



NATIONAL FIRE PROTECTION ASSOCIATION

The leading information and knowledge resource on fire, electrical and related hazards

**Technical Committee on Electrical Safety in the Workplace
First Draft Meeting Agenda for NFPA 70E
Microsoft Teams Meeting
August 2 – 6, 2021
10:00AM – 4:00PM (ET)**

08-21-01	Call to Order & Welcome
08-21-02	Introduction of Committee Members (Attachment A)
08-21-03	Approval of Previous Meeting Minutes (Attachment B)
08-21-04	Chair Remarks
08-21-05	Staff Presentation
08-21-06	Task Group Reports and Review of Public Inputs (Attachment C)
08-21-07	Old Business
08-21-08	New Business
08-21-09	Schedule Next Meeting
08-21-10	Adjournment

Attachment A: Technical Committee Roster

Address List No Phone

07/21/2021
Christopher Coache
EEW-AAA

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Louis A. Barrios Chair Shell Global Solutions 3333 Highway 6 South Houston, TX 77082-3101 American Petroleum Institute Alternate: Eric Glaude	U 1/18/2001 EEW-AAA	Paul D. Barnhart Principal UL LLC 12 Laboratory Drive Research Triangle Park, NC 27709-3995	RT 08/17/2018 EEW-AAA
Steven C. Chybowski Principal Rockwell Automation Inc. 1201 South 2nd Street Milwaukee, WI 53204	M 10/18/2011 EEW-AAA	Daryld Ray Crow Principal DRC Consulting, Ltd. 143 S. East Ridge Drive St. George, UT 84790 The Aluminum Association, Inc. Alternate: Karl M. Cunningham	M 10/1/1995 EEW-AAA
Thomas B. Dyson Principal Ameren Services 1901 Chouteau Avenue St. Louis, MO 63103-3003 Edison Electric Institute	U 08/11/2014 EEW-AAA	Ernest J. Gallo Principal Telcordia Technologies (Ericsson) One Centennial Drive Piscataway, NJ 08854 Alliance for Telecommunications Industry Solutions	U 08/11/2014 EEW-AAA
Bobby J. Gray Principal Hoydar/Buck, Inc. 207 Lone Piper Drive Chelan, WA 98816 Alternate: Larry D. Perkins	E 4/5/2001 EEW-AAA	William R. Harris Principal General Motors Company 30400 Van Dyke Avenue VEC East – 5th Floor Warren, MI 48092-2025 Alternate: Martin Nagel	U 08/17/2015 EEW-AAA
Palmer L. Hickman Principal Electrical Training Alliance 5001 Howerton Way, Suite N Bowie, MD 20715-4459 International Brotherhood of Electrical Workers Alternate: James T. Dollard, Jr.	L 10/3/2002 EEW-AAA	Mark R. Hilbert Principal MR Hilbert Electrical Inspections & Training 14 Beach Pond Road Wolfeboro, NH 03894 International Association of Electrical Inspectors	E 08/17/2018 EEW-AAA
Kevin J. Lippert Principal Eaton Corporation 1000 Cherrington Parkway Moon Township, PA 15108 National Electrical Manufacturers Association Alternate: Gregory J. Steinman	M 8/5/2009 EEW-AAA	Terrance L. McKinch Principal Mortenson Construction 3278 South Duffield Road Lennon, MI 48449-9407 Alternate: Jeffrey Paul Conkwright	U 08/03/2016 EEW-AAA

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Mark McNellis Principal Sandia National Laboratories PO Box 5800, MS0984 Albuquerque, NM 87185 Alternate: Heath Garrison	U 7/28/2006 EEW-AAA	Charles R. Miller Principal Lighthouse Educational Services Charles R. Miller Electrical Education & Training 523 Five Oaks Boulevard Lebanon, TN 37087 Alternate: Jim Phillips	SE 10/29/2012 EEW-AAA
Daleep C. Mohla Principal DCM Electrical Consulting Services, Inc. 4702 Summer Lakes Missouri City, TX 77459-3958 IEEE-IAS/PES JTCC Alternate: Paul Dobrowsky	U 01/14/2005 EEW-AAA	James K. Niemira Principal S&C Electric Company 8940 Ewing Avenue Evanston, IL 60203-1907	M 12/8/2015 EEW-AAA
Thomas D. Norwood Principal Cadick Corporation 111 Hidden Lane Red Oak, TX 75154	SE 10/4/2001 EEW-AAA	David A. Pace Principal Olin Corporation 1638 Industrial Road McIntosh, AL 36553 American Chemistry Council Alternate: Roy K. Sparks, III	U 7/22/1999 EEW-AAA
James G. Stallcup Principal Grayboy, Inc. 6800 Meadow Creek North Richland Hills, TX 76182 Alternate: James W. Stallcup, Jr.	SE 1/1/1991 EEW-AAA	Samuel B. Stonerock Principal Southern California Edison Company 3 Innovation Way Pomona, CA 91768-2560 ASTM International	SE 10/20/2010 EEW-AAA
John M. Tobias Principal US Department of the Army CECOM, Attn: AMEL-SFS-I 3200 Raritan Avenue Aberdeen Proving Grounds, MD 21005 Alternate: Dawn M. Carney	U 10/18/2011 EEW-AAA	Rodney J. West Principal Schneider Electric 5735 College Corner Road Oxford, OH 45056-1070 Alternate: Bill Alderton	M 7/29/2005 EEW-AAA
Jason Wolf Principal The ESCO Group 3450 3rd Street Marion, IA 52302 National Electrical Contractors Association Alternate: Adam Ashton	IM 12/06/2017 EEW-AAA	Lawrence S. Ayer Voting Alternate Biz Com Electric, Inc. 2867 Stanton Avenue Cincinnati, OH 45206 Independent Electrical Contractors, Inc.	IM 7/14/2004 EEW-AAA

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Alternate Schneider Electric 5735 College Corner Road Oxford, OH 45056 Principal: Rodney J. West	EEW-AAA	Alternate Forest Electric 206 McGaw Drive Edison, NJ 08837 National Electrical Contractors Association Principal: Jason Wolf	EEW-AAA
Dawn M. Carney	U 12/02/2020	Jeffrey Paul Conkwright	U 12/6/2017
Alternate US Army Corps of Engineers 25997 Chamberlain Drive Daphne, AL 36526 Principal: John M. Tobias	EEW-AAA	Alternate Eastern Kentucky University 521 Lancaster Avenue Richmond, KY 40475 Principal: Terrance L. McKinch	EEW-AAA
Karl M. Cunningham	M 04/11/2018	Paul Dobrowsky	U 10/18/2011
Alternate Self Employed 6100 W. Ost-West Street Homosassa, FL 34446 The Aluminum Association, Inc. Principal: Daryld Ray Crow	EEW-AAA	Alternate Innovative Technology Services 5701 South Holley Road Holley, NY 14470-9754 IEEE-IAS/PES JTCC Principal: Daleep C. Mohla	EEW-AAA
James T. Dollard, Jr.	L 4/14/2005	Heath Garrison	U 3/7/2013
Alternate IBEW Local Union 98 1701 Spring Garden Street Philadelphia, PA 19130 International Brotherhood of Electrical Workers Principal: Palmer L. Hickman	EEW-AAA	Alternate National Renewable Energy Laboratory 15013 Denver West Parkway Golden, CO 80401 Principal: Mark McNellis	EEW-AAA
Eric Glaude	U 8/2/2010	Martin Nagel	U 04/03/2019
Alternate Chevron 1400 Smith Street Houston, TX 77002 American Petroleum Institute Principal: Louis A. Barrios	EEW-AAA	Alternate General Motors Company 30216 William Durant Boulevard Mc: 480-109-164 Warren, MI 48092-2029 Principal: William R. Harris	EEW-AAA

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Roy K. Sparks, III	U 12/06/2017	James W. Stallcup, Jr.	SE 01/01/1994
Alternate Eli Lilly and Company Lilly Technology Center South 1400 West Raymond Street Drop Code 4005 Indianapolis, IN 46221-2004 American Chemistry Council Principal: David A. Pace	EEW-AAA	Alternate Grayboy, Inc. 6800 Meadow Creek North Richland Hills, TX 76182 Principal: James G. Stallcup	EEW-AAA
Gregory J. Steinman	M 08/03/2016	Carolyn Black	SE 04/11/2018
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Mike Doherty	SE 04/04/2017	David M. Wallis	O 10/10/1998
Alt. to Nonvoting Member Blue Arc Electrical Safety Technologies, Inc. 823 Donegal Avenue Oshawa, ON L1J 6K5 Canada Canadian Standards Association Principal: Carolyn Black	EEW-AAA	Member Emeritus Consultant 9728 Denrob Court Parkville, MD 21234-1861	EEW-AAA
Christopher Coache	3/13/2015		
Staff Liaison National Fire Protection Association One Batterymarch Park Quincy, MA 02169-7471	EEW-AAA		

Attachment B: Previous Meeting Minutes



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NFPA 70E Electrical Safety in the Workplace Technical Committee Second Draft Meeting Chairman's Report

1. **List dates and location of meeting:**

July 16-17, 2019

Sheraton Indianapolis City Centre Hotel, 31 W Ohio St., Indianapolis, IN 46204

2. **List names of TC members and guest in attendance**

The following were in attendance:

