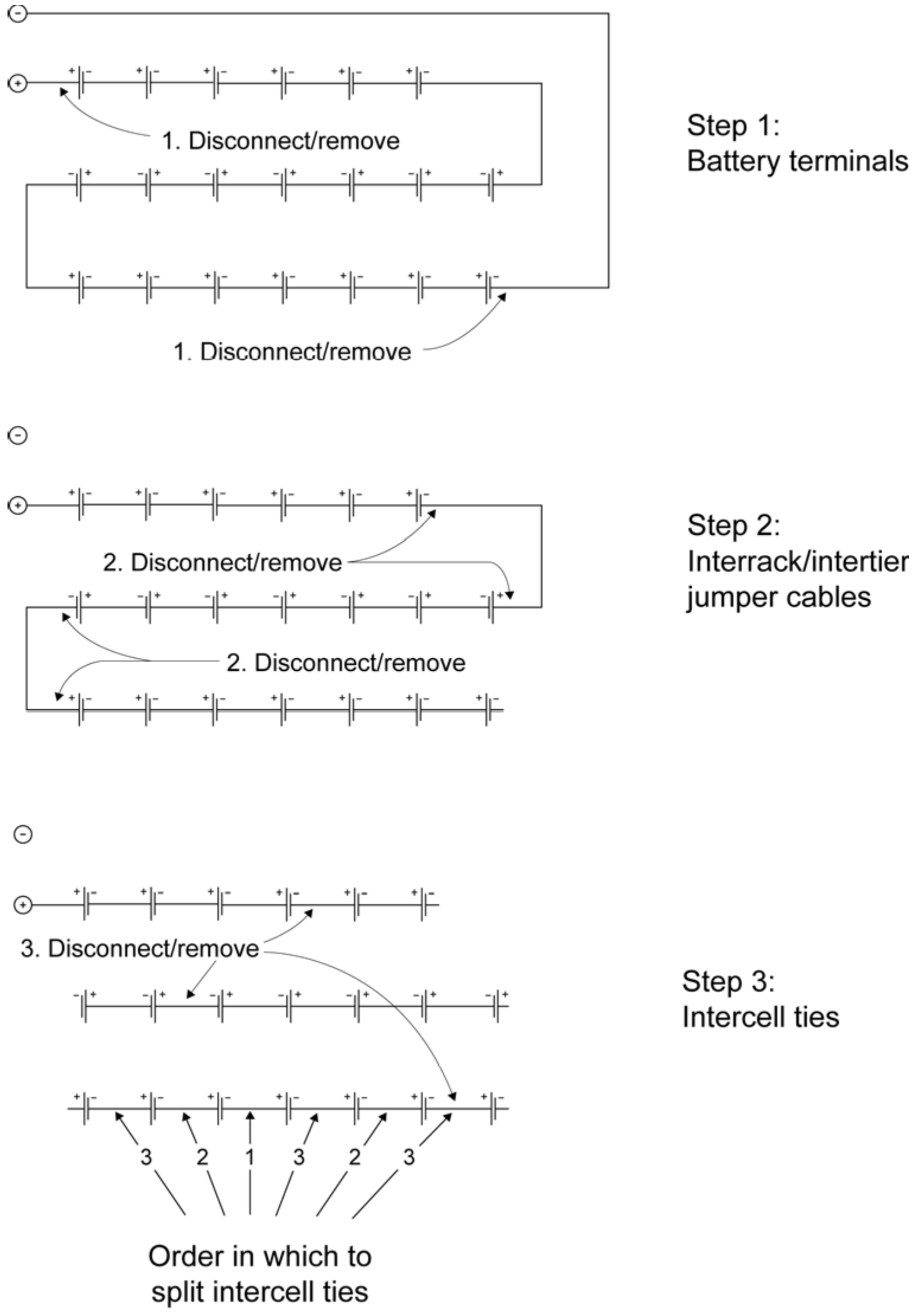
Electrical Work on Batteries

320.4(B) **Establishing a Lower Risk Work Condition in Batteries**

As batteries shall not be required to be de-energized, a battery lockout/tagout procedure shall not be required to establish or verify an electrically safe work condition. Instead, battery lockout/tagout procedure lowers the risk of injury by sectionalizing a battery into lower voltage, lower energy segments. The provisions of Article 120 apply to work on batteries with the following modifications:

(1) Sectionalizing Procedure: Employees performing circuit manipulation of batteries shall plan work to minimize exposure to shock and arc flash hazards. The work plan shall identify the order that battery circuit connections or disconnections are to be made and any resulting changes in the dc voltage, limited approach boundary, restricted approach boundary, shock PPE, arc flash incident energy, arc flash boundary, and arc flash PPE. A battery lockout/tagout procedure shall address the flowing:

   (2) Sectionalizing a battery shall, unless justified, start with any means of disconnection that does not expose the worker to a shock or arc flash hazard. The battery's terminal connections (most positive and most negative) shall then, unless justified, be removed, followed by inter-rack/inter-tier jumper cables and intercell ties according to Figure 320.4(C).



Note: The idea behind splitting the intercell ties in this manner is to reduce the exposed voltage to the fewest number of steps, thereby minimizing contact with energized parts.

Figure 320.4(C) Example of sectionalizing a large, multi-tier battery system.

(1)

(a) Employees shall wear the identified PPE until after a circuit disconnection is performed that reduces the level of shock or arc flash hazard. If a circuit disconnection is hidden from view, then a negative test for conductivity is required in accordance with 320.4(C)(8).

(b) When returning a battery to service, employees shall wear the identified PPE prior to making any circuit connection that increases the level of shock or arc flash hazard.

(2) Identification of disconnecting means: Circuit interrupt switches and plugs that do not expose the worker to a shock or arc flash hazard when maintained and operated properly are permitted circuit

disconnecting means in batteries. Plugs and cables that do not accept a lock shall be secured with a plug box or cable lockout device. Intercell busbars are permitted to be used as disconnecting means but must be held in a locked box or cabinet.

Informational Note 1: Intercell busbars and cables are interchangeable so locking them does not prevent a replacement from being installed. However, their presence or absence in a battery string is visibly verifiable before entering the limited area. There are also many of them in a battery string, so it is a multi-step, labor-intensive process to re-install them once removed. These factors reduce the risk of shock and arc flash to a level similar to applying a lock.

(1) Simple Battery Lockout/Tagout: A battery lockout/tagout procedure that involves only a qualified person(s) sectionalizing a single battery with a single charger for the sole purpose of safeguarding employees from exposure to electrical hazards shall be considered to be a simple battery lockout/tagout procedure. Simple battery lockout/tagout procedures shall not be required to be written for each application. Each worker shall be responsible for their own battery lockout/tagout procedure.

(2) Complex Battery Lockout/Tagout: complex battery lockout/tagout procedure, as specified in 120.4(A)(5), shall be permitted where one or more of the following exists:

- (3) Any electrical work on a battery charger (non-battery lockout/tagout)
- (4) Multiple battery strings connected in parallel
- (5) Multiple battery chargers connected in parallel
- (6) Multiple single string batteries with charges located in close proximity to each other
- (7) Multiple energy sources (excluding the battery)
- (8) Multiple crews
- (9) Multiple crafts
- (10) Multiple locations
- (11) Multiple employers
- (12) Multiple disconnecting means
- (13) Multiple sequences
- (14) Job or task that requires more than one work period

(15) De-energizing Equipment (shutdown): The procedure shall not de-energize the batteries. The procedure shall instead sectionalize the batteries.

(16) Stored Energy: The procedure shall not release the energy stored in batteries

(17) Verification: The procedure shall not require that the batteries be operated (charged or discharged) prior to or after segmentation as this can introduce additional hazards.

(18) Testing: Batteries will have voltage after sectionalizing so testing them for voltage is not required. The purpose of testing in a battery lockout/procedure is to verify that the disconnecting means electrically isolates two points in the battery circuit.

(19) If the disconnecting means can be visually verified by the presence/absence of a cable or busbar, or the disconnection of a plug, then testing is not required.

(20) If the disconnecting means is hidden from view or its state could be confused, such as the internal mechanism of a switch, then the procedure shall establish the following:

(21) Test instrument to be used, the required PPE, and the person who will use it to verify the proper operation of the test instrument on a known connection before and after its use

(1)

(a)

i. Requirement to define the restricted approach boundary, and shock / arc flash PPE

ii. Requirement to test for conductivity before touching the two exposed conductors that are separated by the disconnecting means

iii. Requirement to retest for conductivity when circuit conditions change or when the job location has been left unattended

iv. Planning considerations that include methods of verification where there is no accessible exposed point to take conductivity measurements

(2) Process for Establishing and Verifying a Lower Risk Work Condition in Batteries

Establishing and verifying a lower risk work condition in batteries shall include all of the following steps, which shall be performed in the order presented, if feasible:

(1)

(a) Determine the number, configuration, and voltage of batteries in series and parallel, and the number, configuration, and voltage of battery chargers. Determine if there are any batteries or chargers in close proximity that could be confused for the battery being worked on. Check applicable up-to-date drawings, diagrams, and identification tags.

(b) Turn off any/all battery chargers for the associated battery off and open their ac and/or dc disconnecting device(s).

(c) Where 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.

(d) Apply lockout/tagout devices to the battery charger disconnection means

(e) Sectionalize the battery in accordance with a documented and established procedure

(f) When required, verify the absence of conductivity with an adequately rated portable meter.

Informational Note 2: While this process is similar to the process for establishing and verifying an electrically safe work condition, it is not equivalent. Batteries will always have the potential for short-circuit which can be electrically hazardous even at low voltage.

Additional Proposed Changes

File Name	Description	Approved
sectionalizing.png	Figure 320.4(C) Example of sectionalizing a large, multi-tier battery system. From DOE-HDBK-1092-2013	

Statement of Problem and Substantiation for Public Comment

As the standard is currently written, there is no way to apply LOTO principles to a battery system as there is never an “electrically safe work condition” and it is impossible to “verify zero energy” given the nature of the technology. However, these principles are critical for safe electrical work on batteries with a few modifications. This section references article 120 as much as possible, while clarifying how a battery LOTO can be used to greatly reduce the risk of shock, arc flash, and thermal burns to workers. Because FR-101 has expanded the scope of article 320 to include many batteries below 100 V (where their short circuit power exceeds 1000 watts) the inclusion of these procedure modifications is critical to protection of battery workers.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 63-NFPA 70E-2022 [New Section after 320.3]	builds on

Related Item

• FR-101 • FR-102

Submitter Information Verification

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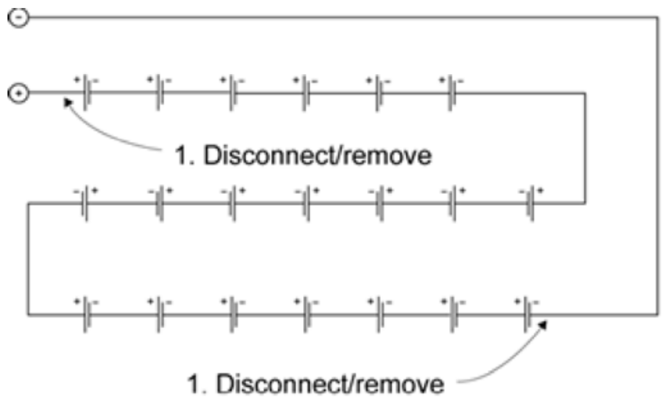
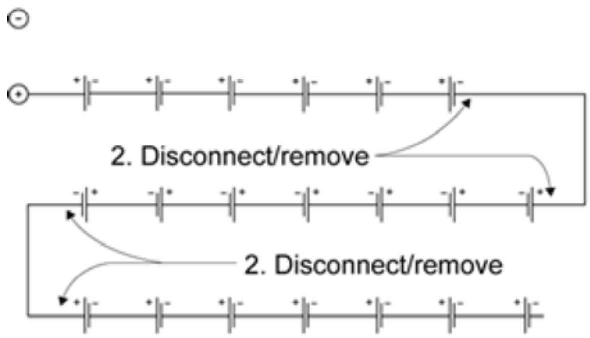
Submittal Date: Fri May 27 14:09:25 EDT 2022

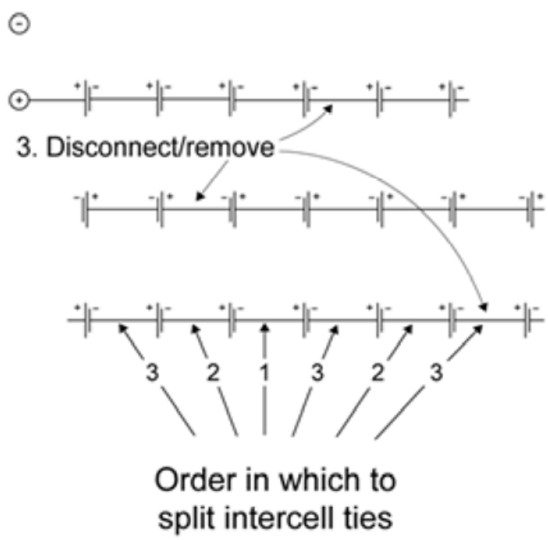
Committee: EEW-AAA



Step 1:
Battery terminals



Step 2:
Interrack/intertier jumper cables



Step 3:
Intercell ties

Note: The idea behind splitting the intercell ties in this manner is to reduce the exposed voltage to the fewest number of steps, thereby minimizing contact with energized parts.

Public Comment No. 181-NFPA 70E-2022 [Section No. 320.3]

320.3 Safety Procedures.

(A) General Safety Hazards.

(1) 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) Thermal: 1000 watts short-circuit power

Informational Note: See Department of Energy, *DOEElectrical 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 an example of a risk assessment method for work on batteries.

(3) Battery Room or Enclosure Requirements.

(a) *Personnel Access to Energized Batteries.* Each battery room or battery enclosure shall be accessible only to authorized personnel.

(b) *Illumination.* Employees shall not enter spaces containing batteries unless illumination is provided that enables the employees to perform the work safely.

Informational Note: Battery terminals are normally exposed and pose possible shock hazard. Batteries are also installed in steps or tiers that can cause obstructions.

(4) Apparel.

Personnel shall not wear electrically conductive objects such as jewelry while working on a battery system.

(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: See IEEE 1491, *Guide for the Selection and Use of Battery Monitoring Equipment in StationaryApplications*, 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..

(6) Warning Signs.

The following warning signs or labels shall be posted in appropriate locations:

(1) Electrical hazard warnings indicating the shock hazard due to the battery voltage and the arc flash hazard due to the prospective short-circuit current, and the thermal hazard.

Informational Note No.1: Because internal resistance, prospective short-circuit current, or both are not always provided on battery container labels or data sheets, and because many variables can be introduced into a battery layout, the battery manufacturer should be consulted for accurate data. Variables can include, but are not limited to, the following:

(1) Series connections

(2) Parallel connections

(3) Charging methodology

(4) Temperature

(5) Charge status

(6) Dc distribution cable size and length

Informational Note No. 2: See 130.5(H) for requirements for equipment labeling.

(2) Chemical hazard warnings, applicable to the worst case when multiple battery types are installed in the same space, indicating the following:

a. Potential presence of explosive gas (when applicable to the battery type)

b. Prohibition of open flame and smoking

c. Danger of chemical burns from the electrolyte (when applicable to the battery type)

(3) Notice for personnel to use and wear protective equipment and apparel appropriate to the hazard for the battery

(4) Notice prohibiting access to unauthorized personnel

(B) Electrolyte Hazards.

(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: 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.

(2) Activities That Do Not Include Handling of Electrolyte.

Employees performing any activity not involving the handling of electrolyte shall wear safety glasses.

Informational Note: Battery maintenance activities usually do not involve handling electrolyte. Batteries that are hermetically sealed (such as most lithium batteries) or immobilized electrolyte (such as valve-regulated lead acid batteries) present little or no electrolyte hazard. Most modern density meters expose a worker to a quantity of electrolyte too minute to be considered hazardous, if at all. Such work would not be considered handling electrolyte. However, if specific gravity readings are taken using a bulb hydrometer, the risk of exposure is higher — this could be considered to be handling electrolyte, and the requirements of 320.3(B)(1) would apply.