Louis Barrios, *Chair*

Chris Coache, *NFPA Staff Liaison*

Principals in Attendance

Paul Barnhart	William Bowman	Steven Chybowski
Daryld Crow	Thomas Dyson	Ernest Gallo
Bobby Gray	William Harris	Palmer Hickman
Mark Hilbert	Kevin Lippert	Terrance McKinch
Mark McNellis	Charles Miller	Daleep Mohla
James Niemira	Thomas Norwood	Charlie Thurmond III
Rodney West	Jason Wolf	Samuel Stonerock, <i>Voting Alternate</i>

Alternates in Attendance

Bill Alderton	Lawrence Ayer	Paul Dobrowsky
James Dollard, Jr.	Heath Garrison	Eric Glaude
Martin Nagel	Jim Phillips	Roy Sparks
Gregory Steinman	Wesley Wheeler	Ron Widup
Carolyn Black, <i>Alt to Nonvoting Member</i>	David Wallis, <i>Member Emeritus</i>	



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Guests in Attendance

Rachel Bugaris, <i>Panduit Corp.</i>	Barry Rodgers, <i>Schneider Electric</i>	Phillip Allen, <i>Grace Engineered Products</i>
Bhanu Srilla, <i>Grace Engineered Products</i>	Thomas Domitrovich, <i>Eaton</i>	Nehad El-Sherif, <i>MNKUBR Technologies, Inc.</i>
Tim Rohrer, <i>Exiscan</i>	Josh Moody, <i>Westex by Milliken</i>	Lloyd Gordon, <i>Los Alamos National Lab</i>
Ryan Downey, <i>AVO Training Institute</i>	Al Havens, <i>e-Hazard Management</i>	Terry Becker, <i>TW Becker Electrical Safety Consult.</i>
Karl Cunningham, <i>Alcoa AL Assoc.</i>	Chip Boertlein, <i>Toyota</i>	Michael King, <i>Eaton</i>
Adam Ashton, <i>NECA</i>	Derek Vigstol, <i>NFPA</i>	Mike Hittel, <i>ISS Rolls Royce</i>

3. **List names of guests addressing the TC, the subject of their address, and the length of time they spoke:**
Bhanu Srilla, Director of Technical Marketing, Grace Engineered Products addressed the Technical Committee related to Public Comments 51, 106, 107, 109 and 121 on proposed new Exception No. 3 to 120.5(7) on absence of voltage testing outside of enclosures. Mr. Srilla spoke for less than 10min with Q&A for 5min.
4. **Number of Public Comments acted upon:** 115
5. **Number of Second Revisions created:** 46
6. **If applicable, list the appointment of any task groups that will be working on any TC subject subsequent to the panel meeting, along with the names of the members of the task group:**
 - a. A task group will be appointed to determine the impact of IEEE 1584 – 2018 on NFPA 70E Tables 130.7(C)(15)(a) and 130.7(C)(15)(b). TG chair and members will be identified at a later date.
 - b. A task group will be appointed to change 110.6(A)(1)(b) to mandatory language. The TG will be chaired by Eric Glaude. TG members will be identified at a later date.
 - c. A task group will be appointed to align the shock protection boundaries in NFPA 70E, Table 130.4(E)(a) and Table 130.4(E)(b) with OSHA minimum approach distances in OSHA 1910.269 Tables R-3, R-4, R-5, R-6, R-7 and R-8. Also refer to the ANSI C2 National Electrical Safety Code Tables 441-1 (ac) and 441-5 (dc). TG chair and members will be identified at a later date.



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7. **If applicable, list any requests contained in a TC statement that requires Correlating Committee attention:** None
8. **If applicable, list any TC actions that, in your opinion, should be referred to another TC for information or correlation:** None
9. **List any public inputs that should be referred to the Toxicity Advisory Committee:** None
10. **Identify any issues that should be brought to the attention of the NFPA research foundation for their input and assistance:** None
11. **List all public comments related to combustibles in plenums or other air handling spaces:** None
12. **List any general TC requests for information or assistance from the Correlating Committee:** None
13. **List any additional information that you feel would be helpful to the Correlating Committee staff or to the process in general:**
 - a. The NFPA 70E Technical Committee requests NFPA staff to separate Tables 130.7(C)(15)(a), 130.7(C)(15)(b) and 130.7(C)(15)(c) into separate sections in TerraView in order to simplify the processing of committee actions.
 - b. The NFPA Technical Committee requests NFPA staff to expedite issuing pdf copy of public comments to committee members for preparation and task group work. For this second draft cycle, pdf copies of the public comments were not available to committee members for several weeks following public comment close date.
 - c. Having MS Word copies of the Standard available for Task Group work simplifies the development of Task Group actions and reduces the chances of transcription errors, especially for the longer sections and tables.
 - d. The Indianapolis Sheraton was a good location for the SD meeting, centrally located for travel, and a good selection of places to eat with 1-3 blocks of the hotel. Room size and layout worked well for this large technical committee and 15-20 guests.
 - e. NFPA staff provided webex during the committee meeting to committee members only. With such a large committee and room, this was very beneficial for committee members to see clearly actions recorded by NFPA staff during the meeting. This is a successful practice that should be replicated in future meetings.
 - f. NFPA staff member Chris Coache did an excellent job keeping up with committee actions and driving the committee to improve committee statements.
14. **Were any units of measure “accepted” by the panel that are not listed in Annex C of the NEC style manual? If so, please list the section number(s) and proposal number(s) below:** None

Attachment C: Public Input Report



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

Action: Delete sections 90.1 through 90.5 and reinsert revised and rearranged 90.1 through 90.5 to comply with the NEC Style Manual. Also incorporate a new 90.6 Units of Measurement to align with the 2020 NEC Style Manual and Section 90.9 of the NEC.

90.1 Purpose. The purpose of this standard is to provide a practical safe working area for employees relative to the hazards arising from the use of electricity.

90.2 Scope.

(A) 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) 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.

90.3 Standard Arrangement. This standard is divided into the introduction and three chapters, as shown in Figure 90.3. Chapter 1 applies generally, Chapter 2 addresses safety-related maintenance requirements, and Chapter 3 supplements or modifies Chapter 1 with safety requirements for special equipment. Informative annexes are not part of the requirements of this standard but are included for informational purposes only.

90.4 Mandatory Rules, Permissive Rules, and Explanatory Material. (A) **Mandatory Rules.** Mandatory rules of this standard are those that identify actions that are specifically required or prohibited and are characterized by the use of the terms shall or shall not.

(B) **Permissive Rules.** Permissive rules of this standard are those that identify actions that are allowed but not required, are normally used to describe options or alternative methods, and are characterized by the use of the terms shall be permitted or shall not be required.

(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.

Such notes are informational only and are not enforceable as requirements of this standard. Brackets containing section references to another NFPA document are for informational purposes only and are provided as a guide to indicate the source of the extracted text. These bracketed references immediately follow the extracted text.

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

(D) Informative Annexes. Nonmandatory information relative to the use of this standard is provided in informative annexes.

Informative annexes are not part of the requirements of this standard, but are included for information purposes only.

90.5 Formal Interpretations. To promote uniformity of interpretation and application of the provisions of this standard, formal interpretation procedures have been established and are found in the Regulations Governing the Development of NFPA Standards.

90.1 Scope.

This article covers the use and arrangement of this standard. It also covers the expression of mandatory, permissive, and nonmandatory text. It also provides guidance on formal interpretations and specifies the use and expression of measurements. Specifics covered are provided in (A) below and those not covered are provided in (B).

(A) 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:

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(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) 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.

90.2 Purpose. The purpose of this standard is to provide a practical safe working area for employees relative to the hazards arising from the use of electricity.

90.3 Standard Arrangement. This standard is divided into the introduction and three chapters, as shown in Figure 90.3. Chapter 1 applies generally, Chapter 2 addresses safety-related maintenance requirements, and Chapter 3 supplements or modifies Chapter 1 with safety requirements for special equipment. Informative annexes are not part of the requirements of this standard but are included for informational purposes only.

Figure 90.3 Standard Arrangement

90.4 Mandatory Rules, Permissive Rules, and Explanatory Material.

(A) Mandatory Rules. Mandatory rules of this standard are those that identify actions that are specifically required or prohibited and are characterized by the use of the terms shall or shall not.

(B) Permissive Rules. Permissive rules of this standard are those that identify actions that are allowed but not required, are normally used to describe options or alternative methods, and are characterized by the use of the terms shall be permitted or shall not be required.

(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. Such notes are informational only and are not enforceable as requirements of this standard. Brackets containing section references to another NFPA document are for informational purposes only and are provided as a guide to indicate the source of the extracted text. These bracketed references immediately follow the extracted text.

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(D) Informative Annexes. Nonmandatory information relative to the use of this standard is provided in informative annexes. Informative annexes are not part of the requirements of this standard, but are included for information purposes only.

90.5 Formal Interpretations. To promote uniformity of interpretation and application of the provisions of this standard, formal interpretation procedures have been established and are found in the Regulations Governing the Development of NFPA Standards.

90.6 Units of Measurement.

(A) Measurement System of Preference. For the purpose of this Standard, metric units of measurement are in accordance with the modernized metric system known as the International System of Units (SI).

(B) Dual System of Units. SI units shall appear first, and inch-pound units shall immediately follow in parentheses.

Conversion from inch-pound units to SI units shall be based on hard conversion except as provided in 90.6(C).

(C) Permitted Uses of Soft Conversion. The cases given in 90.6(C)(1) through (C)(4) shall not be required to use hard conversion and shall be permitted to use soft conversion.

(1) Trade Sizes. Where the actual measured size of a product is not the same as the nominal size, trade size designators shall be used rather than dimensions. Trade practices shall be followed in all cases.

(2) Extracted Material. Where material is extracted from another standard, the context of the original material shall not be compromised or violated. Any editing of the extracted text shall be confined to making the style consistent with that of NFPA 70E and the NEC Style Manual.

(3) Industry Practice. Where industry practice is to express units in inch-pound units, the inclusion of SI units shall not be required.

(4) Safety. Where a negative impact on safety would result, soft conversion shall be used.

(D) Compliance. Conversion from inch-pound units to SI units shall be permitted to be an approximate conversion. Compliance with the numbers shown in either the SI system or the inch-pound system shall constitute compliance with this Standard.

Informational Note No. 1: Hard conversion is considered a change in dimensions or properties of an item into new sizes that might or might not be interchangeable with the sizes used in the original measurement. Soft conversion is considered a direct mathematical conversion and involves a change in the description of an existing measurement but not in the actual dimension.

Informational Note No. 2: SI conversions are based on IEEE/ASTM SI 10-1997, Standard for the Use of the International System of Units (SI): The Modern Metric System.

Additional Proposed Changes

<u>File Name</u>	<u>Description Approved</u>
Global_Public_Input.docx	Global PI

Statement of Problem and Substantiation for Public Input

The revisions to Article 90 are editorial and intended to bring this article into compliance with the 2020 NEC Style Manual and correlate more with the structure of the NEC. In accordance with Section 2.2.1 of the 2020 NEC Style Manual, the first section of an article is required to be the scope. Existing 90.2 has been relocated to 90.1 with new charging text that describes the content (scope) of Article 90. Subdivisions (A) and (B) provide what is covered and not covered respectively, as in the 2021 edition. The purpose of the standard formerly located in 90.1 has been relocated to Section 90.2, with no technical changes proposed by this public input. Sections 90.3, 90.4, and 90.5 remain as in the 2021 edition with no technical changes proposed by this public input. Section 90.6 is new and essentially incorporates the text from 90.9 (in the NEC) addressing units of measure, since they are used in this standard. Editorial revisions only have been made in this text as needed for inclusion in NFPA 70E.

Submitter Information Verification

Submitter Full Name: Agnieszka Golriz

Organization: NECA

Street Address:

City:

State:

Zip:

Submittal Date: Wed May 19 09:55:10 EDT 2021

Committee: EEW-AAA

Global Public Input

Action: Delete sections 90.1 through 90.5 and reinsert revised and rearranged 90.1 through 90.5 to comply with the NEC Style Manual. Also incorporate a new 90.6 Units of Measurement to align with the 2020 NEC Style Manual and Section 90.9 of the NEC.

90.1 Purpose. The purpose of this standard is to provide a practical safe working area for employees relative to the hazards arising from the use of electricity.

90.2 Scope.

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- ~~(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) 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~~
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- ~~(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.~~

~~90.3 Standard Arrangement. This standard is divided into the introduction and three chapters, as shown in Figure 90.3. Chapter 1 applies generally, Chapter 2 addresses safety-related maintenance requirements, and Chapter 3 supplements or modifies Chapter 1 with safety requirements for special equipment. Informative annexes are not part of the requirements of this standard but are included for informational purposes only.~~

~~90.4 Mandatory Rules, Permissive Rules, and Explanatory Material. (A) Mandatory Rules. Mandatory rules of this standard are those that identify actions that are specifically required or prohibited and are characterized by the use of the terms shall or shall not.~~

~~(B) Permissive Rules. Permissive rules of this standard are those that identify actions that are allowed but not required, are normally used to describe options or alternative methods, and are characterized by the use of the terms shall be permitted or shall not be required.~~

~~(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.~~

~~Such notes are informational only and are not enforceable as requirements of this standard. Brackets containing section references to another NFPA document are for informational purposes only and are provided as a guide to indicate the source of the extracted text. These bracketed references immediately follow the extracted text.~~

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

~~(D) Informative Annexes. Nonmandatory information relative to the use of this standard is provided in informative annexes. Informative annexes are not part of the requirements of this standard, but are included for information purposes only.~~

~~90.5 Formal Interpretations. To promote uniformity of interpretation and application of the provisions of this standard, formal interpretation procedures have been established and are found in the Regulations Governing the Development of NFPA Standards.~~

90.1 Scope.

This article covers the use and arrangement of this standard. It also covers the expression of mandatory, permissive, and nonmandatory text. It also provides guidance on formal interpretations and specifies the use and expression of measurements. Specifics covered are provided in (A) below and those not covered are provided in (B).

(A) 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) 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.

90.2 Purpose. The purpose of this standard is to provide a practical safe working area for employees relative to the hazards arising from the use of electricity.

90.3 Standard Arrangement. This standard is divided into the introduction and three chapters, as shown in Figure 90.3. Chapter 1 applies generally, Chapter 2 addresses safety-related maintenance requirements, and Chapter 3 supplements or modifies Chapter 1 with safety requirements for special equipment. Informative annexes are not part of the requirements of this standard but are included for informational purposes only.

Figure 90.3 Standard Arrangement

90.4 Mandatory Rules, Permissive Rules, and Explanatory Material.

(A) Mandatory Rules. Mandatory rules of this standard are those that identify actions that are specifically required or prohibited and are characterized by the use of the terms shall or shall not.

(B) Permissive Rules. Permissive rules of this standard are those that identify actions that are allowed but not required, are normally used to describe options or alternative methods, and are characterized by the use of the terms shall be permitted or shall not be required.

(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. Such notes are informational only and are not enforceable as requirements of this standard. Brackets containing section references to another NFPA document are for informational purposes only and are provided as a guide to indicate the source of the extracted text. These bracketed references immediately follow the extracted text.

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

(D) Informative Annexes. Nonmandatory information relative to the use of this standard is provided in informative annexes. Informative annexes are not part of the requirements of this standard, but are included for information purposes only.

90.5 Formal Interpretations. To promote uniformity of interpretation and application of the provisions of this standard, formal interpretation procedures have been established and are found in the Regulations Governing the Development of NFPA Standards.

90.6 Units of Measurement.

(A) Measurement System of Preference. For the purpose of this Standard, metric units of measurement are in accordance with the modernized metric system known as the International System of Units (SI).

(B) Dual System of Units. SI units shall appear first, and inch-pound units shall immediately follow in parentheses. Conversion from inch-pound units to SI units shall be based on hard conversion except as provided in 90.6(C).

(C) Permitted Uses of Soft Conversion. The cases given in 90.6(C)(1) through (C)(4) shall not be required to use hard conversion and shall be permitted to use soft conversion.

(1) Trade Sizes. Where the actual measured size of a product is not the same as the nominal size, trade size designators shall be used rather than dimensions. Trade practices shall be followed in all cases.

(2) Extracted Material. Where material is extracted from another standard, the context of the original material shall not be compromised or violated. Any editing of the extracted text shall be confined to making the style consistent with that of NFPA 70E and the NEC Style Manual.

(3) Industry Practice. Where industry practice is to express units in inch-pound units, the inclusion of SI units shall not be required.

(4) Safety. Where a negative impact on safety would result, soft conversion shall be used.

(D) Compliance. Conversion from inch-pound units to SI units shall be permitted to be an approximate conversion. Compliance with the numbers shown in either the SI system or the inch-pound system shall constitute compliance with this Standard.

Informational Note No. 1: Hard conversion is considered a change in dimensions or properties of an item into new sizes that might or might not be interchangeable with the sizes used in the original measurement. Soft conversion is considered a direct mathematical conversion and involves a change in the description of an existing measurement but not in the actual dimension.

Informational Note No. 2: SI conversions are based on IEEE/ASTM SI 10-1997, Standard for the Use of the International System of Units (SI): The Modern Metric System.

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

Action: relocated all definitions throughout the standard into Article 100. Arrange the article in one part and in alphabetical order.

Statement of Problem and Substantiation for Public Input

The NFPA 70E Standard for Electrical Safety in the Workplace has definitions located in Article 100 and the .2 sections multiple articles of the standard. All the definitions throughout the NFPA 70E are proposed being relocated to Article 100 to comply with Section 2.2.2 of the 2020 NEC Style Manual. The article will contain only one part and will be arranged in alphabetical order. The scope of Article 100 has been revised to reflect these changes. Parenthetical text (for clarifying specific application) shall be permitted following any defined term if it is a duplicate defined term.

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Submittal Date: Wed May 19 10:17:42 EDT 2021

Committee: EEW-AAA

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

Relocate definitions in 310.2, 320.2, 330.2, 340.2, 350.2 and 360.2 to Article 100. At the end of each definition moving from 310.2, 320.2, 330.2, 340.2, 350.2 and 360.2 to Article 100, add "(310)", "(320)", "(330)", "(340)", "(350)" and "(360)", respectively at the end of each definition from the respective articles.