(C) Tools and Equipment.

(1) Handles.

Tools and equipment for work on batteries shall be equipped with insulated handles rated for the 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.

(D) Cell Flame Arresters and Cell Ventilation.

When present, battery cell ventilation openings shall be unobstructed. Cell flame arresters shall be inspected for proper installation and unobstructed ventilation and shall be replaced when necessary in accordance with the manufacturer's instructions.

Additional Proposed Changes

File Name	Description	Approved
CN_31.pdf	70E_CN31_PC181	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 31 appeared in the First Draft Report on First Revisions No. 102.

The Correlating Committee directs the technical committee to revise the informational note in (2) Battery Risk Assessment and add “See Informative Annex F Figure F.7” to comply with Section 2.1.6 of the NEC Style Manual.

Related Item

- First Revision No. 102

Submitter Information Verification

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Submittal Date: Thu Jun 02 16:53:21 EDT 2022
Committee: EEW-AAA

Correlating Committee Note No. 31-NFPA 70E-2022 [Sections 320.3(A)(1), 320.3(A)(2)]

Submitter Information Verification

Committee: NEC-AAC

Submittal Date: Thu Jan 20 12:24:41 EST 2022

Committee Statement

Committee Statement: The Correlating Committee directs the technical committee to revise the informational note in (2) Battery Risk Assessment and add "See Informative Annex F Figure F.7" to comply with Section 2.1.6 of the NEC Style Manual.

First Revision No. 102-NFPA 70E-2021 [Sections 320.3(A)(1), 320.3(A)(2)]

Ballot Results

✔ **This item has passed ballot**

12 Eligible Voters
1 Not Returned
11 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.
Gallo, Ernest J.
Hickman, Palmer L.
Holub, Richard A.
Hunter, Dean C.
Kendall, David H.
Kovacik, John R.
Manche, Alan
Porter, Christine T.
Schultheis, Timothy James
Williams, David A.

Public Comment No. 58-NFPA 70E-2022 [Section No. 320.3(A)(1)]

(1) 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) Thermal: 1000 watts short-circuit power

Maximum available short circuit power is calculated by multiplying the battery's nominal voltage by its prospective short-circuit current then dividing the result by two.

Informational Note: See Department of Energy, *DOEElectrical Safety Handbook*, DOE-HDBK-1092, for electrical hazard thresholds.

Statement of Problem and Substantiation for Public Comment

The scope of article 320 has been expanded to include the thermal hazard based on available short circuit power but there is no explanation of how to calculate short circuit power if it is not provided already on a battery's specification sheet. The maximum power that can be provided by a battery is when the resistance or the short matches the resistance of the battery. This is a confusing point that as lead many people to overestimate the thermal hazard.

Related Item

• FR-101 • FR-102

Submitter Information Verification

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Submittal Date: Fri May 27 12:46:47 EDT 2022
Committee: EEW-AAA

Public Comment No. 59-NFPA 70E-2022 [Section No. 320.3(A)(2)]

(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.

An energized electrical work permit shall not be required for work within the restricted approach boundary of a battery as it would be redundant to this risk assessment. An energized electrical work permit shall be required for any work within the restricted approach boundary of battery charging equipment.

Informational Note 1 : All work within the restricted approach boundary of a battery is energized electrical work and requires a commensurate level of documented safety. However, battery work is also routine. Requiring battery technicians justify and safety officers sign approvals for day-to-day work would reduce the strict scrutiny that should be applied to energized electrical work permits and reduce the effectiveness of whole safety programs.

Informational Note 2: See F.7 and Figure F.7 for an example of a risk assessment method for work on batteries.

Statement of Problem and Substantiation for Public Comment

This is an important clarification of the risk assessment process for battery systems. Batteries are always energized and so the only additional steps required in an EEWP are to 1) justify that batteries cannot be deenergized, which is obvious to anyone who has ever worked on them, and 2) collect signatures of the company safety officers, which innovates the EEWP review process with routine work. This clarification is especially important with the addition of thermal hazards to the risk assessment process (TR-102) as the thermal hazard can and has been interpreted as an increased burn hazard that is “energized work” according to Article 110.4(C).

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 60-NFPA 70E-2022 [Section No. 320.3(A)(2)]	
Public Comment No. 61-NFPA 70E-2022 [Section No. 320.3(A)(2)]	

Related Item

• TR-101 • TR-102

Submitter Information Verification

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Submittal Date:	Fri May 27 12:54:34 EDT 2022
Committee:	EEW-AAA

Public Comment No. 60-NFPA 70E-2022 [Section No. 320.3(A)(2)]

(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 an example of a risk assessment method for work on batteries.

(1) Elements of a battery risk assessment

The battery risk assessment shall include, but not be limited to the following:

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

(2) Description of the work to be performed

(3) If applicable, the risk assessment shall include a sectionalizing procedure in accordance with 320(C)

(4) Description of the safe work practices to be employed [see 320.4]

(5) Results of the shock risk assessment

(6) The voltage to which personnel will be exposed

(7) Limited approach boundary [see 130.4(E)]

(8) Restricted approach boundary [see 130.4(G)]

(9) 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),130.7(C)(1) through (C)(15) and 130.7(D)]

(10) Results of the arc flash risk assessment

(11) Available incident energy at the working distance [see 130.5]

(12) Personal and other protective equipment required by this standard to safely perform the assigned task and to protect against the arc flash hazard [see 130.4(F),130.7(C)(1) through (C)(15) and 130.7(D)]

(13) Arc flash boundary [see 130.5(E)]

(14) Results of the battery thermal risk assessment

(15) If the task involves a possible short-circuit

(16) The maximum available short-circuit power that the worker could be exposed to

(17) Personal and other protective equipment required by this standard to safely perform the assigned task and to protect against the thermal hazard [see 130.7(E)(7)(e) and 130.7(D)]

(18) Results of the chemical risk assessment

(19) If the task involves handling electrolyte

(20) The electrolyte's chemical hazards from the safety data sheet

(21) The chemical PPE other protective equipment to be used [see 320.3(B)(1)]

(22) The means employed to restrict access of unqualified persons from the work area [see 130.7(E)]

(23) Evidence of completion of a pre-job briefing, including a discussion of any job-specific hazards [see 110.5(I)]

Statement of Problem and Substantiation for Public Comment

This clarification is important considering the addition of thermal hazards to the risk assessment process (TR-102) as the thermal hazard necessitates a battery thermal risk assessment.
This addition builds on Public Comment No. 59-NFPA 70E-2022 [Section No. 320.3(A)(2)] as it specifies that the battery risk assessment requires all elements of a EEWP except the justification and approval signatures.
This addition refers to thermal hand protection specifics in 130.7(E)(7)(e) added in Public Comment No. 57-NFPA 70E-2022 [Section No. 130.7(C)(7)]

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 59-NFPA 70E-2022 [Section No. 320.3(A)(2)]	builds on
Public Comment No. 57-NFPA 70E-2022 [Section No. 130.7(C)(7)]	referanced
Public Comment No. 61-NFPA 70E-2022 [Section No. 320.3(A)(2)]	

Related Item

• FR-101 • FR-102

Submitter Information Verification

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Submittal Date: Fri May 27 13:07:36 EDT 2022
Committee: EEW-AAA

Public Comment No. 61-NFPA 70E-2022 [Section No. 320.3(A)(2)]

(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.

(a) Addisional Protective Measures

If additional protective measures are required, they shall be selected and implemented according to the hierarchy in 110.5(H)(3). The battery's engineering controls shall be considered during the risk assessment. Common engineering controls in batteries, and how to account for them in the risk assessment, include but are not limited to the following:

(1) Disconnects: Mid-string and terminal disconnects that do not expose the worker to an electrical hazard may be used to sectionalize a battery into lower voltage segments. If a circuit disconnection is hidden from view, then a negative test for conductivity is required in accordance with 320.4(C)(8). The shock, arc flash, and thermal risk for any following tasks are then determined based on the voltage and short circuit current battery segments.

(2) Overcurrent Protection: Mid-string breakers, fuses, or contactors may be used to reduce arc flash and thermal risk. To be accounted for in a battery risk assessment, such devices must be rated to interrupt the battery's short circuit current and be listed. The arc flash, and thermal risk for any following tasks are then determined based on the reduced duration of an arc or short circuit, calculated according to the overcurrent protection's trip curve at one-half short circuit current.

(3) Barriers: Battery terminals may be covered with barriers to prevent accidental contact or short circuit. To be accounted for in a battery risk assessment, barriers shall be rated for the battery's nominal voltage and installed in accordance with 130.7(D)(2)(a) through 130.7(D)(2)(c). The description of the work to be performed shall include removal and replacement of barriers.

Informational Note: See F.7 and Figure F.7 for an example of a risk assessment method for work on batteries.

Statement of Problem and Substantiation for Public Comment

This clarification is important considering the addition of thermal hazards to the risk assessment process (TR-102) as the thermal hazard necessitates a battery thermal risk assessment. Thermal risk can be controlled very effectively with these engineering controls and so they should be included alongside the new requirement to consider thermal hazard.
This addition builds on Public Comment No. 59-NFPA 70E-2022 [Section No. 320.3(A)(2)] as it specifies how battery engineering controls shall be considered in the risk assessment process.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 59-NFPA 70E-2022 [Section No. 320.3(A)(2)]	
Public Comment No. 60-NFPA 70E-2022 [Section No. 320.3(A)(2)]	

Related Item

• FR-101 • FR-102

Submitter Information Verification

Submitter Full Name: David Rosewater

Organization:	Sandia National Laboratories
Affiliation:	IEEE Energy Storage and Stationary Battery Committee
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Fri May 27 13:34:58 EDT 2022
Committee:	EEW-AAA

Public Comment No. 143-NFPA 70E-2022 [Section No. 320.3(C)(1)]

(1) Tools and Handles.

Tools and equipment for work on batteries shall be equipped with insulated handles rated for the voltage on which they are used. The length of tools for work on batteries shall be selected to minimize the risk of inadvertent contact.

Statement of Problem and Substantiation for Public Comment

Add “Tools and” to the title because the second sentence is about tool length not about only handles.

Related Item

- fr 103

Submitter Information Verification

Submitter Full Name: Paul Dobrowsky
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City:
State:
Zip:

Submittal Date: Tue May 31 21:32:49 EDT 2022
Committee: EEW-AAA

Public Comment No. 62-NFPA 70E-2022 [Section No. 320.3(C)(1)]

(1) Handles.

Tools and equipment for work on batteries shall be equipped with insulated handles rated for the voltage on which they are used in accordance with 130 .7(D)(1). The length of tools for work on batteries shall be selected to minimize the risk of inadvertent contact.

Statement of Problem and Substantiation for Public Comment

Cross referencing changes from FR-102 to specific requirements for insulated tools in article 130.

Related Item

- FR-103

Submitter Information Verification

Submitter Full Name:	David Rosewater
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Zip:	
Submittal Date:	Fri May 27 13:39:13 EDT 2022
Committee:	EEW-AAA

Public Comment No. 97-NFPA 70E-2022 [Section No. 320.3(C)(1)]

(1) Handles.

Tools and equipment for work on batteries shall be equipped with insulated handles rated for the voltage on which they are used. The length and insulation of tools for work on batteries shall be selected to minimize the risk of inadvertent ~~contact~~ short circuit .

Statement of Problem and Substantiation for Public Comment

Battery tools make contact, otherwise they are not very useful. The issue is preventing a short circuit between adjacent terminals or busses. This is done by using shorter tools, or insulating one end to prevent short circuit.

Related Item

- PI No. 285

Submitter Information Verification

Submitter Full Name: Lloyd Gordon
Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Mon May 30 09:27:30 EDT 2022
Committee: EEW-AAA

Public Comment No. 182-NFPA 70E-2022 [Section No. 330.1]

330.1 Scope.

This article covers safety-related work practices for maintaining lasers and their associated equipment.

Informational Note No. 1: See ANSI Z136.1, *Standard for Safe Use of Lasers*, for recommendations on laser safety requirements for laser use.

Informational Note No. 2: 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.

Additional Proposed Changes

File Name	Description	Approved
CN_32.pdf	70E_CN32_PC182	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 32 appeared in the First Draft Report on First Revisions No. 126.

The Correlating Committee directs the technical committee to remove the word "recommendations" from Informational Note No. 1 and consider replacing it with "information."

Related Item

• First Revision No. 126

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC
Organization: NEC Correlating Committee
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jun 02 16:54:42 EDT 2022
Committee: EEW-AAA

Correlating Committee Note No. 32-NFPA 70E-2022 [Section No. 330.1]

Submitter Information Verification

Committee: NEC-AAC

Submittal Date: Thu Jan 20 12:25:23 EST 2022

Committee Statement

Committee Statement: The Correlating Committee directs the technical committee to remove the word "recommendations" from Informational Note No. 1 and consider replacing it with "information."

First Revision No. 126-NFPA 70E-2021 [Section No. 330.1]

Ballot Results

✔ **This item has passed ballot**

12 Eligible Voters
1 Not Returned
11 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.
Gallo, Ernest J.
Hickman, Palmer L.
Holub, Richard A.
Hunter, Dean C.
Kendall, David H.
Kovacik, John R.
Manche, Alan
Porter, Christine T.
Schultheis, Timothy James
Williams, David A.

Public Comment No. 110-NFPA 70E-2022 [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 capacitor banks

(4) Ionizing radiation, including X-rays at voltages greater than 5 kV in a vacuum

(5) Assessing the listing status of electrical equipment and the need for field evaluation of nonlisted equipment

Statement of Problem and Substantiation for Public Comment

Correct wording so that it reflects the original change from PI No. 287. The originally proposed wording was "Stored energy hazards, including capacitors and capacitor banks".

Related Item

• FR-146 • PI-287

Submitter Information Verification

Submitter Full Name:	Louis Barrios
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Affiliation:	API
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Mon May 30 11:36:04 EDT 2022
Committee:	EEW-AAA

Public Comment No. 183-NFPA 70E-2022 [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

(4) Ionizing radiation, including X-rays at voltages greater than 5 kV in a vacuum

(5) Assessing the listing status of electrical equipment and the need for field evaluation of nonlisted equipment

Additional Proposed Changes

File Name	Description	Approved
CN_34.pdf	70E_CN34_PC183	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 34 appeared in the First Draft Report on First Revisions No. 146.

The Correlating Committee directs the technical committee to review the affirmative ballot statements and address the revisions in 330.4(B)(3)-stored energy hazards, including capacitors and capacitor banks and 330.4(B)(4)-Ionizing radiation, including X-rays generated by equipment having vacuum interrupters or vacuum tubes operating at voltages greater than 5KV.

Related Item

• First Revision No. 146

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC
Organization: NEC Correlating Committee
Street Address:
City:
State:
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Submittal Date: Thu Jun 02 16:56:15 EDT 2022
Committee: EEW-AAA

Correlating Committee Note No. 34-NFPA 70E-2022 [Section No. 330.4(B)]

Submitter Information Verification

Committee: NEC-AAC

Submittal Date: Thu Jan 20 12:32:41 EST 2022

Committee Statement

Committee Statement: The Correlating Committee directs the technical committee to review the affirmative ballot statements and address the revisions in 330.4(B)(3)-stored energy hazards, including capacitors and capacitor banks and 330.4(B)(4)-Ionizing radiation, including X-rays generated by equipment having vacuum interrupters or vacuum tubes operating at voltages greater than 5KV.

First Revision No. 146-NFPA 70E-2021 [Section No. 330.4(B)]

Ballot Results

✔ **This item has passed ballot**

12 Eligible Voters
1 Not Returned
11 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.
Gallo, Ernest J.
Hickman, Palmer L.
Holub, Richard A.
Hunter, Dean C.
Kendall, David H.
Kovacik, John R.
Manche, Alan
Porter, Christine T.
Schultheis, Timothy James
Williams, David A.

Public Comment No. 28-NFPA 70E-2022 [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~~ and capacitor banks

(4) Ionizing radiation, including X-rays at voltages greater than 5 kV in a vacuum

(5) Assessing the listing status of electrical equipment and the need for field evaluation of nonlisted equipment

Statement of Problem and Substantiation for Public Comment

words were in wrong order due to editing error. revised bullet 3 to put words in the correct order.

Related Item

• FR-146-NFPA 70E-2021

Submitter Information Verification

Submitter Full Name: James Niemira
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Zip:
Submittal Date: Fri Apr 08 17:19:36 EDT 2022
Committee: EEW-AAA

Public Comment No. 94-NFPA 70E-2022 [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 capacitor banks

(4) Ionizing radiation, including X-rays at voltages greater than ~~5~~ 10 kV in a vacuum

(5) Assessing the listing status of electrical equipment and the need for field evaluation of nonlisted equipment

Statement of Problem and Substantiation for Public Comment

Two errors were made in entering PI No. 287, which was approved at the first draft meeting.

Related Item

- PI No. 287

Submitter Information Verification

Submitter Full Name:	Lloyd Gordon
Organization:	[Not Specified]
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Sun May 29 22:48:55 EDT 2022
Committee:	EEW-AAA

Public Comment No. 184-NFPA 70E-2022 [Section No. 330.5(E)]

(E) Listing.

Laser system electrical equipment presenting electrical hazards shall be listed or field evaluated prior to use.

Additional Proposed Changes

File Name	Description	Approved
CN_38.pdf	70E_CN38_PC184	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 38 appeared in the First Draft Report on First Revisions No. 129.

The Correlating Committee directs the technical committee to review what is meant by the vague word "presenting" and consider revising it for clarity and usability.

Related Item

- First Revision No. 129

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC

Organization: NEC Correlating Committee

Street Address:

City:

State:

Zip:

Submittal Date: Thu Jun 02 16:57:50 EDT 2022

Committee: EEW-AAA

Correlating Committee Note No. 38-NFPA 70E-2022 [Section No. 330.5(E)]

Submitter Information Verification

Committee: NEC-AAC

Submittal Date: Thu Jan 20 12:45:50 EST 2022

Committee Statement

Committee Statement: The Correlating Committee directs the technical committee to review what is meant by the vague word “presenting” and consider revising it for clarity and usability.

First Revision No. 129-NFPA 70E-2021 [Section No. 330.5(E)]

Ballot Results

This item has passed ballot

12 Eligible Voters
1 Not Returned
11 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.
Gallo, Ernest J.
Hickman, Palmer L.
Holub, Richard A.
Hunter, Dean C.
Kendall, David H.
Kovacik, John R.
Manche, Alan
Porter, Christine T.
Schultheis, Timothy James
Williams, David A.

Public Comment No. 95-NFPA 70E-2022 [Section No. 340.1]

340.1 Scope.

This article 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) Equipment that includes rectifiers and inverters such as the following:

(6) _ Motor drives

(7) _ Uninterruptible power supply systems

(8) _ Lighting controllers

(9) Generators producing sub RF (1 kHz to 3 kHz) and RF (3 kHz to 100 MHz) fields

(10) Ionizing radiation field generators including X-rays, magnetrons, klystrons, thyratrons, vacuum tubes, and similar high-voltage vacuum devices

(11) Nonionizing radiation field generating equipment, including:

(12) Antennas and RF transmission lines

(13) Radar equipment

(14) Industrial scientific and medical equipment

(15) RF induction and dielectric heaters

(16) Industrial microwave heaters and diathermy radiators

(17) Magnetic resonance imagers (MRIs)

(18) Large electromagnets

Informational Note: See the following standards for specific guidance 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*

(3) International Commission on Radiological Protection (ICRP) Publication 33, *Protection Against Ionizing Radiation from External Sources Used in Medicine*

Statement of Problem and Substantiation for Public Comment

The term RF, for frequencies from 3 kHz to 100 MHz) was inadvertently left out. It is important.

Related Item

• PI No. 335

Submitter Information Verification

Submitter Full Name: Lloyd Gordon

Organization: [Not Specified]
Street Address:
City:
State:
Zip:
Submittal Date: Sun May 29 22:58:01 EDT 2022
Committee: EEW-AAA

Public Comment No. 98-NFPA 70E-2022 [Section No. 340.4]

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 $(f/3)^{*0.3}$, f in MHz

(7) AC (30 MHz to 110 MHz): 200 mA

Informational Note No. 1: Items (B) through (F) see IEEE Std C95.1-2019, IEEE Standard for Safety Levels with Respect to Human Exposure to Electrical, Magnetic, and Electromagnetic Fields, 0 Hz to 300 GHz. Assumes workers are trained in sub RF and RF shock. Assumes grasping contact.

Informational Note No. 2: Items (C) through (F) are irregardless of voltage, but based on available RF current.

Statement of Problem and Substantiation for Public Comment

These two informational notes in the original PI No. 328 are important for the following reasons:
The source of these thresholds, from the IEEE C95.1-2019, are necessary because the user will have questions on their application.
The statement that these threshold assume worker training in sub RF and RF shock hazards is important because there are different rules for untrained workers.
Assuming grasping contact is important, because finger touch does use these thresholds.
Stating that these current thresholds are "irregardless of voltage" is very important for items 4 - 7 to prevent someone trying to apply a voltage threshold, such as 50 V. As the frequency increases contact impedance decreases dramatically due to capacitive coupling through the skin. Skin resistance is negligible. For instance, the skin impedance at 100 MHz will be a few ohms, allowing a 10 V, 100 MHz circuit to be a substantial shock and burn hazard, if there is sufficient current. Trying to use a "50 V ac rule" would be WRONG.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 128-NFPA 70E-2022 [Chapter 3]	

Related Item

- PI No. 328

Submitter Information Verification

Submitter Full Name: Lloyd Gordon
Organization: [Not Specified]
Street Address:
City:

State:	
Zip:	
Submittal Date:	Mon May 30 09:35:19 EDT 2022
Committee:	EEW-AAA

Public Comment No. 112-NFPA 70E-2022 [Article 350]

Article 350 Safety-Related Work Requirements: ~~Research and Development Laboratories~~ Specialized Industrial and Research Laboratory Equipment

350.1 Scope.

The requirements of this article shall apply to the electrical installations in those areas, with custom or special electrical equipment, designated by the facility management ~~for~~ found in industry and research and development (R&D) ~~or as~~ laboratories. This type of equipment may contain electrical hazards not covered by Chapter 1.

350.3 Applications of Other Articles.

The electrical ~~system for R&D~~ systems for specialized industrial and laboratory applications shall meet the requirements of the remainder of this document, except as amended by ~~Article 350~~ Chapter 3 .

> Informational Note: Examples of these applications include low-voltage–high-current power systems; high-voltage–low-current power systems; dc power supplies; capacitors; cable trays for signal cables and other systems, such as steam, water, air, gas, or drainage; and custom-made electronic equipment.

350.4 Electrical Safety Authority (ESA).

Each industry, laboratory or R&D system application shall be permitted to assign an ESA to ensure the use of appropriate electrical safety-related work practices and controls. The ESA shall be permitted to be an electrical safety committee, engineer, or equivalent qualified individual. The ESA shall be permitted to delegate authority to an individual or organization within their control.

(A) Responsibility.

The ESA shall act in a manner similar to an authority having jurisdiction for R&D electrical systems and electrical safe work practices.

(B) Qualifications.

The ESA shall be competent in the following:

(1) The requirements of this standard

(2) Electrical system requirements applicable to the R&D laboratories

350.5 Specific Measures and Controls for Personnel Safety.

Each industry, laboratory or R&D system application shall designate a competent person as defined in this article to ensure the use of appropriate electrical safety-related work practices and controls.

(A) Job Briefings.

Job briefings shall be performed in accordance with 110.3(I).

Exception: Prior to starting work, a brief discussion shall be permitted if the task and hazards are documented and the employee has reviewed applicable documentation and is qualified for the task.

(B) Personnel Protection.

Safety-related work practices shall be used to safeguard employees from injury while they are exposed to electrical hazards from exposed electrical conductors or circuit parts that are or can become energized. The specific safety-related work practices shall be consistent with the electrical hazard(s) and the associated risk. For calibration and adjustment of equipment as it pertains to sensors, motor controllers, control hardware, and other devices that need to be installed inside equipment or control cabinet, surrounded by electrical hazards, the ESA shall define the required PPE based on the risk and exposure.

Use of electrical insulating blankets, covers, or barriers shall be permitted to prevent inadvertent contact to exposed terminals and conductors. Insulated/nonconductive adjustment and alignment tools shall be used where feasible.

350.6 Approval Requirements.

The equipment or systems used in the industry, R&D area, or in the laboratory shall be listed or field evaluated prior to use.

Informational Note: Laboratory and R&D equipment or systems can pose unique electrical hazards that might require mitigation. Such hazards include ac and dc, low voltage and high amperage, high voltage and low current, large electromagnetic fields, induced voltages, pulsed power, multiple frequencies, and similar exposures.

350.7 Custom Built, Non-Listed Research Equipment, 1000 Volts or less AC or DC.

(A) Equipment Marking and Documentation.

(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: See ANSI Z535, *Series of Standards for Safety Signs and Tags*, for more information on precautionary marking of electrical systems or equipment.

(2) Documentation.

Sufficient documentation shall be provided and readily available to personnel that install, operate, and maintain equipment that describes operation, shutdown, safety concerns, and nonstandard installations.

Schematics, drawings, and bill of materials describing power feeds, voltages, currents, and parts used for construction, maintenance, and operation of the equipment shall be provided.

(3) Shutdown Procedures.

Safety requirements and emergency shutdown procedures of equipment shall include lockout/tagout (LOTO) requirements. If equipment-specific LOTO is required, then documentation outlining this procedure and PPE requirements shall be made readily available.

(4) Specific Hazards.

Specific hazards, other than electrical, associated with research equipment shall be documented and readily available.

(5) Approvals.

Drawings, standard operational procedures, and equipment shall be approved by the ESA on site before initial startup. Assembly of equipment shall comply with national standards where applicable unless research application requires exceptions. Equipment that does not meet the applicable standards shall be required to be approved by the ESA. Proper safety shutdown procedures and PPE requirements shall be considered in the absence of grounding and/or bonding.

(B) Tools, Training, and Maintenance.

Documentation shall be provided if special tools, unusual PPE, or other equipment is necessary for proper maintenance and operation of equipment. The ESA shall make the determination of appropriate training and qualifications required to perform specific tasks.

350.8 Custom Built, Unlisted Research Equipment, >1000 V AC or DC.

Installations shall comply with all requirements of 350.7.

In the event that research equipment requires PPE beyond what is commercially available, the ESA shall determine safe work practices and PPE to be used.

350.9 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: 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.

350.10 Establishing an Electrically Safe Work Condition.

Energized electrical conductors and circuit parts shall be put into an electrically safe work condition before an employee performs work.

Exception: At the discretion of the ESA, alternative methods of ensuring worker safety shall be permitted to be employed for the following conditions:

(1) Minor tool changes and adjustments, and other normal production operations that are routine, repetitive, or sequential and integral to the use of the equipment for production

(2) Minor changes to the unit under test and other minor servicing activities, to include the activities listed under 350.10 Exception condition (1), that take place during research and development

(3) Work on cord-and-plug-connected equipment for which exposure to the hazards of unexpected energization or start up is controlled by the following:

(4) <u>Unplugging the equipment from the energy source</u>

(5) <u>The employee performing the work maintaining exclusive control of the plug</u>

Statement of Problem and Substantiation for Public Comment

The purpose of the change is absolutely to open up the current scope of Article 350. It in no way exposes industrial workers to additional hazards that are not normally foreseen. That statement does not make sense. How does broadening the scope expose workers to hazards? Not normally foreseen? That is the very point, we must cover those hazards in industry to protect workers.

This submission was not the idea of the submitter but was requested by many industrial representatives, some of who are on the NFPA 70E committee. Naming this section "R&D" was short sighted, as many of the HAZARDS discussed in Article 350 appear throughout industry and are NOT covered by Chapter 1. Many of the SAFE WORK PRACTICES presented in Article 350 are useful to industry and are NOT covered by Chapter 1. Indeed, the whole purpose of broadening the scope of Article 350 was to ensure that industrial workers are AWARE of and have tools to WORK SAFELY with the hazards not covered by Chapter 1.
These hazards include high voltage/low current, low voltage/high current, capacitor, sub RF and RF hazards, all of which are not covered by Chapter 1. In addition, many industries are replete with unlisted, custom built equipment, that must meet the OSHA requirement for listed or approved electrical equipment. The concept of an Electrical Safety Authority (similar to an AHJ) is to ensure that there can be a process to approve such equipment. It is a very useful concept for industry.

The following is a list of industries that could benefit from this expansion. Some are rapidly growing and are not covered by 70E Chapter 1, or any other worker safety standard.

Large Scale Battery Energy Storage Systems.
Battery technologies other than lead acid (the focus of Article 320), including Lithium Ion, flow, and molton metal.
Fuel cells
Very high power (100 MW) inverters, rectifiers, and energy conversion for solid state transformers, solid state breakers, 100-MW energy conversion between solar power/wind generation plants and current AC energy transmission.
Hyperloop, supersonic, magnetically levitated trains running in a vacuum tube. All of the magnetic levitation, acceleration and vacuum equipment is stationary equipment.
Existing electrochemical plants. Not everything is covered by electrolytic cells (Article 310).
Metals industries, using many MW solid state switching supplies with capacitor, sub RF and RF hazards.

If 70E is to cover Electrical Safety in ALL Workplaces, it must move beyond the classical 60 Hz power (90% of Chapter 1), and basic DC (10% of Chapter 1) and embrace all electrical hazards, which occur throughout laboratories and industry. All of Chapter 3 is ripe for reorganization to embrace rapidly changing technology.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 128-NFPA 70E-2022 [Chapter 3]	

Related Item

- PI No. 304

Submitter Information Verification

Submitter Full Name:	Lloyd Gordon
Organization:	[Not Specified]
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Mon May 30 11:43:54 EDT 2022
Committee:	EEW-AAA

Public Comment No. 99-NFPA 70E-2022 [Section No. 350.9]

350.9 Electrical Hazard Thresholds.

~~Energy exposure~~ 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: 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.

Statement of Problem and Substantiation for Public Comment

These are NOT energy thresholds. Per the original approved PI No. 328, take out the word "Energy"

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 128-NFPA 70E-2022 [Chapter 3]	

Related Item

- PI No. 321

Submitter Information Verification

Submitter Full Name:	Lloyd Gordon
Organization:	[Not Specified]
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Mon May 30 09:46:55 EDT 2022
Committee:	EEW-AAA

Public Comment No. 80-NFPA 70E-2022 [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 more information on working safely with capacitors.

Informational Note: Capacitors that are components of listed products do not usually present an electrical hazard to the user as long as all manufacturer's instructions are followed during the servicing of the equipment.

Statement of Problem and Substantiation for Public Comment

The charging statement in 360.1 is that this article covers "...capacitors that present an electrical hazard." But what is a capacitor that presents an electrical hazard? The Scope of this article concerns specialized, usually stand-alone, capacitors for R&D or other uses like Power Factor Correction. The informational note makes it more clear that capacitors in listed products generally do not present a hazard and are therefore not included in the scope of 360. This is a parallel issue to Article 460 capacitors in NFPA70. The scope statement in Art. 460 is "Surge capacitors or capacitors included as a component part of other apparatus and conforming with the requirements of such apparatus are excluded from these requirements."

Related Item

- 228-NFPA 70E-2021

Submitter Information Verification

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Submittal Date:	Sun May 29 13:52:49 EDT 2022
Committee:	EEW-AAA

Public Comment No. 122-NFPA 70E-2022 [Section No. 360.3]

~~360.3~~ 2 Stored Energy Hazard Thresholds.