Statement of Problem and Substantiation for Public Input

2.2.2 of the new 2020 NEC Style manual require locating all definitions of terms used in the requirements of the document in Article 100. 2.2.2.3.2 of the new 2020 NEC Style manual indicates where definitions apply to only one article, the article number in parenthesis should follow the definition.

See related PIs 120, 121, 123, 124 and 125.

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 120-NFPA 70E-2021 [Section No. 310.2]	
Public Input No. 121-NFPA 70E-2021 [Section No. 320.2]	
Public Input No. 122-NFPA 70E-2021 [Section No. 330.2]	
Public Input No. 123-NFPA 70E-2021 [Section No. 340.2]	
Public Input No. 124-NFPA 70E-2021 [Section No. 350.2]	
Public Input No. 125-NFPA 70E-2021 [Section No. 360.2]	
Public Input No. 120-NFPA 70E-2021 [Section No. 310.2]	
Public Input No. 121-NFPA 70E-2021 [Section No. 320.2]	
Public Input No. 122-NFPA 70E-2021 [Section No. 330.2]	
Public Input No. 123-NFPA 70E-2021 [Section No. 340.2]	
Public Input No. 124-NFPA 70E-2021 [Section No. 350.2]	
Public Input No. 125-NFPA 70E-2021 [Section No. 360.2]	

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

New Informative Annex S – Assessing the Condition of Maintenance

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

S.1 Introduction. Electrical safety programs contain requirements to consider the condition of maintenance of electrical equipment and systems. The objective of these requirements is to emphasize the inherent risk to workers associated with performing tasks on electrical equipment that is not properly rated, not properly installed, has not been properly maintained or otherwise exhibits evidence of an increased risk level for electrical workers or operators. The following sections describe methods of obtaining information that are useful when assessing the condition of maintenance of electrical equipment and systems.

S.2 Assess the Risk. Safe work practices should always be used when gathering information to be used to assess the condition of maintenance of electrical equipment. Tasks such as opening hinged doors or removal of bolted covers might expose workers to energized conductors or circuit parts inside the equipment. Works should always follow the requirements of their electrical safety program when assessing the condition of electrical equipment.

S.3 Visual Inspection. Visual inspection of equipment might be used to verify that it is installed in a workmanlike manner in accordance with applicable industry codes, standards and the manufacturer's instructions. Visual inspections might also be used to identify evidence of issues or impending failure such as arcing, overheating, loose or bound mechanisms, missing hardware, visible damage, water or dust contamination, or corrosion damage.

S.4 Periodic Testing and Inspection. Periodic testing and detailed inspection methods are used to help workers determine the condition of the equipment at the time of the test. Portable equipment is used to conduct manual tests and inspection such as infrared thermography, measure voltage and current, confirm overcurrent protective device operation, and conduct insulation resistance testing. Depending on the test or inspection, these tasks are performed with the equipment in an electrically safe work condition or with the equipment online.

S.5 Permanently Installed Monitoring. Continuous monitoring of specific equipment conditions can be performed using an uninterrupted method of data collection. Examples include the use of permanently mounted counters, sensors or controllers to measure a condition or state inside the equipment. Multiple types of data might be monitored, including voltage, current, temperature, humidity, cycle count, open/closed state, and others. The data could be used to actively alert personnel to the existence of a condition that is either above or below a predetermined control limit. Permanently installed monitoring systems often allow data collection without removing covers or opening doors and without exposing workers to electrical hazards. The use of real time data is useful when determining the condition of the equipment and is also used to modify (shorten or lengthen) the predetermined maintenance intervals for other inspections and tests.

S.6 Predictive Techniques. Predictive techniques monitor conditions in equipment using sensors and analyze and interpret the data using analytical methods and algorithms. These proactive techniques identify trends or issues and notify personnel of recommended actions before the condition reaches an alarm point or alert them to urgent issues that are at or over a predetermined level. These technologies and methods often detect minor items before they propagate into major issues or equipment failure, enabling workers to interact with or operate the equipment while it is still in a normal operating condition as opposed to an abnormal condition.

S.7 Maintenance History. The maintenance history of electrical equipment is an important factor to consider when assessing if the equipment has been properly maintained in accordance with the manufacturer's recommendations and applicable industry codes and standards. Ready access to maintenance history gives workers important information that is useful in making their assessment. There are various methods used to communicate the maintenance history but the two most common are labels and digital methods.

S.7.1 Labels. Labels, decals, or other markings might be color coded and placed on the exterior enclosure or surface of the electrical equipment or device to communicate the condition of maintenance as of the last assessment. Generally, these markings provide a simple method to categorize the condition of the equipment at the time of the inspection. One example is a three-level system, such as Serviceable, Limited service, or non-serviceable.

S.7.2 Digital and other Electronic Methods. Digital technology is used as a method of storing and sharing maintenance related information. This method stores information locally within the equipment itself, on its associated network, or remotely in a digital asset management system. In addition to recording the last inspection date, these methods are real time and can contain additional details. For example, digital logs record the date and time of the trip events of a circuit breaker and the reason for the trip.

S.8 Standard for Electrical Equipment Maintenance. NFPA 70B is an example of a document that contains further information on the practical safeguarding of persons, property and processes from the risks associated with failure, breakdown, or malfunction. NFPA 70B provides a means to establish and maintain an acceptable condition of maintenance of electrical equipment and systems to address safety and reliability.

Statement of Problem and Substantiation for Public Input

This public input proposes the creation of a new Annex S. NFPA 70E defines the Condition of Maintenance as "The state of the electrical equipment considering the manufacturers' instructions, manufacturers' recommendations, and applicable industry codes, standards, and recommended practices." While this definition is helpful, it is crucial for users of the document to consider how they can determine what requirements exist as well as what information is available to assist in their assessment. This proposed annex provides non-mandatory, informative information to assist the qualified worker identify sources of information that are useful when making their determination. The suggested methods and techniques align with language that will appear in the first draft of NFPA 70B, which is being converted from a recommended practice to a standard.

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**Public Input No. 268-NFPA 70E-2021 [Global Input]**

Section 110.3 and Section 110.4 must be moved under Article 130 because Electrical Safe Work Condition, Energized Work and Energized Electrical Work Permit is Work Involving Electrical Hazard and it must be under same Article. Right now, it is confusing because specific live work was listed under general requirement. Please note that Live Work is more important than general requirement and it requires Energized Electrical Work Permit. Therefore, this three sections must be under same article and must be moved to Article 130. Section 110.3 and Section 110.4 must be moved under Article 130 because Electrical Safe Work Condition, Energized Work and Energized Electrical Work Permit is Work Involving Electrical Hazard and it must be under same Article. Right now, it is confusing because specific live work was listed under general requirement. Please note that Live Work is more important than general requirement and it requires Energized Electrical Work Permit. Therefore, this three sections must be under same article and must be moved to Article 130.

Statement of Problem and Substantiation for Public Input

what happened was in NFPA 70E 2021, part of Article 130 – Work Involving Electrical Hazards was moved to Article 110 – General Requirements for Electrical Safety-Related Work Practices. The separation has led to confusion.

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Submittal Date: Mon May 31 13:49:05 EDT 2021

Committee: EEW-AAA

**Public Input No. 289-NFPA 70E-2021 [Global Input]**

310.2 Global Public Input Action: Relocate the definition(s) in existing 310.2 to article 100 and arrange Article 100 with only one part and in alphabetical order.

310.2 Definitions. For the purposes of this article, the definitions that follow shall apply.

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.

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)

Additional Proposed Changes

<u>File Name</u>	<u>Description Approved</u>
310.docx	310

Statement of Problem and Substantiation for Public Input

The relocation of definitions in the .2 sections of the articles in Chapter 3 are necessary to comply with Section 2.2.2 of the 2020 NEC Style Manual.

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Submittal Date: Tue Jun 01 09:20:43 EDT 2021

Committee: EEW-AAA

310.2 Global Public Input Action: Relocate the definition(s) in existing 310.2 to article 100 and arrange Article 100 with only one part and in alphabetical order.

~~310.2 Definitions. For the purposes of this article, the definitions that follow shall apply.~~

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.

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)

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

320.2 Global Public Input Action: Relocate the definition(s) in existing 320.2 to article 100 and arrange Article 100 with only one part and in alphabetical order.

320.2 Definitions. For the purposes of this article definitions that follow shall apply.

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)

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

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

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)

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)

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

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.

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)

Additional Proposed Changes

<u>File Name</u>	<u>Description Approved</u>
320.docx	320

Statement of Problem and Substantiation for Public Input

The relocation of definitions in the .2 sections of the articles in Chapter 3 are necessary to comply with Section 2.2.2 of the 2020 NEC Style Manual

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Committee: EEW-AAA

320.2 Global Public Input Action: Relocate the definition(s) in existing 320.2 to article 100 and arrange Article 100 with only one part and in alphabetical order.

~~320.2 Definitions. For the purposes of this article definitions that follow shall apply.~~

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)

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

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

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)

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)

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

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.

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)

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

330.2 Global Public Input Action: Relocate the definition(s) in existing 330.2 to article 100 and arrange Article 100 with only one part and in alphabetical order.

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. (330)

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. (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)

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

Additional Proposed Changes

<u>File Name</u>	<u>Description Approved</u>
330.docx	330

Statement of Problem and Substantiation for Public Input

The relocation of definitions in the .2 sections of the articles in Chapter 3 are necessary to comply with Section 2.2.2 of the 2020 NEC Style Manual

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Committee: EEW-AAA

330.2 Global Public Input Action: Relocate the definition(s) in existing 330.2 to article 100 and arrange Article 100 with only one part and in alphabetical order.

~~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. (330)

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. (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)

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

**Public Input No. 292-NFPA 70E-2021 [Global Input]**

340.2 Global Public Input Action: Relocate the definition(s) in existing 340.2 to article 100 and arrange Article 100 with only one part and in alphabetical order.

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)~~

Additional Proposed Changes

<u>File Name</u>	<u>Description Approved</u>
340.docx	340

Statement of Problem and Substantiation for Public Input

The relocation of definitions in the .2 sections of the articles in Chapter 3 are necessary to comply with Section 2.2.2 of the 2020 NEC Style Manual.

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340.2 Global Public Input Action: Relocate the definition(s) in existing 340.2 to article 100 and arrange Article 100 with only one part and in alphabetical order.

~~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)

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

350.2 Global Public Input Action: Relocate the definition(s) in existing 350.2 to article 100 and arrange Article 100 with only one part and in alphabetical order.

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. (350)

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. (350)

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)

Research and Development (R&D). An activity in an installation specifically designated for research or development conducted with custom or special electrical equipment. (350)

Additional Proposed Changes

<u>File Name</u>	<u>Description Approved</u>
350.docx	350

Statement of Problem and Substantiation for Public Input

The relocation of definitions in the .2 sections of the articles in Chapter 3 are necessary to comply with Section 2.2.2 of the 2020 NEC Style Manual.

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Submittal Date: Tue Jun 01 09:29:55 EDT 2021

Committee: EEW-AAA

350.2 Global Public Input Action: Relocate the definition(s) in existing 350.2 to article 100 and arrange Article 100 with only one part and in alphabetical order.

~~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. (350)

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. (350)

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)

Research and Development (R&D). An activity in an installation specifically designated for research or development conducted with custom or special electrical equipment. (350)

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

360.2 Global Public Input Action: Relocate the definition(s) in existing 360.2 to article 100 and arrange Article 100 with only one part and in alphabetical order.

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. (360)

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

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

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

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. (360)

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.

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

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)

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

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)

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

Additional Proposed Changes

<u>File Name</u>	<u>Description Approved</u>
360.docx	360

Statement of Problem and Substantiation for Public Input

The relocation of definitions in the .2 sections of the articles in Chapter 3 are necessary to comply with Section 2.2.2 of the 2020 NEC Style Manual.

Submitter Information Verification

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Submittal Date: Tue Jun 01 09:31:01 EDT 2021
Committee: EEW-AAA

360.2 Global Public Input Action: Relocate the definition(s) in existing 360.2 to article 100 and arrange Article 100 with only one part and in alphabetical order.

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. (360)

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

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

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

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. (360)

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.

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

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)

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

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)

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

**Public Input No. 305-NFPA 70E-2021 [Global Input]**

Change “normal operating condition” to “normal equipment condition” throughout the document.

Alternately, revise to “normal equipment operating condition”.

Statement of Problem and Substantiation for Public Input

Long time users of the document may readily understand what is meant by “normal operating condition,” however, new users, and particularly non-electrical Safety Professionals attempting to understand and apply the requirements may not.

Revising the phrase “normal operating condition” to “normal equipment condition” clarifies the meaning of the phrase without changing intent as the phrase is used consistently throughout the document in the context of the condition of the electrical equipment that is to be operated.

The proposed revision will also clarify the distinction between “normal operation” and “normal operating condition”, which in the submitter's experience are often confused.

The proposed revision is also consistent with the header of Table 130.5(C) column two “Equipment condition”.

Note: A word search for “normal operating condition” indicates that the phrase occurs 7 times:

Article 100 definition of Arc Flash Hazard – two times

Section 110.3(D) – three times

Table 130.5(C) in Table Note (a) – one time

Annex I, Figure I.2 – one time

Submitter Information Verification

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Submittal Date: Tue Jun 01 12:24:51 EDT 2021

Committee: EEW-AAA

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

Per FR 54

Change "leather protectors" to "protectors". ASTM F2675 no longer exempts arc rating D120 or F696 gloves and recent research indicates that many F696 protectors on the market contain a flammable melting cuff. OSHA calls them "protectors" and does not directly require leather.. ASTM F2675 now allows arc rating of protector gloves and this will eliminate those cuffs over time. This also leaves room for other "protector" gloves as the standards are completed. A proposed ASTM AR protector standard could be completed before NFPA 70E 2021 is published. This change will not preclude using the new standard gloves (which may or may not contain leather allowing more dexterity or better cut resistance and grip).

Additionally the new statement that "Rubber insulating gloves with leather protectors provide arc flash protection in addition to shock protection. Higher class rubber insulating gloves with leather protectors, due to their increased thickness, provide increased arc flash protection." Is a little problematic.

I suggest the following as more accurate.

Rubber insulating gloves with protectors (traditionally leather) provide arc flash protection in addition to shock protection. Higher class rubber insulating gloves with protectors, due to their increased thickness, can provide increased arc flash protection but these gloves can ignite, and different colors and different rubber formulations ignite at difference levels. Rubber insulating gloves and protector gloves can be arc rated per ASTM F2675."

Additional Proposed Changes

<u>File Name</u>	<u>Description</u>	<u>Approved</u>
NPA_70E_PC_62.pdf	NFPA 70E Public Comment No. 62	

Statement of Problem and Substantiation for Public Input

NOTE: This Public Input appeared as "Reject but Hold" in Public Comment No. 62 of the (A2020) Second Draft Report for NFPA 70E and per the Regs. at 4.4.8.3.1.

This public comment introduces a concept that has not had public review by being included in a related Public Input or First Revision as shown in the First Draft. The action taken on this public comment is "Reject but Hold" in accordance with the Regulations Governing the Development of NFPA Standards section 4.4.8.3.1.

Submitter Information Verification

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Submittal Date: Fri Jun 04 13:04:23 EDT 2021

Committee: EEW-AAA



Public Comment No. 62-NFPA 70E-2019 [Global Input]

Per FR 54

Change “leather protectors” to “protectors”. ASTM F2675 no longer exempts arc rating D120 or F696 gloves and recent research indicates that many F696 protectors on the market contain a flammable melting cuff. OSHA calls them “protectors” and does not directly require leather.. ASTM F2675 now allows arc rating of protector gloves and this will eliminate those cuffs over time. This also leaves room for other “protector” gloves as the standards are completed. A proposed ASTM AR protector standard could be completed before NFPA 70E 2021 is published. This change will not preclude using the new standard gloves (which may or may not contain leather allowing more dexterity or better cut resistance and grip).

Additionally the new statement that “Rubber insulating gloves with leather protectors provide arc flash protection in addition to shock protection. Higher class rubber insulating gloves with leather protectors, due to their increased thickness, provide increased arc flash protection.” Is a little problematic.

I suggest the following as more accurate.

Rubber insulating gloves with protectors (traditionally leather) provide arc flash protection in addition to shock protection. Higher class rubber insulating gloves with protectors, due to their increased thickness, can provide increased arc flash protection but these gloves can ignite, and different colors and different rubber formulations ignite at different levels. Rubber insulating gloves and protector gloves can be arc rated per ASTM F2675.”

Statement of Problem and Substantiation for Public Comment

See comments in proposal

Related Item

- FR54

Submitter Information Verification

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Submittal Date: Fri May 03 11:37:28 EDT 2019

Committee:

Committee Statement

Committee Action: Rejected but held

Resolution: This public comment introduces a concept that has not had public review by being included in a related Public Input or First Revision as shown in the First Draft. The action taken on this public comment is “Reject but Hold” in accordance with the Regulations Governing the Development of NFPA Standards section 4.4.8.3.1.

**Public Input No. 241-NFPA 70E-2021 [New Section after 90.2(A)]****TITLE OF NEW CONTENT**

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

Statement of Problem and Substantiation for Public Input

Telecommunications utilities have the exact same types of offices, buildings, warehouses, garages, machine shop and recreational buildings containing the exact same electrical hazards as electric utilities have. However, communications utilities are exempt from implementing NFPA 70E work practices in such locations because they are not listed in 90.2(A) Covered. By adding a new step 90.2(A)(3) for communications utilities will ensure electrical workers in these locations are offered the exact same safety protection as those workers in electric utility companies.

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Submittal Date: Thu May 27 20:47:10 EDT 2021

Committee: EEW-AAA

**Public Input No. 272-NFPA 70E-2021 [Section No. 90.2(A)]****(A) 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 injury from machines, tools, appliances, and appliances special electrical equipment .

Statement of Problem and Substantiation for Public Input

We are protecting all workers from all electrical injury, not just shock. Machines, tools and appliances does not cover the expansion to all types of electrical equipment that we are now embracing in Chapter 3, including specialized industrial, research and other unique electrical equipment, such as capacitor and battery banks.