Appropriate controls shall be applied where any of the following hazard thresholds are exceeded:

(1) Less than 100 volts and greater than 100 joules of stored energy

(2) Greater than or equal to 100 volts and greater than 1.0 joule of stored energy

(3) Greater than or equal to 400 volts and greater than 0.25 joules of stored energy

Statement of Problem and Substantiation for Public Comment

to update numbering with removal of definitions

Related Item

• PI No. 108

Submitter Information Verification

Submitter Full Name: Lloyd Gordon
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Submittal Date: Mon May 30 13:31:54 EDT 2022
Committee: EEW-AAA

Public Comment No. 123-NFPA 70E-2022 [Section No. 360.4]

360.4 ~~4~~ 3 Specific Measures for Personnel Safety.

(A) Qualification and Training.

The following qualifications and training shall be required for personnel safety:

(1) Employees who perform work on electrical equipment with capacitors that exceed the energy thresholds in 360.3 shall be qualified and shall be trained in, and familiar with, the specific hazards and controls required for safe work.

(2) Unqualified persons who perform work on electrical equipment with capacitors shall be trained in, and familiar with, any electrical safety-related work practices necessary for their safety.

(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 more information on calculating capacitor stored energy, arc flash, and arc blast boundaries.

Informational Note No. 2: Heavy duty leather with a minimum thickness of 0.03 in. (0.7 mm) provides protection from thermal hazards.

Statement of Problem and Substantiation for Public Comment

To update numbering with removal of definitions.

Related Item

• PI No. 108

Submitter Information Verification

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Committee:	EEW-AAA

Public Comment No. 124-NFPA 70E-2022 [Section No. 360.5]

360.~~5~~ 4 Establishing an Electrically Safe Work Condition for a Capacitor(s).

(A) Written Procedure.

Where a conductor or circuit part is connected to a capacitor(s) operating at or above the thresholds in 360.3, a written procedure shall be used to document the necessary steps and sequence to discharge the capacitor(s) and place the equipment into an electrically safe work condition. The written procedure shall incorporate the results of the risk assessment performed in 360.5(B) and specify the following at a minimum:

(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) 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.

Statement of Problem and Substantiation for Public Comment

to update numbering with removal of definitions

Related Item

• PI No. 108

Submitter Information Verification

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Public Comment No. 125-NFPA 70E-2022 [Section No. 360.6]

360.6 ~~–~~ **5** Ground Sticks.

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 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.

Statement of Problem and Substantiation for Public Comment

to update numbering with removal of definitions

Related Item

• PI No. 108

Submitter Information Verification

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Committee: EEW-AAA

Public Comment No. 127-NFPA 70E-2022 [Section No. 360.6(A)]

(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~~ ground 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.

Statement of Problem and Substantiation for Public Comment

I caught one more inconsistent use of "grounding stick" instead of "ground stick"

Related Item

• PI No. 373

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Public Comment No. 105-NFPA 70E-2022 [Section No. A.3.6]

A.3.6 IEC Publications.

International Electrotechnical Commission, 3, rue de Varembé, P.O. Box 131, CH-1211 Geneva 20, Switzerland.

IEC TS 60479-1, *Effects of Current on Human Beings and Livestock Part 1: General Aspects*, Edition 1.0, Dec. 2016.

~~IECTS~~ IEC TS 60479-2, *Effects of Current on ~~Humans~~ Human Beings and ~~Livestock~~ Livesto ck , Part 2 ~~,~~ : Special Aspects* , ~~2017.~~ Edition 1.0, May 2019.

IEC 61243-1, *Live Working — Voltage Detectors — Part 1: Capacitive type to be used for voltages exceeding 1kV a.c.*, 2009.

IEC 61243-2, *Live Working — Voltage Detectors — Part 2: Resistive type to be used for voltages of 1kV to 36 kV a.c.*, 2002.

IEC 61243.3, *Live Working — Voltage Detectors — Part 3: Two-pole low voltage type*, 2014.

Statement of Problem and Substantiation for Public Comment

Mosty editorial corrections. However, IEC 60479-2 has been updated over what was listed. It is important to reference to most recent versions. Both 60479-1 and 60479-2 are very important revisions, since, after 30 years, they were upgraded from Technical Reports to IEC Standards. Thus, they are both "Edition 1.0" of the new Standards. Also, they are referenced in Article 340.

Related Item

• PI No. 345

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Submittal Date: Mon May 30 10:45:39 EDT 2022
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Public Comment No. 41-NFPA 70E-2022 [Section No. C.2]

C.2 Basis for Distance Values in Tables 130.4(E)(a) and 130.4(E)(b).

C.2.1 General Statement.

Columns 2 through 5 of Table 130.4(E)(a) and Table 130.4(E)(b) show various distances from the exposed energized electrical conductors or circuit parts. They include dimensions that are added to a basic minimum air insulation distance. Those basic minimum air insulation distances ~~for voltages 72.5 kV and under~~ are based on ~~IEEE 4,~~ ~~*Standard Techniques for High Voltage Testing,*~~ ~~Appendix 2B; and voltages over 72.5 kV are based on IEEE 516,~~ ~~*Guide for Maintenance Methods on Energized Power Lines*~~ ~~. The minimum air insulation distances that are required to avoid flashover are as follows:~~

(1) ~~≤300 V: 1 mm (0 ft 0.03 in.)~~

(2) ~~>300 V to ≤750 V: 2 mm (0 ft 0.07 in.)~~

(3) ~~>750 V to ≤2 kV: 5 mm (0 ft 0.19 in.)~~

(4) ~~>2 kV to ≤15 kV: 39 mm (0 ft 1.5 in.)~~

(5) ~~>15 kV to ≤36 kV: 161 mm (0 ft 6.3 in.)~~

(6) ~~>36 kV to ≤48.3 kV: 254 mm (0 ft 10.0 in.)~~

(7) ~~>48.3 kV to ≤72.5 kV: 381 mm (1 ft 3.0 in.)~~

(8) ~~>72.5 kV to ≤121 kV: 640 mm (2 ft 1.2 in.)~~

(9) ~~>138 kV to ≤145 kV: 778 mm (2 ft 6.6 in.)~~

(10) ~~>161 kV to ≤169 kV: 915 mm (3 ft 0.0 in.)~~

(11) ~~>230 kV to ≤242 kV: 1.281 m (4 ft 2.4 in.)~~

(12) ~~>345 kV to ≤362 kV: 2.282 m (7 ft 5.8 in.)~~

(13) ~~>500 kV to ≤550 kV: 3.112 m (10 ft 2.5 in.)~~

(14) ~~>765 kV to ≤800 kV: 4.225 m (13 ft 10.3 in.)~~

OSHA's 29 CFR 1910.269, Table R-3.

C.2.1.1 Column 1.

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

C.2.1.2 Column 2.

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

C.2.1.3 Column 3.

The distances in column 3 are based on the following:

(1) ≤750 V: Use *NEC* Table 110.26(A)(1), Working Spaces, Condition 2, for the 151 V to 600 V range.

(2) ~~>750 V~~ >751 V to ≤145 kV: Use *NEC* Table 110.34(A), Working Space, Condition 2, using 751 V instead of 1000 V for the lowest voltage range .

(3) >145 kV: Use OSHA's 3.05 m (10 ft) rules as used in Column 2.

C.2.1.4 Column 4.

The distances in column 4 are based on ~~adding to the flashover dimensions shown in C.2.1 the following inadvertent movement distance:~~

~~≤300 V: Avoid contact.~~

~~Based on experience and precautions for household 120/240-V systems:~~

~~>300 V to ≤750 V: Add 304.8 mm (1 ft 0 in.) for inadvertent movement.~~

~~These values have been found to be adequate over years of use in ANSI/IEEE C2, *National Electrical Safety Code,* in the approach distances for communication workers.~~

~~>72.5 kV: Add 304.8 mm (1 ft 0 in.) for inadvertent movement.~~

~~These values have been found to be adequate over years of use in ANSI/IEEE C2, *National Electrical Safety Code,* in the approach distances for supply workers.~~

OSHA's 29 CFR 1910.269, Table R6 for voltages of 72.5 kV. However, it is assumed that the withstand distance for voltages of 750 V and less is negligible; thus, the restricted approach boundary for voltages of 151 V to 750 V 0.31 m (1 ft 0 in.) rather than 0.33 m (1 ft 9 in.) from Table R-6 (OSHA's table includes a 0.02-m (0.07-ft) withstand distance added to the 0.31-m (1 ft 0 in.) inadvertant movement distance.)

Additional Proposed Changes

File Name	Description	Approved
Annex_C_Revised_-_TG_2_-_2-11-22.docx		

Statement of Problem and Substantiation for Public Comment

This public comment is being submitted on behalf of 2024 NFPA 70E Task Group 2, Shock Protection Boundaries. The members of the task group included Ernie Gallo, Thomas Dyson, Mark Hilbert, James Stallcup, Jr., James Stallcup, Sr. and David Wallis.

Annex C.2.1, C.2.2, C.2.3 and C.2.4 were revised to support the changes made in Table 130.4(E)(a) to corelate with OSHA's 29 CFR 1910.269 Tables R-3, R-6 and R-7.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 40-NFPA 70E-2022 [Section No. 130.4(E)]	
Public Comment No. 40-NFPA 70E-2022 [Section No. 130.4(E)]	

Related Item

- PI 94

Submitter Information Verification

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Committee:	EEW-AAA

C Limits of Approach

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

C.1 Preparation for Approach.

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

C.1.1 Unqualified Persons, Safe Approach Distance.

Unqualified persons are safe when they maintain a distance from the exposed energized conductors or circuit parts, including the longest conductive object being handled, so that they cannot contact or enter a specified air insulation distance to the exposed energized electrical conductors or circuit parts. This safe approach distance is the limited approach boundary. Further, persons must not cross the arc flash boundary unless they are wearing appropriate personal protective clothing and are under the close supervision of a qualified person. Only when continuously escorted by a qualified person should an unqualified person cross the limited approach boundary. Under no circumstance should an unqualified person cross the restricted approach boundary, where special shock protection techniques and equipment are required.

C.1.2 Qualified Persons, Safe Approach Distance.

C.1.2.1

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

C.1.2.2

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

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

C.1.2.3

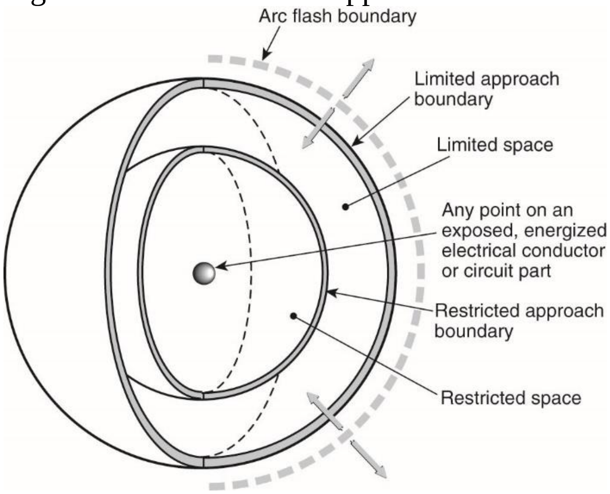
To cross the restricted approach boundary and enter the restricted space, qualified persons should meet the following criteria:

1. As applicable, have an energized electrical work permit authorized by management.
2. Use personal protective equipment (PPE) that is rated for the voltage and energy level involved.

3. Minimize the likelihood of bodily contact with exposed energized conductors and circuit parts from inadvertent movement by keeping as much of the body out of the restricted space as possible and using only protected body parts in the space as necessary to accomplish the work.
4. Use insulated tools and equipment.

(See Figure C.1.2.3.)

Figure C.1.2.3 Limits of Approach.



C.2 Basis for Distance Values in Tables 130.4(E)(a) and 130.4(E)(b).
C.2.1 General Statement.

Columns 2 through 5 of Table 130.4(E)(a) and Table 130.4(E)(b) show various distances from the exposed energized electrical conductors or circuit parts. They include dimensions that are added to a basic minimum air insulation distance. Those basic minimum air insulation distances ~~for voltages 72.5 kV and under~~ are based on ~~IEEE 4-1995, *Standard Techniques for High Voltage Testing*, Appendix 2BTable 11~~OSHA's 29 CFR 1910.269, Table R-3~~; and voltages over 72.5 kV are based on IEEE 516-2009, *Guide for Maintenance Methods on Energized Power Lines*. The minimum air insulation distances that are required to avoid flashover sparkover are as follows:~~

~~≤300 V: 1 mm (0 ft 0.03 in.)~~

~~>300 V to ≤750 V: 2 mm (0 ft 0.07 in.)~~

~~>750 V to ≤2 kV: 5 mm (0 ft 0.19 in.)~~

~~>2 kV to ≤15 kV: 39 mm (0 ft 1.5 in.)~~

~~>15 kV to ≤36 kV: 161 mm (0 ft 6.3 in.)~~

~~>36 kV to ≤48.3 kV: 254 mm (0 ft 10.0 in.)~~

~~>48.3 kV to ≤72.5 kV: 381 mm (1 ft 3.0 in.)~~

~~>72.5 kV to ≤121 kV: 640 mm (2 ft 1.2 in.)~~

~~>138 kV to ≤145 kV: 778 mm (2 ft 6.6 in.)~~

~~>161 kV to ≤169 kV: 915 mm (3 ft 0.0 in.)~~

~~>230 kV to ≤242 kV: 1.281 m (4 ft 2.4 in.)~~

~~>345 kV to ≤362 kV: 2.282 m (7 ft 5.8 in.)~~

~~>500 kV to ≤550 kV: 3.112 m (10 ft 2.5 in.)~~

~~>765 kV to ≤800 kV: 4.225 m (13 ft 10.3 in.)~~

C.2.1.1 Column 1.

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

C.2.1.2 Column 2.

The distances in column 2 are based on OSHA's rule for unqualified persons to maintain a 3.05 m (10 ft) clearance for all voltages up to 50 kV (voltage-to-ground), plus 0.10~~0~~ m~~m~~ (4.0 in.) for each 10 kV over 50 kV.

C.2.1.3 Column 3.

The distances in column 3 are based on the following:

1. ≤750 V: Use *NEC* Table 110.26(A)(1), Working Spaces, Condition 2, for the 151 V to 600 V range.
2. >751~~0~~ V to ≤145 kV: Use *NEC* Table 110.34(A), Working Space, Condition 2, using 751 instead of 1000 V for the lowest voltage range~~.~~
3. >145 kV: Use OSHA's 3.05-~~-~~m (10-~~-~~ft) rules as used in Column 2.

C.2.1.4 Column 4.

The distances in column 4 are based on OSHA's 29 CFR 1910.269, Table R-6 for voltages of 72.5 kV and less and Table R-7 for voltages of more than 72.5 kV. However, it is assumed that the withstand distance for voltages of 750 V and less is negligible; thus, the restricted approach boundary for voltages of 151 to 750 V is 0.31 m (1 ft) rather than 0.33 m (1.09 ft) from Table R-6. (OSHA's table includes a 0.02-m (0.07-ft) withstand distance added to the 0.31-m (1 ft) inadvertent-movement distance.)~~adding to the flashover dimensions shown in C.2.1 the following inadvertent movement distance:~~

~~≤300 V: Avoid contact.~~

~~Based on experience and precautions for household 120/240-V systems:~~

~~>300 V to ≤750 V: Add 304.8 mm (1 ft 0 in.) for inadvertent movement.~~

~~These values have been found to be adequate over years of use in ANSI/IEEE C2, *National Electrical Safety Code*, in the approach distances for communication workers.~~

~~>72.5 kV: Add 304.8 mm (1 ft 0 in.) for inadvertent movement.~~

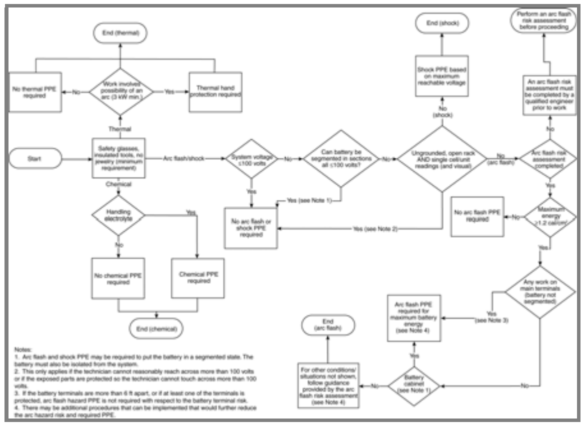
~~These values have been found to be adequate over years of use in ANSI/IEEE C2, *National Electrical Safety Code*, in the approach distances for supply workers.~~

Public Comment No. 65-NFPA 70E-2022 [Section No. F.7]

F.7 Battery Risk Assessment.