Submitter Information Verification

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Submittal Date: Tue Jun 01 07:30:35 EDT 2021

Committee: EEW-AAA

**Public Input No. 71-NFPA 70E-2021 [Section No. 90.2(B)]****(B) 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) Cord and plug connected equipment, when the equipment is disconnected from the source
- (5) Installations under the exclusive control of an electric utility where such installations:
 - (6) Consist of service drops or service laterals, and associated metering, or
 - (7) 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
 - (8) 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
 - (9) 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.

Statement of Problem and Substantiation for Public Input

Quite a bit of conversation has taken place concerning cord and plug equipment and how to handle it. Article 120 specifically states that cord and plug equipment is excluded when the plug is under the exclusive control of the worker. But what happens when the worker leaves the area? It is not appropriate for the cord cap to be locked with the worker's lock because the worker is no longer exposed to the equipment. If the equipment needs to be protected from being plugged in, in order to not expose affected or other workers, this would fall under OSHA 1910.145, not 1910.147. In any event, this would be outside the scope of 70E.

Placing cord and plug equipment under 90.2(B) would clarify that this equipment is outside the scope of 70E.

Submitter Information Verification

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Submittal Date: Wed Mar 31 11:41:49 EDT 2021
Committee: EEW-AAA

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

Explanatory material, such as references to other standards, references to related sections of this standard, or information related to a rule in this standard, is included in this standard in the form of informational notes or an informative annex . Unless the standard reference includes a date, the reference is to be considered as the latest edition of the standard . Such notes are informational only and are not enforceable as requirements of this standard.

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

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

Statement of Problem and Substantiation for Public Input

NFPA 70E® contains multiple references to other Standards. As required by the NEC Style Manual, these references are included in either an informative annex (for example, Annex A for Informative Publications), or in Informational Notes. Every cycle, a considerable effort is expended to update these references to ensure the latest edition of the standard is identified. In most of these cases, this is an effort that yields little benefit, as the intent in most cases is to maintain a reference to the latest edition of the Standard. There are limited cases where the technical committee makes an intentional decision to cite an older edition of the Standard, but this is by far the exception, not the rule. To reduce the effort needed to maintain an up-to-date citation for an informative reference, this Public Input would note that, unless a date is included, that the reference is to be considered as the latest edition of that standard. A similar public input was submitted to CMP 1 for the 2023 NEC® and resulted in a First Revision No. 8379.

Submitter Information Verification

Submitter Full Name: Kelly Nicoletto

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City:

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Submittal Date: Mon May 31 12:48:34 EDT 2021

Committee: EEW-AAA



Public Input No. 112-NFPA 70E-2021 [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 Flash Hazard.

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

Informational Note No. 1: The likelihood of occurrence of an arc flash incident increases when energized electrical conductors or circuit parts are exposed or when they are within equipment in a guarded or enclosed condition, provided a person is interacting with the equipment in such a manner that could cause an electric arc. An arc flash incident is not likely to occur under normal operating conditions when enclosed energized equipment has been properly installed and maintained. See 110.4(D) for further information.

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

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: ATPV is defined in ASTM F1959/F1959M, *Standard Test Method for Determining the Arc Rating of Materials for Clothing*, as the incident energy (cal/cm^2) on a material or a multilayer system of materials that results in a 50 percent probability that sufficient heat transfer through the tested specimen is predicted to cause the onset of a second degree skin burn injury based on the Stoll curve.

Informational Note No. 3: E_{BT} is defined in ASTM F1959/F1959M, *Standard Test Method for Determining the Arc Rating of Materials for Clothing*, 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.

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.

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.

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.

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.

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

Boundary, Restricted Approach.

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

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]

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.

Conductive.

Suitable for carrying electric current.

Conductor, Bare.

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

Conductor, Covered.

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.

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]

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 (Disconnecter, 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.

Information Note No. 1: Criteria to consider when determining an electrical hazard may include where an employee is exposed or has the potential to be exposed to 50 volts or more, arc flash incident energies above 1.2 cal/cm², or flying objects resulting from electrical explosions.

Informational Note No.2: 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 temporarily eliminating electrical hazards for the period of time for which the state is maintained.

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.

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

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

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.

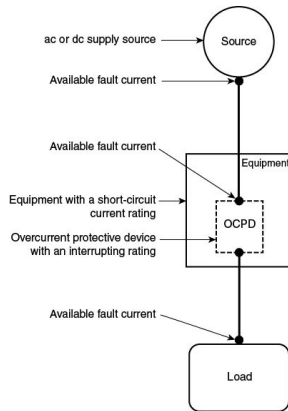
The amount of current delivered at a point on the system during a short-circuit condition.

Fault Current, Available.

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

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

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.

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]

Grounded (Grounding).

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

Grounded, Solidly.

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

Grounding Conductor, Equipment (EGC).

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]

Hazard.

A source of possible injury or damage to health.

Hazardous.

Involving exposure to at least one hazard.

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.

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]

Maintenance, Condition of.

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]

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]

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.

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.

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]

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.

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.

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.

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.

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.

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.

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]

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.

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.

Working Distance.

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

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

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. There are two categories of "working on": *Diagnostic (testing)* is 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. *Repair* is any physical alteration of electrical equipment, conductors, or circuit parts (such as making or tightening connections, removing or replacing components, etc.).

Statement of Problem and Substantiation for Public Input

Recent revisions to NFPA 70E have replaced the statement "operating at 50 volts or more" and replaced with "where an electrical hazard exists". This expands the criteria to include shock, arc flash and arc blast. Adding this informational note will provide users clarity during the risk assessment process when identifying electrical hazards.

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Public Input No. 238-NFPA 70E-2021 [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 Flash Hazard.

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

Informational Note No. 1: The likelihood of occurrence of an arc flash incident increases when energized electrical conductors or circuit parts are exposed or when they are within equipment in a guarded or enclosed condition, provided a person is interacting with the equipment in such a manner that could cause an electric arc. An arc flash incident is not likely to occur under normal operating conditions when enclosed energized equipment has been properly installed and maintained. See 110.4(D) for further information.

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

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: ATPV is defined in ASTM F1959/F1959M, *Standard Test Method for Determining the Arc Rating of Materials for Clothing*, as the incident energy (cal/cm^2) on a material or a multilayer system of materials that results in a 50 percent probability that sufficient heat transfer through the tested specimen is predicted to cause the onset of a second degree skin burn injury based on the Stoll curve.

Informational Note No. 3: E_{BT} is defined in ASTM F1959/F1959M, *Standard Test Method for Determining the Arc Rating of Materials for Clothing*, 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.

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.

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.

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.

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.

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

Boundary, Restricted Approach.

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

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]

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.

Conductive.

Suitable for carrying electric current.

Conductor, Bare.

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

Conductor, Covered.

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.

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]

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 (Disconnecter, 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 temporarily eliminating electrical hazards for the period of time for which the state is maintained.

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.

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

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

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.

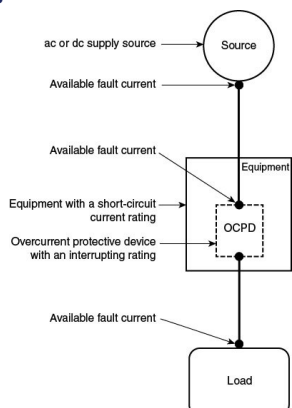
The amount of current delivered at a point on the system during a short-circuit condition.

Fault Current, Available.

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

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

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.

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]

Grounded (Grounding).

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

Grounded, Solidly.

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

Grounding Conductor, Equipment (EGC).

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]

Hazard.

A source of possible injury or damage to health.

Hazardous.

Involving exposure to at least one hazard.

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.

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]

Maintenance, Condition of.

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 conditions.

Informational Note: The neutral conductor is a current-carrying conductor that is not safe to work on while energized.

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]

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.

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.

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]

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.

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.

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.

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.

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.

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.

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]

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.

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.

Working Distance.

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

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

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. There are two categories of "working on": *Diagnostic (testing)* is 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. *Repair* is any physical alteration of electrical equipment, conductors, or circuit parts (such as making or tightening connections, removing or replacing components, etc.).

Statement of Problem and Substantiation for Public Input

Enhanced recognition of the hazard of an energized neutral conductor.

This proposed addition of the definition of the Neutral Conductor and the associated Informational note is a direct copy of the definition of the Neutral Conductor in NFPA 70, National Electrical Code (NEC) - 2020 edition, Article 100 Definitions.

This proposed addition of the associated Informational note is a direct copy of the "Enhanced Content" for the definition of the Neutral Conductor in NFPA 70, National Electrical Code (NEC) - 2020 edition, Article 100 Definitions.

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
<u>Public Input No. 237-NFPA 70E-2021 [Section No. 120.5]</u>	Neutral shock hazard awareness

Submitter Information Verification

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Committee: EEW-AAA

**Public Input No. 320-NFPA 70E-2021 [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 Flash Hazard.

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

Informational Note No. 1: The likelihood of occurrence of an arc flash incident increases when energized electrical conductors or circuit parts are exposed or when they are within equipment in a guarded or enclosed condition, provided a person is interacting with the equipment in such a manner that could cause an electric arc. An arc flash incident is not likely to occur under normal operating conditions when enclosed energized equipment has been properly installed and maintained. See 110.4(D) for further information.

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

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: ATPV is defined in ASTM F1959/F1959M, *Standard Test Method for Determining the Arc Rating of Materials for Clothing*, as the incident energy (cal/cm^2) on a material or a multilayer system of materials that results in a 50 percent probability that sufficient heat transfer through the tested specimen is predicted to cause the onset of a second degree skin burn injury based on the Stoll curve.

Informational Note No. 3: E_{BT} is defined in ASTM F1959/F1959M, *Standard Test Method for Determining the Arc Rating of Materials for Clothing*, 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.

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.

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.

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.

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.

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

Boundary, Restricted Approach.

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

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]

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.

Conductive.

Suitable for carrying electric current.

Conductor, Bare.

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

Conductor, Covered.

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.

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]

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 (Disconnecter, 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 temporarily eliminating electrical hazards for the period of time for which the state is maintained.

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.

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

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

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.

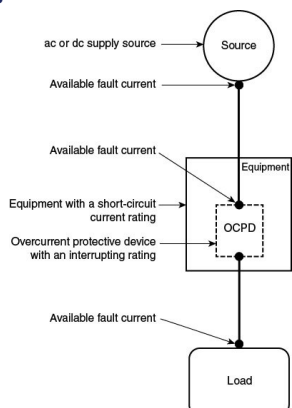
The amount of current delivered at a point on the system during a short-circuit condition.

Fault Current, Available.

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

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

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.

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]

Grounded (Grounding).

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

Grounded, Solidly.

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

Grounding Conductor, Equipment (EGC).

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]

Hazard.

A source of possible injury or damage to health.

Hazardous.

Involving exposure to at least one hazard.

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.

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]

Maintenance, Condition of.

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]

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]

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.

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.

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]

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.

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.

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.

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.

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.

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.

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]

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.

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.

In Sight From (Within Sight From, Within Sight).

Where this standard specifies that Energy Isolation devices is “in sight from,” “within sight from,” or “within sight of,” and so forth, of amachinery or equipment, the energy isolation device t is to be visible and not more than 15 m (50 ft) distant from the machinery or equipment

Working Distance.

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

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

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. There are two categories of “working on”: *Diagnostic (testing)* is 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. *Repair* is any physical alteration of electrical equipment, conductors, or circuit parts (such as making or tightening connections, removing or replacing components, etc.).

Statement of Problem and Substantiation for Public Input

There is currently no definition in NFPA 70E for In Sight From (Within Sight From, Within Sight)

A new definition based on NEC is added for In Sight From (Within Sight From, Within Sight) aligned with PI 308 and PI 316

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 316-NFPA 70E-2021 [Section No. 120.3(A)]	
Public Input No. 308-NFPA 70E-2021 [New Section after O.2.4]	
Public Input No. 331-NFPA 70E-2021 [Section No. O.2.4]	

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**Public Input No. 67-NFPA 70E-2021 [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 Flash Hazard.

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

Informational Note No. 1: The likelihood of occurrence of an arc flash incident increases when energized electrical conductors or circuit parts are exposed or when they are within equipment in a guarded or enclosed condition, provided a person is interacting with the equipment in such a manner that could cause an electric arc. An arc flash incident is not likely to occur under normal operating conditions when enclosed energized equipment has been properly installed and maintained. See 110.4(D) for further information.

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

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: ATPV is defined in ASTM F1959/F1959M, *Standard Test Method for Determining the Arc Rating of Materials for Clothing*, as the incident energy (cal/cm^2) on a material or a multilayer system of materials that results in a 50 percent probability that sufficient heat transfer through the tested specimen is predicted to cause the onset of a second degree skin burn injury based on the Stoll curve.

Informational Note No. 3: E_{BT} is defined in ASTM F1959/F1959M, *Standard Test Method for Determining the Arc Rating of Materials for Clothing*, 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 Program

An ongoing program of verifying the integrity of the equipment grounding conductor of cord sets and cord-and-plug connected equipment. Requirements for an assured equipment grounding program can be found in Article 590.6(B)(2) of the National Electric Code (NFPA 70).

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.

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.

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.

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.

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

Boundary, Restricted Approach.

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

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]

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.

Conductive.

Suitable for carrying electric current.

Conductor, Bare.

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

Conductor, Covered.

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.

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]

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 (Disconnecter, 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 temporarily eliminating electrical hazards for the period of time for which the state is maintained.

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.

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

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

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.

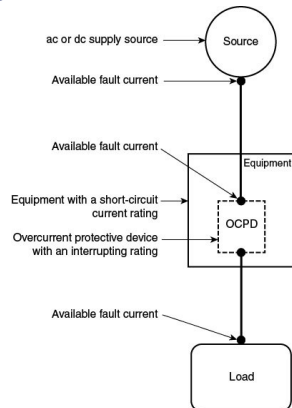
The amount of current delivered at a point on the system during a short-circuit condition.

Fault Current, Available.

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

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

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.

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]

Grounded (Grounding).

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

Grounded, Solidly.

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

Grounding Conductor, Equipment (EGC).

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]

Hazard.

A source of possible injury or damage to health.

Hazardous.

Involving exposure to at least one hazard.

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.

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]

Maintenance, Condition of.

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]

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]

Person in Charge

A person assigned to be in charge of a specific task and perform or help to perform that task

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.

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.

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]

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.

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.

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.

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.

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.

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.

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]

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.

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.

Working Distance.

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

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

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. There are two categories of "working on": *Diagnostic (testing)* is 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. *Repair* is any physical alteration of electrical equipment, conductors, or circuit parts (such as making or tightening connections, removing or replacing components, etc.).

Statement of Problem and Substantiation for Public Input

A definition of Person in Charge needs to be included in the NFPA 70E definitions to define Person In Charge

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**Public Input No. 69-NFPA 70E-2021 [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 Flash Hazard.

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

Informational Note No. 1: The likelihood of occurrence of an arc flash incident increases when energized electrical conductors or circuit parts are exposed or when they are within equipment in a guarded or enclosed condition, provided a person is interacting with the equipment in such a manner that could cause an electric arc. An arc flash incident is not likely to occur under normal operating conditions when enclosed energized equipment has been properly installed and maintained. See 110.4(D) for further information.

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

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: ATPV is defined in ASTM F1959/F1959M, *Standard Test Method for Determining the Arc Rating of Materials for Clothing*, as the incident energy (cal/cm^2) on a material or a multilayer system of materials that results in a 50 percent probability that sufficient heat transfer through the tested specimen is predicted to cause the onset of a second degree skin burn injury based on the Stoll curve.

Informational Note No. 3: E_{BT} is defined in ASTM F1959/F1959M, *Standard Test Method for Determining the Arc Rating of Materials for Clothing*, 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.

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.

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.

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.

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.

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

Boundary, Restricted Approach.

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

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]

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.

Conductive.

Suitable for carrying electric current.

Conductor, Bare.

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

Conductor, Covered.

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.

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]

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 (Disconnecter, 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 temporarily eliminating electrical hazards for the period of time for which the state is maintained.

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.

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

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

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.

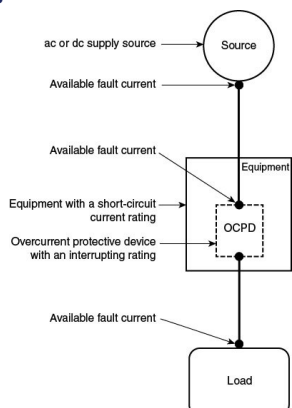
The amount of current delivered at a point on the system during a short-circuit condition.

Fault Current, Available.

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

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

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.

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]

Grounded (Grounding).

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

Grounded, Solidly.

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

Grounding Conductor, Equipment (EGC).

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]

Hazard.

A source of possible injury or damage to health.

Hazardous.

Involving exposure to at least one hazard.

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.

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]

Maintenance, Condition of.

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]

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]

Person In Charge

A person assigned to be in charge of a specific task and perform or help perform that task

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.

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.

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]

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.

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.

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.

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.

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.

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.

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]

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.

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.

Working Distance.

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

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

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. There are two categories of "working on": *Diagnostic (testing)* is 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. *Repair* is any physical alteration of electrical equipment, conductors, or circuit parts (such as making or tightening connections, removing or replacing components, etc.).

Statement of Problem and Substantiation for Public Input

the definition of person in charge needs to be added to definitions

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Public Input No. 242-NFPA 70E-2021 [New Article after 100]

New Definition

Person/Employee in Charge. The individual who has the overall responsibility for the employers Lockout/Tagout program and procedures.

Statement of Problem and Substantiation for Public Input

The term "Person in Charge" or "Employee in Charge" is used over 10 times in NFPA 70E, however there is no definition to describe the overall responsibility for this individual. With no official definition, the reader is left guess who this person is and what authority he has been invested with.

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Public Input No. 3-NFPA 70E-2020 [New Article after 100]

Proposal: Add definition for "Arc Flash"

Substantiation:

The term "ArcFlash" appears through out Chapter 1 of NFPA 70E without ever being defined. To better educate field users in laymen's terms we need to explain the nature of a hazard prior to defining the hazard. As an example, the term "Shock" is defined.

Type your content here ...

A proposed definition for the term Arc Flash, excerpted from Wikipedia is: An arc flash is the light and heat produced from an electric arc supplied with sufficient electrical energy to cause substantial damage, harm, fire, or injury.