Multiple hazards may be encountered when working on batteries (shock, arc flash, chemical, thermal). PPE selection should take into account all of the hazards depending on the task. The flow chart displayed in Figure F.7 will assist users to assess all hazards associated with work on batteries.

Figure F.7 Assessing Hazards Associated with Work on Batteries.



<Change Figure's thermal protection threshold from 3 kW to 1 kW>

Statement of Problem and Substantiation for Public Comment

Article 320 now has a thermal hazard threshold of 1kW, after FR-101 and FR-102, and this figure should be changed to match it.

Related Item

• FR-101 • FR-102

Submitter Information Verification

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Committee:	EEW-AAA

Public Comment No. 185-NFPA 70E-2022 [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 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 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.

Additional Proposed Changes

File Name	Description	Approved
CN_39.pdf	70E_CN39_PC185	

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 39 appeared in the First Draft Report on First Revisions No. 140.

The Correlating Committee directs that the use of the terms shock, electric shock, and electrical shock throughout the standard be reviewed and a single term that can be consistently used in the standard be considered unless there is a technical reason to retain the current multiple terms. The Correlating Committee notes that the definition of “electrical hazard” uses the term “electric shock.” For correlation, the defined term “shock hazard” may be more appropriately titled “electric shock hazard.” The Correlating Committee directs the technical committee to review the negative ballot comments on First Revision 140.

Related Item

- First Revision No. 140

Submitter Information Verification

Submitter Full Name: CC on NEC-AAC
Organization: NEC Correlating Committee
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Submittal Date:	Thu Jun 02 17:04:14 EDT 2022
Committee:	EEW-AAA

Correlating Committee Note No. 39-NFPA 70E-2022 [Section No. K.1]

Submitter Information Verification

Committee: NEC-AAC

Submittal Date: Thu Jan 20 12:52:04 EST 2022

Committee Statement

Committee Statement: The Correlating Committee directs that the use of the terms shock, electric shock, and electrical shock throughout the standard be reviewed and a single term that can be consistently used in the standard be considered unless there is a technical reason to retain the current multiple terms. The Correlating Committee notes that the definition of “electrical hazard” uses the term “electric shock.” For correlation, the defined term “shock hazard” may be more appropriately titled “electric shock hazard.” The Correlating Committee directs the technical committee to review the negative ballot comments on First Revision 140.

First Revision No. 140-NFPA 70E-2021 [Section No. K.1]

Ballot Results

✔ **This item has passed ballot**

12 Eligible Voters
1 Not Returned
11 Affirmative All
0 Affirmative with Comments
0 Negative with Comments
0 Abstention

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.

Gallo, Ernest J.

Hickman, Palmer L.

Holub, Richard A.

Hunter, Dean C.

Kendall, David H.

Kovacik, John R.

Manche, Alan

Porter, Christine T.

Schultheis, Timothy James

Williams, David A.

Public Comment No. 16-NFPA 70E-2022 [Annex N]

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

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

N.

~~1 Introduction~~

1 Introduction .

This informative annex is an example of an industrial procedure for working near overhead electrical systems. Areas covered include operations that could expose employees or equipment to contact with overhead electrical systems.

When working near electrical lines or equipment, avoid direct or indirect contact. Direct contact is contact with any part of the body. Indirect contact is when part of the body touches or is in dangerous proximity to any object in contact with energized electrical equipment. The following two assumptions should always be made:

(1) Lines are "live" (energized).

(2) Lines are operating at high voltage (over 1000 volts).

As the voltage increases, the minimum working clearances increase. Through arc-over, injuries or fatalities could occur, even if actual contact with high-voltage lines or equipment is not made. Potential for arc-over increases as the voltage increases.

N.

~~2 Overhead~~

2 Overhead Power Line Policy (OPP).

This informative annex applies to all overhead conductors, regardless of voltage, and requires the following:

(1) That employees not place themselves in close proximity to overhead power lines. "Close proximity" is within a distance of 3 m (10 ft) for systems up to 50 kV, and should be increased 100 mm (4 in.) for every 10 kV above 50 kV.

(2) That employees be informed of the hazards and precautions when working near overhead lines.

(3) That warning decals be posted on cranes and similar equipment regarding the minimum clearance of 3 m (10 ft).

(4) That a "spotter" be designated when equipment is working near overhead lines. This person's responsibility is to observe safe working clearances around all overhead lines and to direct the operator accordingly.

(5) That warning cones be used as visible indicators of the 3 m (10 ft) safety zone when working near overhead power lines.

Informational Note:

~~"Working~~

(1)

"Working near," for the purpose of this informative annex, is defined as working within a distance from any overhead power line that is less than the combined height or length of the lifting device plus the associated load length and the required minimum clearance distance [as stated in N.2(1)]. Required clearance is expressed as follows:

.

Required clearance = lift equipment height or length + load length + at least 3 m (10 ft)

(2) That the local responsible person be notified at least 24 hours before any work begins to allow time to identify voltages and clearances or to place the line in an electrically safe work condition.

N.

~~3 Policy~~

3 Policy .

All employees and contractors shall conform to the OPP. The first line of defense in preventing electrical contact accidents is to remain outside the limited approach boundary. Because most company and contractor employees are not qualified to determine the system voltage level, a qualified person shall be called to establish voltages and minimum clearances and take appropriate action to make the work zone safe.

N.

~~4 Procedures~~

4 Procedures .

N.4.

~~1 General~~

1 General .

Prior to the start of all operations where potential contact with overhead electrical systems is possible, the person in charge shall identify overhead lines or equipment, reference their location with respect to prominent physical features, or physically mark the area directly in front of the overhead lines with safety cones, survey tape, or other means. Electrical line location shall be discussed at a pre-work safety meeting of all employees on the job (through a job briefing). All company employees and contractors shall attend this meeting and require their employees to conform to electrical safety standards. New or transferred employees shall be informed of electrical hazards and proper procedures during orientations.

On construction projects, the contractor shall identify and reference all potential electrical hazards and document such actions with the on-site employers. The location of overhead electrical lines and equipment shall be conspicuously marked by the person in charge. New employees shall be informed of electrical hazards and of proper precautions and procedures.

Where there is potential for contact with overhead electrical systems, local area management shall be called to decide whether to place the line in an electrically safe work condition or to otherwise protect the line against unintentional contact. Where there is a suspicion of lines with low clearance [height under 6 m (20 ft)], the local on-site electrical supervisor shall be notified to verify and take appropriate action.

All electrical contact incidents, including “near misses,” shall be reported to the local area health and safety specialist.

N.4.

~~2 Look~~

2 Look Up and Live Flags.

In order to prevent unintentional contact with all aerial lifts, cranes, boom trucks, service rigs, and similar equipment shall use look up and live flags. The flags are visual indicators that the equipment is currently being used or has been returned to its “stowed or cradled” position. The flags shall be yellow with black lettering and shall state in bold lettering “LOOK UP AND LIVE.”

The procedure for the use of the flag follows.

(1) When the boom or lift is in its stowed or cradled position, the flag shall be located on the load hook or boom end.

(2) Prior to operation of the boom or lift, the operator of the equipment shall assess the work area to determine the location of all overhead lines and communicate this information to all crews on site. Once completed, the operator shall remove the flag from the load hook or boom and transfer the

flag to the steering wheel of the vehicle. Once the flag is placed on the steering wheel, the operator can begin to operate the equipment.

(3) After successfully completing the work activity and returning the equipment to its stowed or cradled position, the operator shall return the flag to the load hook.

(4) The operator of the equipment is responsible for the placement of the look up and live flag.

N.4.

~~3 High~~

3 High Risk Tasks.

N.4.3.

~~1 Heavy~~

1 Heavy Mobile Equipment.

Prior to the start of each workday, a high-visibility marker (orange safety cones or other devices) shall be temporarily placed on the ground to mark the location of overhead wires. The supervisors shall discuss electrical safety with appropriate crew members at on-site tailgate safety talks. When working in the proximity of overhead lines, a spotter shall be positioned in a conspicuous location to direct movement and observe for contact with the overhead wires. The spotter, equipment operator, and all other employees working on the job location shall be alert for overhead wires and remain at least 3 m (10 ft) from the mobile equipment.

All mobile equipment shall display a warning decal regarding electrical contact. Independent truck drivers delivering materials to field locations shall be cautioned about overhead electrical lines before beginning work, and a properly trained on-site or contractor employee shall assist in the loading or off-loading operation. Trucks that have emptied their material shall not leave the work location until the boom, lift, or box is down and is safely secured.

N.4.3.

~~2 Aerial~~

2 Aerial Lifts, Cranes, and Boom Devices.

Where there is potential for near operation or contact with overhead lines or equipment, work shall not begin until a safety meeting is conducted and appropriate steps are taken to identify, mark, and warn against unintentional contact. The supervisor will review operations daily to ensure compliance.

Where the operator's visibility is impaired, a spotter shall guide the operator. Hand signals shall be used and clearly understood between the operator and spotter. When visual contact is impaired, the spotter and operator shall be in radio contact. Aerial lifts, cranes, and boom devices shall have appropriate warning decals and shall use warning cones or similar devices to indicate the location of overhead lines and identify the 3 m (10 ft) minimum safe working boundary.

N.4.3.

~~3 Tree~~

3 Tree Work.

Wires shall be treated as live and operating at high voltage until verified as otherwise by the local area on-site employer. The local maintenance organization or an approved electrical contractor shall remove branches touching wires before work begins. Limbs and branches shall not be dropped onto overhead wires. If limbs or branches fall across electrical wires, all work shall stop immediately and the local area maintenance organization is to be called. When climbing or working in trees, pruners shall try to position themselves so that the trunk or limbs are between their bodies and electrical wires. If possible, pruners shall not work with their backs toward electrical wires. An insulated bucket truck is the preferred method of pruning when climbing poses a greater threat of electrical contact. Personal protective equipment (PPE) shall be used while working on or near lines.

N.4.

~~4 Underground~~

4 Underground Electrical Lines and Equipment.

Before excavation starts and where there exists reasonable possibility of contacting electrical or utility lines or equipment, the local area supervision (or USA DIG organization, when appropriate) shall be called and a request is to be made for identifying/marking the line location(s).

When USA DIG is called, their representatives will need the following:

(1) Minimum of two working days' notice prior to start of work, name of county, name of city, name and number of street or highway marker, and nearest intersection

(2) Type of work

(3) Date and time work is to begin

(4) Caller's name, contractor/department name and address

(5) Telephone number for contact

(6) Special instructions

Utilities that do not belong to USA DIG must be contacted separately. USA DIG might not have a complete list of utility owners. Utilities that are discovered shall be marked before work begins. Supervisors shall periodically refer their location to all workers, including new employees, subject to exposure.

N.4.

~~5 Vehicles~~

5 Vehicles with Loads in Excess of 4.25 m (14 ft) in Height.

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

The specific procedures for moving loads in excess of 4.25 m (14 ft) in height or via routes with lower clearance heights are as follows:

(1) Prior to movement of any load in excess of 4.25 m (14 ft) in height, the local health and safety department, along with the local person in charge, shall be notified of the equipment move.

(2) An on-site electrician, electrical construction representative, or qualified electrical contractor should check the intended route to the next location before relocation.

(3) The new site is to be checked for overhead lines and clearances.

(4) Power lines and communication lines shall be noted, and extreme care used when traveling beneath the lines.

(5) The company moving the load or equipment will provide a driver responsible for measuring each load and ensuring each load is secured and transported in a safe manner.

(6) An on-site electrician, electrical construction representative, or qualified electrical contractor shall escort the first load to the new location, ensuring safe clearances, and a service company representative shall be responsible for subsequent loads to follow the same safe route.

If proper working clearances cannot be maintained, the job must be shut down until a safe route can be established or the necessary repairs or relocations have been completed to ensure that a safe working clearance has been achieved.

All work requiring movement of loads in excess of 4.25 m (14 ft) in height are required to begin only after a general work permit has been completed detailing all pertinent information about the move.

N.4.

~~6 Emergency~~

6 Emergency Response.

If an overhead line falls or is contacted, the following precautions should be taken:

(1) Keep everyone at least 3 m (10 ft) away.

(2) Use flagging to protect motorists, spectators, and other individuals from fallen or low wires.

(3) Call the local area electrical department or electric utility immediately.

(4) Place barriers around the area.

(5) Do not attempt to move the wire(s).

(6) Do not touch anything that is touching the wire(s).

(7) Be alert to water or other conductors present.

(8) Crews shall have emergency numbers readily available. These numbers shall include local area electrical department, utility, police/fire, and medical assistance.

(9) If an individual becomes energized, DO NOT TOUCH the individual or anything in contact with the person. Call for emergency medical assistance and call the local utility immediately. If the individual is no longer in contact with the energized conductors, CPR, rescue breathing, or first aid should be administered immediately, but only by a trained person. It is safe to touch the victim once contact is broken or the source is known to be de-energized.

(10) Wires that contact vehicles or equipment will cause arcing, smoke, and possibly fire. Occupants should remain in the cab and wait for the local area electrical department or utility. If it becomes necessary to exit the vehicle, leap with both feet as far away from the vehicle as possible, without touching the equipment. Jumping free of the vehicle is the last resort.

(11) If operating the equipment and an overhead wire is contacted, stop the equipment immediately and, if safe to do so, jump free and clear of the equipment. Maintain your balance, keep your feet together and either shuffle or bunny hop away from the vehicle another 3 m (10 ft) or more. Do not return to the vehicle or allow anyone else for any reason to return to the vehicle until the local utility has removed the power line from the vehicle and has confirmed that the vehicle is no longer in contact with the overhead lines.

Additional Proposed Changes

File Name	Description	Approved
Annex_N_-_For_Working_Near_OverheadElectrical_Lines_and_Equipment.docx	This word document contains the complete revisions suggested for Annex N that should bring it in better alignment with terms and definitions used within NFPA 70E.	

Statement of Problem and Substantiation for Public Comment

Informational Annex N was first added to 70E during the 2009 edition and has essentially been unchanged since then and is in need of an update. While overhead line work is outside of the scope of NFPA 70E, those employees who work near overhead lines and equipment are in great risks of injury and must be provided with a practical method to establish some kind of safety procedure to help keep their workers safe from inadvertent contact with or arc over from overhead lines. As an employee of the largest electric utility company in the State of AZ, keeping other workers safe from inadvertent contact with our overhead lines and from digging into our underground distribution lines is an ongoing challenge and unfortunately many people have been killed or seriously injured. According to Electrical Safety Foundation International (ESFI) approximately 39% of all workplace electrical fatalities were caused by overhead power lines between 2011 and 2020.
https://www.esfi.org/overhead-powerline-safety/
Therefore I've submitted a substantially revised version of Annex N while using its original formatting which uses many of the terms and definitions currently found and used in NFPA 70E or in one of the other Annexes such as "limited approach boundary of exposed moveable conductors" from table 130.4(E), "pre-job briefing"and "job-site review" from Annex Q, "Person in Charge" used throughout 70E and several others.
I've also included more instructions to coordinate with the local electric utility company whenever work is going to be performed near overhead lines and increased the safety distance from 10 feet to 35 feet if a vehicle should become energized. Since an energized vehicle not only poses touch potential hazards to workers but also step potential hazards, a distance of 10 feet may not be adequate for extra high voltage (EHV) transmission lines contact events. The 35 feet distance was derived from Electrical Safety Foundation International (ESFI). Also ESFI uses the term "limited approach boundary" in their safety literature for overhead line safety practices
https://www.esfi.org/workplace-safety-overhead-power-line-contact/
https://www.esfi.org/workplace-safety-limits-of-approach-always-look-up/
https://www.esfi.org/downed-power-line-safety-always-assume-downed-lines-are-live/
The attached word document contains the details of the entire annex N to be revised. New text is shown in red and strikeouts are used to indicate deletions of the original text.

Related Item

- PI

Submitter Information Verification

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Submittal Date:	Mon Mar 21 13:53:15 EDT 2022
Committee:	EEW-AAA

N.1 Introduction.

This informative annex is an example of an industrial procedure for working near overhead and underground electrical systems. Areas covered include operations that could expose employees or equipment to contact with or unsafe approach to overhead electrical systems or when performing excavating activities. When working near electrical lines or equipment, avoid ~~direct or indirect contact~~ entering into the limited approach boundary of exposed movable conductors. Direct contact is ~~contact with any part of the body~~ when any part of the body crosses into the restricted approach boundary while unprotected. Indirect contact is when any part of the body ~~touches~~ crosses into the limited approach boundary of exposed ~~or is in dangerous proximity to any object in contact with~~ energized electrical overhead lines ~~equipment~~.

The following ~~two~~ assumptions should always be made regarding overhead lines:

(1) Lines are "live" (energized).
(2) Lines are bare or uninsulated
(3) Lines are considered exposed movable conductors (as defined by 70E)
(4) Most lines are energized at high voltages (greater than 600 volts)

~~(2) Lines are operating at high voltage (over 1000 volts).~~

As the voltage increases, the minimum working ~~clearances increase~~ distances must be also increased to prevent arc-over which can cause ~~Through arc-over,~~ injuries or fatalities ~~could occur~~, even if ~~actual~~ direct contact with high-voltage lines or equipment is not made. High voltage overhead lines normally use air space distances as the insulator. Arc-over occurs when a conductive object is moved closer to the line than the dielectric strength of the air can withstand. Potential for arc-over increases as the voltage increases.

N.2 Overhead Power Line Policy (OPP).

This informative annex applies to all overhead conductors, regardless of voltage, ~~and~~ that requires all of the following:

(1) ~~That e~~ Employees ~~not~~ ~~place themselves~~ ~~in close proximity to overhead power lines. "Close proximity" is within a distance of 3 m (10 ft) for systems up to 50 kV, and should be increased 100 mm (4 in.) for every 10 kV above50 kV~~ shall maintain the limited approach boundary, at a minimum, from overhead lines.

(2) ~~That e~~ Employees be informed of the hazards and precautions when working near overhead lines.

(3) ~~That w~~ Warning ~~decals~~ signs be posted on cranes and similar equipment regarding the ~~minimum clearance of 3 m (10 ft)~~ dangers of overhead lines.

(4) ~~That a~~ A "spotter", trained and qualified for the duty, shall be ~~designated~~ present when ~~equipment is working near~~ working in elevated positions or crane operations near overhead lines. This ~~person's~~ spotter's responsibility is to ~~observe safe working clearances around all~~ ensure all workers and aerial equipment do not enter the limited approach boundary of overhead lines. ~~and to direct the operator accordingly.~~

(5) ~~That~~ w Warning cones or other methods shall be used as visible indicators of the ~~3 m (10 ft) safety zone~~ applicable limited approach boundary when working near overhead power lines.

Informational Note: "Working near," for the purpose of this informative annex, is defined as working within ~~a distance from any overhead power line that is less than the combined height or length of the lifting device plus the associated load length and the required minimum clearance distance [as stated inN.2(1)]. Required clearance is expressed as follows: Required clearance = lift equipment height or length + load length + at least 3 m (10 ft)~~ the limited approach boundary of exposed movable conductors.

(6) ~~That~~ t The local electric utility company or responsible person be notified at least 24 hours before any work begins to allow adequate time to identify specific voltages and ~~clearances~~ any safety practices required by the utility or to place the line in an electrically safe work condition.

N.3 Policy. All employees and contractors shall ~~conform to~~ comply with the OPP. The first line of defense in preventing electrical contact accidents is to remain outside the limited approach boundary. Because most company and contractor employees are not qualified to determine the system voltage level, a qualified person shall be ~~called to establish~~ the individual to identify specific voltages of the overhead line(s), ~~and minimum clearances~~ establish the required limited approach boundary and take appropriate actions to make the work zone safe.

N.4 Procedures.

N.4.1 General. Prior to the start of ~~all operations where potential contact with overhead electrical systems is possible, the person in charge shall identify overhead lines or equipment, reference their location with respect to prominent physical features, or physically mark the area directly in front of the overhead lines with safety cones, survey tape, or other means. Electrical line location shall be discussed at a pre-work safety meeting of all employees on the job (through a job briefing). All company employees and contractors shall attend this meeting and require their employees to conform to electrical safety standards. New or transferred employees shall be informed of electrical hazards and proper procedures during orientations.~~ any work near overhead power lines, the person in charge shall conduct a pre-job briefing of all affected workers and parties in attendance, including representatives of the local electric utility company if applicable. Topics to be covered during the pre-job briefing should include but not limited to the following:

(1) The voltages involved

(2) The limited approach boundary of exposed movable conductors

(3) The specific method to be used to protect workers, i.e. the installation of temporary covering, the use of warning signs, the use of a spotter, if the line(s) will be placed in an electrically safe work condition, etc.

(4) The means of identifying the hazardous locations, such as safety cones, barrier tape, warning signs, etc.

(5) The means of communications between the spotter and the operator of the crane or similar aerial equipment.

(6) The "Stop Work" criteria.

(7) The specific equipment and practices used for grounding and bonding the frames of cranes and similar aerial equipment.

(8) If temporary protective grounding is used, the requirement for all unqualified workers to not touch grounding cables or grounded vehicles while booms are in the elevated position.

(9) The agreed to established corridor(s) where cranes or similar aerial equipment are permitted to traverse underneath the overhead lines.

(10) The phone number, method and person(s) designated to contact emergency services in the event of an accident or injury.

~~On construction projects, the contractor shall identify and reference all potential electrical hazards and document such actions with the on-site employers. The location of overhead electrical lines and equipment shall be conspicuously marked by the person in charge. New employees shall be informed of electrical hazards and of proper precautions and procedures.~~

~~Where there is potential for contact with overhead electrical systems, local area management shall be called to decide whether to place the line in an electrically safe work condition or to otherwise protect the line against unintentional contact. Where there is a suspicion of lines with low clearance [height under 6 m (20 ft)], the local on-site electrical supervisor shall be notified to verify and take appropriate action.~~

All electrical ~~contact~~ incidents, including "near misses," and "close calls" shall be reported to the local area health and safety specialist by the person in charge.

N.4.2 ~~Look Up and Live~~ Warning Reminder Flags. ~~In order to prevent~~ To reduce the risks of encroachment into the limited approach boundary and unintentional contact with all aerial lifts, cranes, boom trucks, dump trucks, service rigs, and similar equipment, ~~shall~~ the use of "Look Up and Live", "Always Look Up" or similar flags should be considered. The flags are visual indicators that the equipment is currently being used or has been returned to its "stowed or cradled" position. The flags ~~shall~~ should be yellow with black lettering and ~~shall state in~~ with bold lettering reading "LOOK UP AND LIVE", "ALWAYS LOOK UP" or similar text.

The procedure for the use of the flag follows:

(1) When the boom or lift is in its stowed or cradled position, the flag shall be located on the load hook or boom end.

(2) Prior to operation of the boom or lift, the operator of the equipment shall assess the work area to determine the location of all overhead lines and communicate this information to all crews on site. Once completed, the operator shall remove the flag from the load hook or boom and transfer the flag to the steering wheel of the vehicle. Once the flag is placed on the steering wheel, the operator can begin to operate the equipment.

(3) After successfully completing the work activity and returning the equipment to its stowed or cradled position, the operator shall return the flag to the load hook

(4) The operator of the equipment is responsible for the placement of the look up and live flag.

N.4.3 High Risk Tasks.

N.4.3.1 ~~Heavy~~ Mobile Equipment. Prior to the start of each workday, ~~a high-visibility marker (orange safety cones or other devices) shall be temporarily placed on the ground to mark the location of overhead wires~~ a new job-site review shall be performed to cover the details of the pre-job briefing. The ~~supervisors~~ person in charge shall discuss electrical safety with ~~appropriate~~ all crew members ~~at on-site tailgate safety talks~~ during the job-site review. Traffic cones or other warning devices should be placed on the ground to identify approve travel paths next to or underneath overhead lines. When working in the proximity of overhead lines, a spotter shall be positioned in a conspicuous location to direct movement and observe for infringement into or contact with the overhead ~~wires~~ lines. The spotter, equipment operator, and all other ~~employees working on~~ affected workers at the job location shall be alert for overhead wires and remain at least 3 m (10 ft) from the mobile equipment.

All mobile equipment ~~shall~~ should display a warning ~~decal~~ signs regarding electrical contact hazards from overhead lines. Independent truck drivers delivering materials to field locations shall be ~~cautioned~~ also be briefed about overhead ~~electrical~~ lines before beginning work by the person in charge and a properly trained on-site ~~or contractor employee~~ worker shall assist in the loading or off-loading operation. Dump ~~T~~ trucks that have emptied their material shall not leave the work location until the boom, lift, or box is down and is safely secured.

N.4.3.2 Aerial Lifts, Cranes, and Boom Devices. Where there is ~~potential for near operation~~ a possibility of infringement of the limited approach boundary or contact with overhead lines or equipment, work shall not begin until a ~~safety meeting~~ new job-site review is conducted and appropriate steps are taken to identify, mark, and warn against unintentional contact. The ~~supervisor~~ person in charge will review operations daily to ensure compliance.

Where the equipment operator's visibility is impaired, a spotter shall guide the operator. Hand signals shall be used and clearly understood between the operator and spotter. When visual contact is impaired between the spotter and operator ~~shall be in radio contact~~ radio communications shall be used. Aerial lifts, cranes, and boom devices shall have appropriate warning ~~decals~~ signs and shall use warning cones or similar devices to ~~indicate the location of overhead lines and~~ identify the 3 m (10 ft) minimum safe working boundary around the equipment.

N.4.3.3 Tree Work. ~~Wires shall be treated as live and operating at high voltage until verified as otherwise by the local area onsite employer. The local maintenance organization or an approved electrical contractor shall remove branches touching wires before work begins. Limbs and branches shall not bedropped onto overhead wires. If limbs or branches fall across electrical wires, all work shall stop immediately and the local area maintenance organization is to be called. When climbing or working in trees, pruners shall try to position themselves so that the trunk or limbs are between their bodies and electrical wires. If possible, pruners shall not work with their backs toward electrical wires. An insulated bucket truck is the prefer-red method of pruning when climbing poses a greater threat of electrical contact. Personal protective equipment (PPE) shall be used while working on or near lines~~ Only workers who have been trained and are qualified to perform tree trimming activities within the limited approach boundary of exposed moveable conductors are permitted to perform this activity.

N.4.4 Underground Electrical Lines and Equipment. Before excavation starts ~~and where there exists reasonable possibility of contacting~~ and to prevent accidental contact with underground electrical or utility lines or equipment, the ~~local area supervision (or USA DIG organization, when appropriate) shall be called and a request is to be made for identifying/marking the line location(s)~~ person in charge shall call "811" or access the 811 website for the specific state's contact requirements to request all underground utilities be identified and marked prior to digging operations. ~~When USA DIG is called, their representatives will need the following:~~

~~(1) Minimum of two working days' notice prior to start of work, name of county, name of city, name and number of street or highway marker, and nearest intersection~~

~~(2) Type of work~~

~~(3) Date and time work is to begin~~

~~(4) Caller's name, contractor/department name and address~~

~~(5) Telephone number for contact~~

~~(6) Special instructions~~

~~Utilities~~ Locating, identifying and marking underground lines and equipment that are not owned by the electric utility company, shall be the responsibility of the owner of the underground lines and equipment. ~~that do not belong to USA DIG must be contacted separately. USA DIG might not have a complete list of utility owners. Utilities that are discovered shall be marked before work begins. Supervisors shall periodically refer their location to all workers, including new employees, subject to exposure.~~

N.4.5 Vehicles with Loads in Excess of 4.25 m (14 ft) in Height. This policy requires that all vehicles with ~~loads~~ an overall height in excess of 4.25 m (14 ft) ~~in height~~, including all associated loads, shall use specific procedures to maintain safe working ~~clearances~~ distances when in ~~transit~~ traversing below overhead lines.

The specific procedures for moving loads in excess of 4.25 (14 ft) in height or via routes with lower clearance heights are as follows:

(1) Prior to movement of any ~~load~~ vehicles in excess of 4.25 m (14 ft) in height, ~~the local health and safety department, along with the local person in charge, shall be notified of the equipment move~~ the person in charge shall be notified prior to the move.

(2) The person in charge shall in turn notify, the respective health and safety department and the owner of the overhead lines of the move.

(3) A representative of the local electric utility company, or other qualified person should check the intended route to verify the adequacy of the travel path distances from the overhead lines. ~~on-site electrician, electrical construction representative, or qualified electrical contractor should check the intended route to the next location before relocation~~.

(4) The new site is to be checked for overhead lines and clearances.

(5) Power lines and communication lines shall be noted, and extreme care used when traveling beneath the lines. The use of spotters should be considered.

(6) The company moving the load or operating the equipment ~~will~~ shall provide a qualified driver who is responsible for accurately measuring ~~each load and ensuring each load is secured and~~ the overall height of the vehicle and load, to ensure the load is properly secured and transported in a safe manner.

(6) ~~An on-site electrician, electrical construction representative, or qualified electrical contractor~~ The person in charge or other qualified person designated by the person in charge shall escort the first load to the new location, ~~ensuring~~ to ensure safe ~~clearances~~ distances are maintained. ~~and a service~~ The company moving the load or vehicle ~~representative~~ shall be responsible for subsequent loads to follow the same ~~safe~~ established route.

If ~~proper~~ safe working ~~clearances~~ distances cannot be maintained, ~~the job must be shut down until a safe route can be established or the necessary repairs or relocations have been completed to ensure that a safe working clearance has been achieved~~ all work shall STOP until an alternate safe route can be identified and agreed to by all parties involved.

~~All work requiring movement of loads in excess of 4.25 m(14 ft) in height are required to begin only after a general work permit has been completed detailing all pertinent information about the move.~~

N.4.6 Emergency Response. If an overhead line falls or is contacted, the following precautions ~~should~~ shall be taken:

(1) Keep everyone at least ~~3~~ 11 m (~~10~~ 35 ft) away.

(2) Call "911" or the site-specific emergency number

(3) Use ~~flagging to protect motorists, spectators, and other individuals from fallen or low wires~~ use attendants or other methods to keep everyone at least 11 m (35 ft) away from the vehicle or the energized lines laying on the ground.

(4) Call the local area electrical department or electric utility immediately.

~~(4) Place barriers around the area.~~

(5) Do not attempt to move the wire(s).

(6) Do not touch anything that is touching the wire(s).

(7) Be alert to water or other conductors present.

~~(8) Crews shall have emergency numbers readily available. These numbers shall include local area electrical department, utility, police/fire, and medical assistance~~

(8) If an individual becomes energized, DO NOT TOUCH the individual or anything in contact with the person. ~~Call for emergency medical assistance and call the local utility immediately.~~ Only workers who have specific contact release training are permitted to execute safe release of the victim.

(9) If the individual is no longer in contact with the energized conductors, CPR, ~~rescue breathing, or~~ first aid ~~should~~ and/or an AED must be administered immediately, but only by a trained person. ~~It is safe to touch the victim once contact is broken or the source is known to be de-energized.~~

(10) ~~Wires that contact vehicles or equipment will cause arcing, smoke, and possibly fire. Occupants should remain in the cab and wait for the local area electrical department or utility.~~ If the vehicle becomes energized, all occupants should remain inside the vehicle and wait for

emergency services to arrive. Exiting the vehicle must only be attempted if other hazards immediately dangerous to life and safety are imminent such as a fire. If it becomes necessary to exit the vehicle, leap with both feet as far away from the vehicle as possible, without touching the equipment and either shuffle your feet or “bunny hop” away from the vehicle. However, jumping free of the vehicle is the last resort.

(11) ~~If operating the equipment and an overhead wire is contacted, stop the equipment immediately and, if safe to do so, jump free and clear of the equipment. Maintain your balance, keep your feet together and either shuffle or bunny hop away from the vehicle another 3 (10 ft) or more.~~ Do not return to the vehicle or allow anyone else for any reason to return to the vehicle until the local utility has removed the power line from the vehicle and has confirmed that the vehicle is no longer in contact with the overhead lines.

Public Comment No. 53-NFPA 70E-2022 [Section No. O.2.3]

O.2.3 Incident Energy Reduction Methods.

The following methods have proved to be effective in reducing incident energy:

(1) Zone-selective interlocking. This is a method that allows two or more circuit breakers to communicate with each other so that a short circuit or ground fault will be cleared by the breaker closest to the fault with no intentional delay. Clearing the fault in the shortest time aids in reducing the incident energy.

(2) Differential relaying. The concept of this protection method is that current flowing into protected equipment must equal the current out of the equipment. If these two currents are not equal, a fault must exist within the equipment, and the relaying can be set to operate for a fast interruption. Differential relaying uses current transformers located on the line and load sides of the protected equipment and fast acting relay.

(3) Energy-reducing maintenance switching with a local status indicator. An energy-reducing maintenance switch allows a worker to set a circuit breaker trip unit to operate faster while the worker is working within an arc flash boundary, as defined in *NFPA 70E*, and then to set the circuit breaker back to a normal setting after the work is complete.

(4) Energy-reducing active arc flash mitigation system. This system can reduce the arcing duration by creating a low impedance current path, located within a controlled compartment, to cause the arcing fault to transfer to the new current path, while the upstream breaker clears the circuit. The system works without compromising existing selective coordination in the electrical distribution system.

(5) Energy-reducing line side isolation. This is equipment that encloses the line side conductors and circuit parts and has been listed to provide both shock and arc flash protection from events on the line side of a circuit breaker or switch.

(6) Arc flash relay. An arc flash relay typically uses light sensors to detect the light produced by an arc flash event. Once a certain level of light is detected, the relay will issue a trip signal to an upstream overcurrent device.

(7) High-resistance grounding ~~. A great majority of electrical faults are of the phase-to-ground type. High-resistance grounding~~ will ~~insert an impedance in the ground return path and will typically limit the fault current to 10 amperes and below (at 5 kV nominal or below), leaving insufficient fault energy and thereby helping reduce the arc flash hazard level. High-resistance grounding will~~ not affect arc flash energy for line-to-line or line-to-line-to-line ~~arcs.~~ <u>or line to ground arcs. The IEEE/ **NFPA** collaboration test result did not show any significant impact of the system grounding or bonding on the incident energy releases by the arc.</u>

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

(9) Shunt-trip. Adding a shunt-trip that is signaled to open from an open-fuse relay to switches 800 amperes and greater reduces incident energy by opening the switch immediately when the first fuse opens. The reduced clearing time reduces incident energy. This is especially helpful for arcing currents that are not within the current-limiting threshold of the three current-limiting fuses.

Statement of Problem and Substantiation for Public Comment

I would like draw your attention towards the inconsistency between NFPA 70E and IEEE 1584.

In NFPA 70E 2021 informative Annex O.2.3 (7), it is mentioned that “high resistance grounding will insert an impedance in the ground return path and will typically limit the fault current to 10amperes and below (at 5kV nominal and below), leaving insufficient fault energy and thereby helping reduce the arc flash hazard level” this statement is not matching with the IEEE std 1584-2018 (IEEE Guide for Performing Arc Flash Hazard Calculations) informative Annex G.7.11, System Grounding, which state that “The IEEE/NFPA collaboration test result did not show any significant impact of the system grounding or bonding on the incident energy releases by the arc”.

The IEEE standard 1584-2002 used to use K2 (variable) in the Arc current equation, which now removed and in 2018 version this equation is independent of the system grounding. Therefore I request your interpretations of Annex O.2.3 (7) and my opinion this section need to be revised in per the new information gather during the test conducted by IEEE/NFPA collaboration.

Related Item

- PI

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Public Comment No. 56-NFPA 70E-2022 [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 troubleshooting and voltage presence measurement through door.

Statement of Problem and Substantiation for Public Comment

Test portals are a valuable tool for troubleshooting and measuring voltage presence. However, test portals may provide incorrect readings when used to test for the absence of voltage.

- Verifying absence of voltage through a permanently mounted device requires assurance that you are in contact with the test point when the measurement is taken. If the device is not properly terminated, and the device leads are disconnected, no voltage will be detected, regardless of whether or not the conductor is energized. This is why permanently mounted voltage testers are required to have an installation test to confirm that the product is in contact with the conductor at the time the voltage measurement is taken. Test portals do not have a feature to verify sensor leads are connected to the source conductor when a measurement with a portable test instrument is taken. This condition could result in reading zero voltage at the portal when voltage is present at the source.
- Overcurrent protection is often required for test portals with leads longer than 12 inches in order for the installation to meet NEC or UL 508A requirements. For fused installations, the portals will only be testing the

load side of the fuse, NOT the actual source conductor. The circuit part i.e. source conductor could be energized if the fuse is open and a portable test instrument would not detect voltage through the test portal. This condition could result in reading zero voltage at the portal when voltage is present at the source.

A distinction should be made between use of test portals for voltage presence testing and absence of voltage testing.

Related Item

• PI 376 • FR 145

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Public Comment No. 118-NFPA 70E-2022 [Annex O [Title Only]]

Employee Safety-Related Design Concepts~~ and Facility Responsibilities~~

Statement of Problem and Substantiation for Public Comment

Remove "and Facility Responsibilities" from the title since this Annex does not provide facility responsibilities. Facility responsibilities also imply a set of requirements in an Informative Annex. The title is simplified to "Employee Safety-Related Design Concepts".

Related Item

- FR-85

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Public Comment No. 29-NFPA 70E-2022 [Section No. R.3.1]

R.3.1 General.

The capacitor shock hazard to a person is an impulse shock with an exponential decay curve. The severity of the shock is related to the amount of energy (joules) delivered and the time in which the energy is delivered. Injuries from capacitor shock include severe reflex action, internal and external burns, and heart fibrillation. Reflex injury can occur at energy levels as low as 0.25 joules when the capacitor voltage is over the skin breakdown threshold (about 400 volts), resulting in a very rapid delivery of the energy. Reflex action can result in injuries from falling, involuntarily coming in contact with other hazards, tearing muscles, tendons, and ligaments, or dislocation of joints. Internal burn injuries to nervous system and other tissues can occur at energies as low as ~~10s~~ tens of joules. Heart fibrillation can happen when the voltage exceeds 100 volts and the stored energy delivered exceeds 10 joules under certain circumstances. However, even without fibrillation, a high-voltage, high-energy shock can cause serious injuries, either directly or through reflex action, down to as low as 0.25 joules. Instances of temporary paralysis, loss of consciousness, hearing damage, temporary loss of eyesight, burns, and dislocated joints have been reported. [See Figure R.3.1(a) for a capacitive shock circuit and Figure R.3.1(b) for a capacitive discharge curve.]

Figure R.3.1(a) Capacitor Shock Circuit.

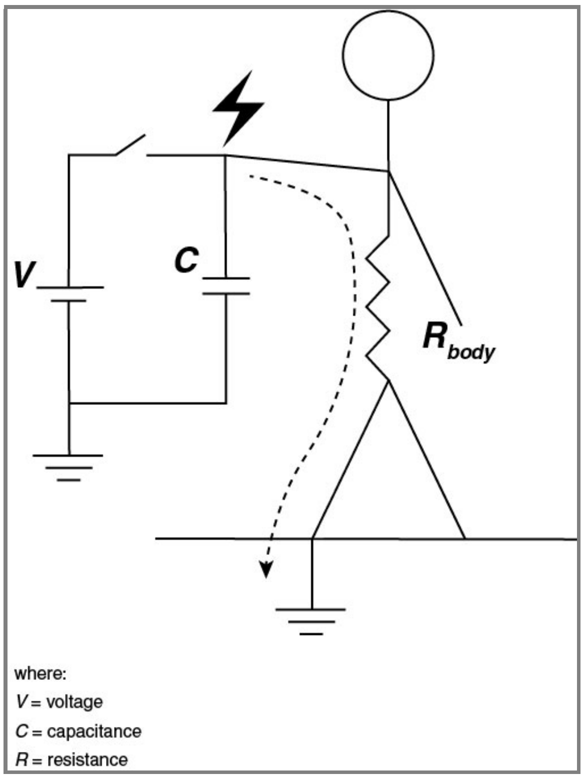
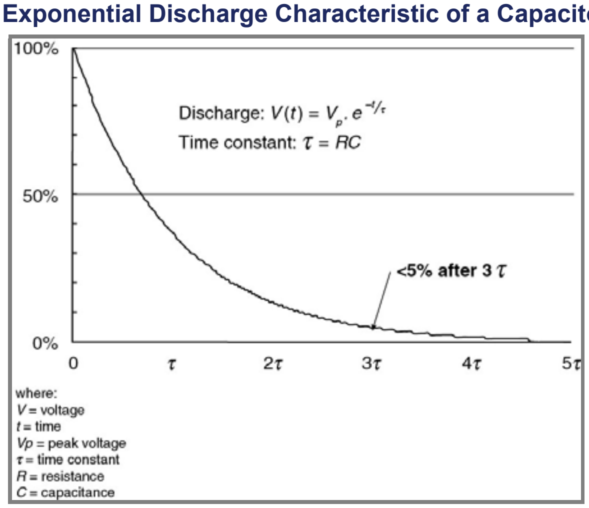


Figure R.3.1(b) Typical Exponential Discharge Characteristic of a Capacitor Through a Resistor.



Statement of Problem and Substantiation for Public Comment

Replace "10s" with "tens" to avoid confusion. The mix of numerals with letters "10s" could mistakenly be read as "ten seconds" instead of the intended meaning "tens".

Related Item

- SR-47-NFPA 70E-2019

Submitter Information Verification

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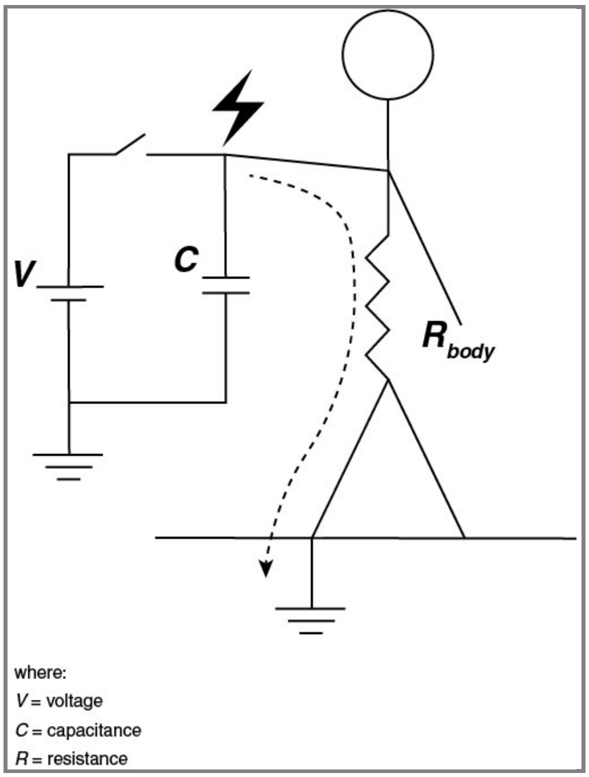
Committee:	EEW-AAA

Public Comment No. 72-NFPA 70E-2022 [Section No. R.3.1]

R.3.1 General.

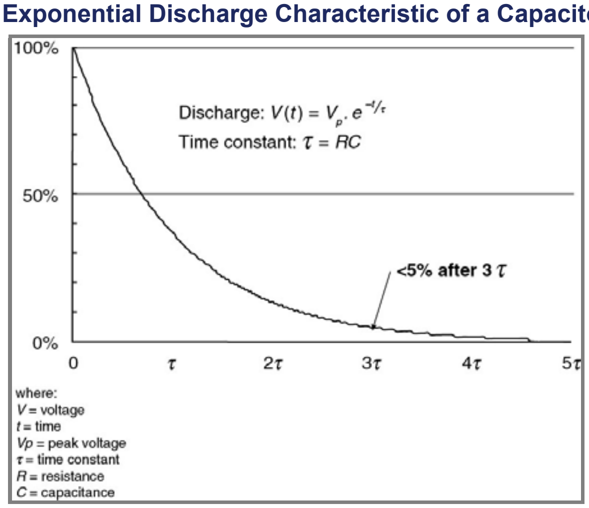
The capacitor shock hazard to a person is an impulse shock with an exponential decay curve. The severity of the shock is related to the amount of energy (joules) delivered and the time in which the energy is delivered. Injuries from capacitor shock include severe reflex action, internal and external burns, and heart fibrillation. Reflex injury can occur at energy levels as low as 0.25 joules when the capacitor voltage is over the skin breakdown threshold (about 400 volts), resulting in a very rapid delivery of the energy. Reflex action can result in injuries from falling, involuntarily coming in contact with other hazards, tearing muscles, tendons, and ligaments, or dislocation of joints. Internal burn injuries to nervous system and other tissues can occur at energies as low as 10s of joules. Heart fibrillation can happen when the voltage exceeds 100 volts and the stored energy delivered exceeds 10 joules under certain circumstances. However, even without fibrillation, a high-voltage, high-energy shock can cause serious injuries, either directly or through reflex action, down to as low as 0.25 joules. Instances of temporary paralysis, loss of consciousness, hearing damage, temporary loss of eyesight, burns, and dislocated joints have been reported. [See Figure R.3.1(a) for a capacitive shock circuit and Figure R.3.1(b) for a capacitive discharge curve.]

Figure R.3.1(a) Capacitor Shock Circuit.



See graphic in attachment

Figure R.3.1(b) Typical Exponential Discharge Characteristic of a Capacitor Through a Resistor.



Additional Proposed Changes

File Name	Description	Approved
capacitor_shock.pptx	slides on paths for capacitor shocks	

Statement of Problem and Substantiation for Public Comment

The graphic could be considered incorrect, or at least misleading. The current graphic shows the current going into the soil. It should show a complete circuit. The symbol used in the graphic is typically for Earth ground, although it has been used for multiple purposes. Even IEEE-142 has used this symbol when they mean to use a 'common connection' symbol.
The committee statement on my PI 229 is that i did not submit a graphic. This time, I submitted a power point presentation with different graphics. The one that is probably most appropriate is slide number 3

Related Item

• 229-NFPA 70E-2021

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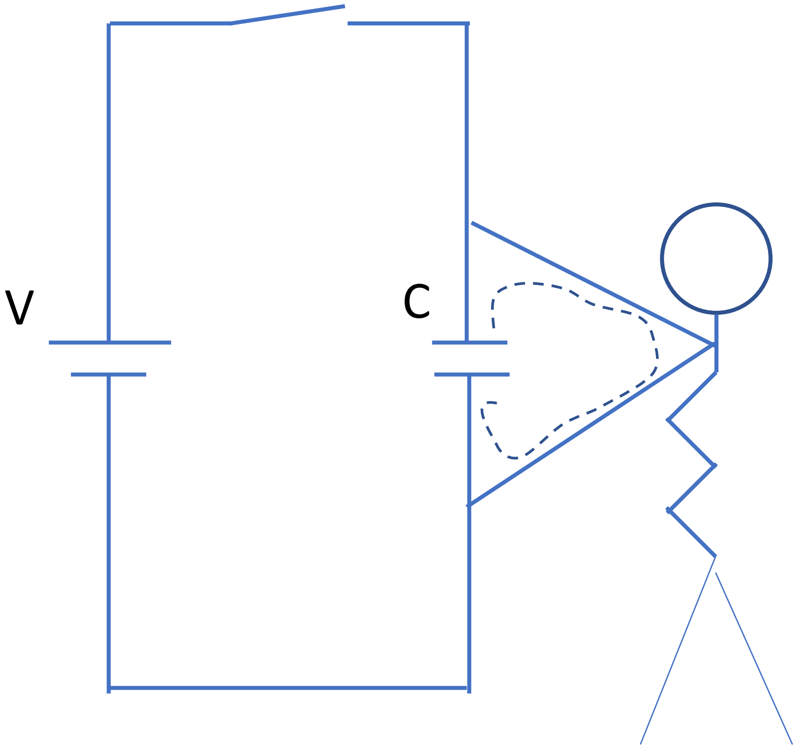
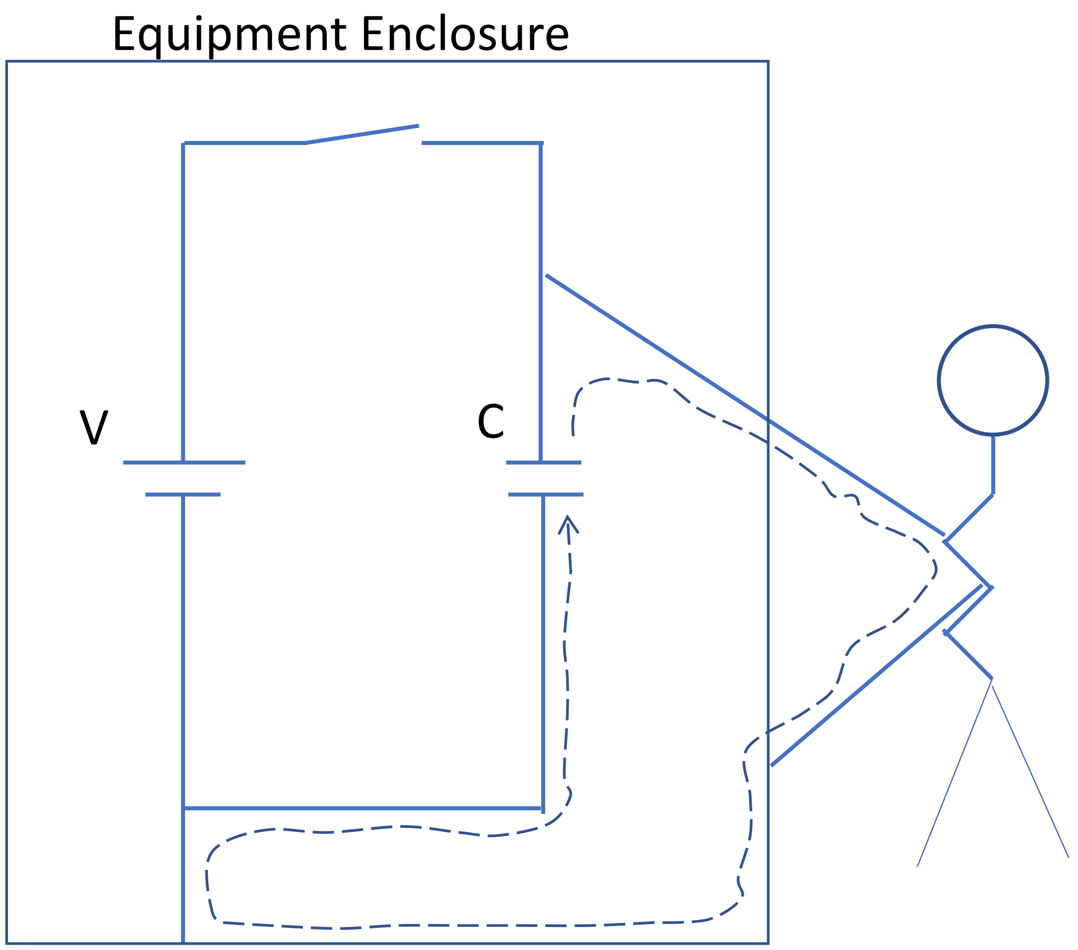
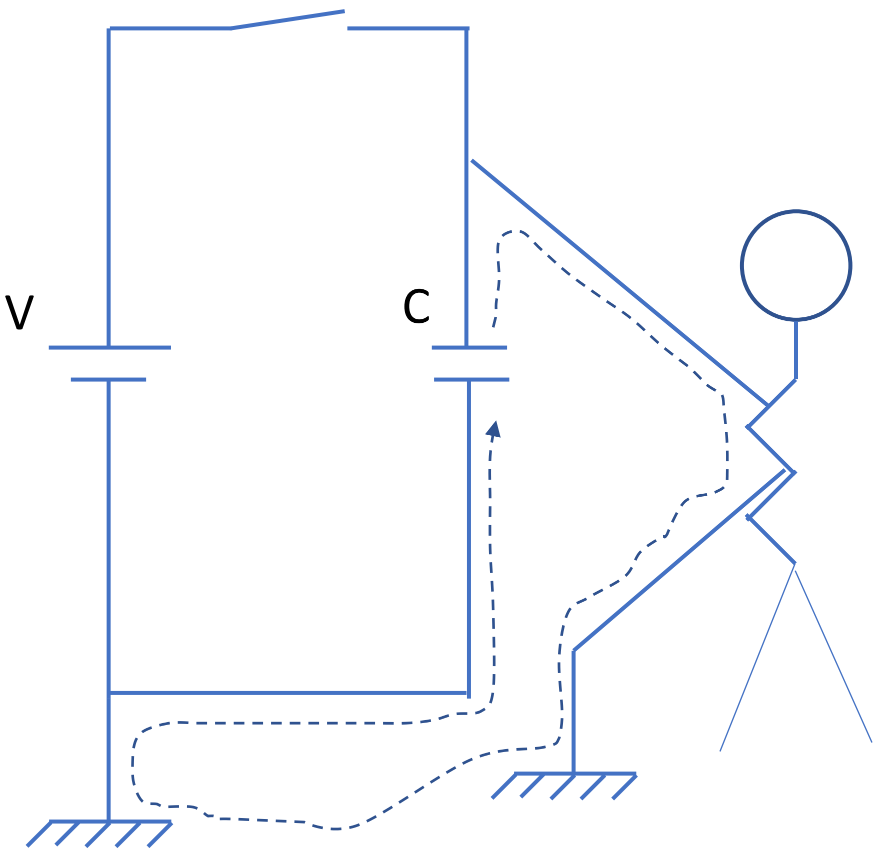
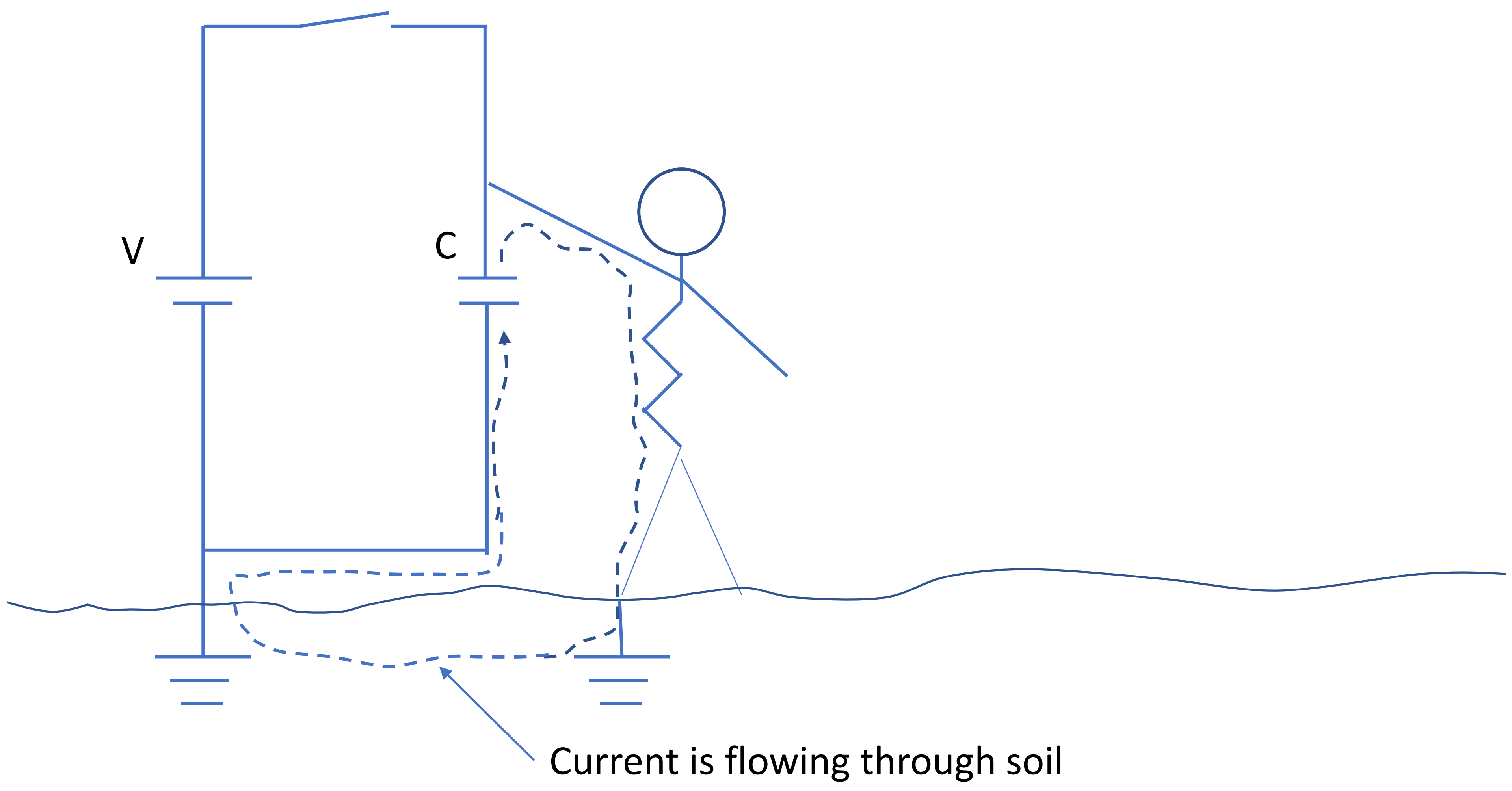
Committee: EEW-AAA

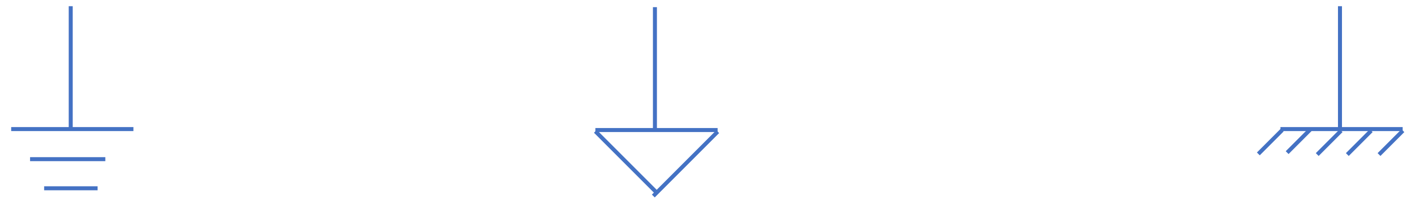
Paths for capacitor discharge current


V
C


Equipment Enclosure
V
C


V
C


V
C
Current is flowing through soil



Earth Ground　　Signal Ground　　Chassis Ground

IEC 60417

Public Comment No. 31-NFPA 70E-2022 [Section No. R.8.3]

R.8.3 Capacitor Calculations.

Total capacitance of capacitor banks is calculated as follows:

(1) For capacitors in parallel, add the capacitance as follows:

$$C_{total} = C_1 + C_2 + C_3 + \ldots \quad \text{[R.8.3a]}$$

(2) For capacitors in series, use the following:

$$\frac{1}{C_{total}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \ldots \quad \text{[R.8.3b]}$$

(3) Capacitor banks used for power factor correction are often labeled with a kVAr value (kilovolt-amperes reactive) to facilitate power engineering calculations. Calculate the capacitance as follows:

$$C = \frac{Q}{2\pi f V^2} \quad \text{[R.8.3c]}$$

where:

C = total capacitance in farads

Q = reactive power in VAr (volt-amperes reactive)

f = frequency in hertz

V = phase-to-phase voltage in volts rms

(4) Long high-voltage coaxial cables can have significant capacitance, normally on the order of 45 pF/~~m–10 pF~~ m–115 pF /m (1 picofarad = 1 × 10^{-12} F) for low-current applications, or 150 pF/m–450 pF/m for utility-grade, medium-voltage insulated cable. Manufacturer's specifications on capacitance per meter should be consulted.

Statement of Problem and Substantiation for Public Comment

change value from 10 pF/m to 115 pF/m to correct error. When this material was first added, US customary units were used and the value was stated as 35 pF/ft which should have been converted to metric equivalent 115 pF/m.

Related Item

• SR-47-NFPA 70E-2019 • FR-89-NFPA 70E-2018

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Committee: EEW-AAA

Public Comment No. 32-NFPA 70E-2022 [Section No. R.9.1]

R.9.1 Incident Energy.

The maximum theoretical possible arc flash incident energy can be calculated by assuming that all of the stored energy is dissipated as radiant energy in a spherical expansion in open air. While this is unlikely, it helps set a lower bound of stored energy below which an arc flash hazard is unlikely.

$$IE_{open\ air} = \frac{Energy}{Area} = \frac{\frac{1}{2}CV^2}{4\pi r^2} = \frac{CV^2}{8\pi r^2} J / cm^2 \qquad \textbf{[R.9.1a]}$$

Converting to cal/cm2 (1 cal = 4.184 joules) we obtain the following:

$$IE_{open\ air} = \frac{CV^2}{105.1r^2} = \frac{E}{52.6r^2} cal / cm^2 \qquad \textbf{[R.9.1b]}$$

where:

IE = incident energy

E = energy, joules

C = capacitance, farads

V = voltage, volts

r = radius, cm

Statement of Problem and Substantiation for Public Comment

For clarity, revise variable definitions to include required units of measure. The equations will give incorrect results unless correct units of measure are used.

Related Item

- SR-47-NFPA 70E-2019

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Public Comment No. 33-NFPA 70E-2022 [Section No. R.12.3]

R.12.3 Voltages Greater Than 1000 Volts.

For voltages greater than 1000 volts, the discharge time will need to be longer than 3τ and should be calculated. Use the following formula to determine the minimum wait time:

$$\tau = RC \qquad \text{[R.12.3a]}$$

$$T_d = -1\text{n}\left(\frac{100}{V_p}\right)\tau \qquad \text{[R.12.3b]}$$

where:

τ = time constant, seconds

R = discharge path resistance, ohms

C = total capacitance, farads

T_d = discharge time (wait time), seconds

V_p = peak voltage, volts

Statement of Problem and Substantiation for Public Comment

For clarity, revise variable definitions to include required units of measure. The equations will give incorrect results unless correct units of measure are used.

Related Item

- SR-47-NFPA 70E-2019

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Public Comment No. 73-NFPA 70E-2022 [Section No. S.3]

S.3 Visual Inspection.

Visual inspection of equipment might be used to verify that it is installed in a ~~workmanlike~~ professional and skillful 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.

Statement of Problem and Substantiation for Public Comment

Change "workmanlike" to "professional and skillful manner" to align with changes made to 110.12 of the 2023 edition of NFPA 70 in order to make this term more gender neutral.

Related Item

- FR-147

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