Statement of Problem and Substantiation for Public Input

This proposed change would assist the user to fully understand any terms used in NFPA 70E related to the term arc flash by defining the term.

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Submittal Date: Fri Nov 06 11:50:28 EST 2020

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

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

Informational Note: According to the Stoll skin burn injury model, the onset of a second degree burn on unprotected skin is likely to occur at an exposure of 1.2 cal/cm^2 (5 J/cm^2) for one second.

Statement of Problem and Substantiation for Public Input

Add "(Arc Flash Boundary)" to definition title.

2.2.2.3.1 of the new 2020 NEC Style Manual requires defined terms that have subparts per 2.2.2.3 shall then appear in parentheses as it would be found in the document.

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Committee: EEW-AAA

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

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

Statement of Problem and Substantiation for Public Input

Add "(Bare Conductor)" to definition title.

2.2.2.3.1 of the new 2020 NEC Style Manual requires defined terms that have subparts per 2.2.2.3 shall then appear in parentheses as it would be found in the document.

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

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

Statement of Problem and Substantiation for Public Input

Add "(Covered Conductor)" to definition title.

2.2.2.3.1 of the new 2020 NEC Style Manual requires defined terms that have subparts per 2.2.2.3 shall then appear in parentheses as it would be found in the document.

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

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

Statement of Problem and Substantiation for Public Input

Add "(Insulated Conductor)" to definition title.

2.2.2.3.1 of the new 2020 NEC Style Manual requires defined terms that have subparts per 2.2.2.3 shall then appear in parentheses as it would be found in the document.

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

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

Informational Note No. 1: See 110.4(D) for further information. The likelihood of occurrence of an arc flash incident increases when energized electrical conductors or circuit parts are exposed or when they are within equipment in a guarded or enclosed condition, provided a person is interacting with the equipment in such a manner that could cause an electric arc. An arc flash incident is not likely to occur under normal operating conditions when enclosed energized equipment has been properly installed and maintained. ~~See 110.4(D) for further information.~~

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

Statement of Problem and Substantiation for Public Input

Revised Informational Note to comply with new 2020 NEC Style Manual.

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

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**Public Input No. 324-NFPA 70E-2021 [Definition: Arc Flash Hazard.]****Arc Flash Hazard.**

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

Informational Note No. 1: The likelihood of occurrence of an arc flash incident increases when energized electrical conductors or circuit parts are exposed or when they are within equipment in a guarded or enclosed condition, provided a person is interacting with the equipment in such a manner that could cause an electric arc. An arc flash incident is not likely to occur under normal operating conditions when enclosed energized equipment has been properly installed and maintained. See 110.4(D) for further information.

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

Informational Note No. 3 Sustainable arcs are possible but less likely in three-phase systems operating at 240 V nominal or less with an available short-circuit current less than 2000A

Statement of Problem and Substantiation for Public Input

At present there are no published data on when an arc can be sustained.

Based on testing performed by IEEE/NFPA Collaborative Project, it was determined that Sustainable arcs are possible but less likely in three-phase systems operating at 240 V nominal or less with an available short-circuit current less than 2000A

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

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

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

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

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

Statement of Problem and Substantiation for Public Input

Revised Informational Note to comply with new 2020 NEC Style Manual.

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

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

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

Statement of Problem and Substantiation for Public Input

Add "(Limited Approach Boundary)" to definition title.

2.2.2.3.1 of the new 2020 NEC Style Manual requires defined terms that have subparts per 2.2.2.3 shall then appear in parentheses as it would be found in the document.

Submitter Information Verification

Submitter Full Name: Louis Barrios

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Submittal Date: Sun May 23 10:17:36 EDT 2021

Committee: EEW-AAA

**Public Input No. 22-NFPA 70E-2020 [Definition: Boundary, Limited Approach.]****Boundary, Limited Approach.**

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

Statement of Problem and Substantiation for Public Input

"electric" is added before "shock" to read "electric shock" to correlate with the use of "electric shock" in the definition of "electrical hazard" and Boundary, Restricted Approach as well as to clarify that the type of shock hazard being defined is a shock hazard rather than others forms of shock such as where one would go into shock due to a severe injury or a reaction associated with fright.

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.

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

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 15-NFPA 70E-2020 [Definition: Shock Hazard.]	Related issue.

Submitter Information Verification

Submitter Full Name: Palmer Hickman
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Submittal Date: Tue Dec 22 14:35:29 EST 2020
Committee: EEW-AAA

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

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

Statement of Problem and Substantiation for Public Input

Add "(Restricted Approach Boundary)" to definition title.

2.2.2.3.1 of the new 2020 NEC Style Manual requires defined terms that have subparts per 2.2.2.3 shall then appear in parentheses as it would be found in the document.

Submitter Information Verification

Submitter Full Name: Louis Barrios

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Submittal Date: Sun May 23 10:19:01 EDT 2021

Committee: EEW-AAA

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

A state in which an electrical conductor or circuit part has been disconnected from energized parts, locked/tagged in accordance with established standards, tested to verify the absence of voltage, and, if necessary, temporarily grounded for personnel protection.

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

Statement of Problem and Substantiation for Public Input

Editorial correction to remove redundant text . The definition is clear that the electrical hazard is only eliminated for the period of time for which the state is maintained - which is temporary and not permanent

Submitter Information Verification

Submitter Full Name: Daleep Mohla

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Submittal Date: Tue Jun 01 13:29:17 EDT 2021

Committee: EEW-AAA

**Public Input No. 344-NFPA 70E-2021 [Definition: Electrically Safe Work Condition.]****Electrically Safe Work Condition.**

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

Statement of Problem and Substantiation for Public Input

Section 120.5(7) was revised for the 2021 edition to differentiate between "testing for the absence of voltage" and "determining satisfactory operation of a test instrument through verification". The definition of "electrically safe work condition" needs to be consistent with how those terms are used.

Submitter Information Verification

Submitter Full Name: Paul Dobrowsky

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Submittal Date: Tue Jun 01 15:16:33 EDT 2021

Committee: EEW-AAA

**Public Input No. 347-NFPA 70E-2021 [Definition: Electrically Safe Work Condition.]****Electrically Safe Work Condition.**

A state in which an electrical conductor or circuit part has been disconnected from energized parts, locked/tagged in accordance with established standards, tested to verify the absence of voltage, and, if necessary, temporarily grounded for personnel protection.

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

Statement of Problem and Substantiation for Public Input

Establishing an electrically safe work condition is more appropriately described as an administrative control method. It is very subject to human error and that needs to be considered and emphasized. In certain situations, tagout can be used without a lock to establish an electrically safe work condition.

Elimination is typically described in other documents as completely removing a hazard. An electrically safe work condition is a control method which can be compromised both during the process of establishing it and afterwards. Component failures, equipment malfunctions, etc. can result in exposure to electrical hazards even when using an electrically safe work condition. Temporarily controlling a hazard is not the same as completely removing it.

Deleting the wording as suggested will not decrease the need to establish an electrically safe work condition. It is an important method, just as is PPE which is used daily by many, even though it is the least effective method in the hierarchy. Aligning the concept that an electrically safe work condition is part of an administrative control method is a much better approach.

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 348-NFPA 70E-2021 [Section No. 110.1]	
Public Input No. 368-NFPA 70E-2021 [Section No. F.3]	

Submitter Information Verification

Submitter Full Name: Paul Dobrowsky
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Submittal Date: Tue Jun 01 15:25:04 EDT 2021
Committee: EEW-AAA

**Public Input No. 49-NFPA 70E-2021 [Definition: Electrically Safe Work Condition.]****Electrically Safe Work Condition.**

A state in which an electrical conductor or circuit part has been disconnected from energized parts, locked/tagged in accordance with established standards, tested to verify the absence of voltage, and, if necessary, temporarily grounded for personnel protection.

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

Statement of Problem and Substantiation for Public Input

The word "de-energized" is removed to make this informational note technically correct since something that is de-energized is not equivalent to something that is in an electrically safe work condition. Note that de-energizing is one step in an electrically safe work condition. For example, see OSHA 1910.333(b)(1), Application, in part, where "[c]onductors and parts of electric equipment that have been deenergized but have not been locked out or tagged in accordance with paragraph (b) of this section shall be treated as energized parts, and paragraph (c) of this section applies to work on or near them." This in essence states that conductors and parts of electric equipment that have been deenergized but have not been locked out or tagged are considered energized. This state where something that is deenergized is considered energized is clearly not a state meeting the definition or requirements of an electrically safe work condition.

Submitter Information Verification

Submitter Full Name: Palmer Hickman

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Submittal Date: Mon Feb 22 13:29:56 EST 2021

Committee: EEW-AAA



Public Input No. 60-NFPA 70E-2021 [Definition: Electrically Safe Work Condition.]

Electrically Safe Work Condition.

A state in which an electrical conductor or circuit part has been disconnected from energized parts, locked/tagged in accordance with established standards, tested to verify the absence of voltage, and, if necessary, temporarily grounded for personnel protection.

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

Informational Note: After an electrically safe work condition has been achieved, hazardous energy may still be present when a neutral conductor is disconnected. This can happen when there is a neutral connection that connects a load from an unknown source. When neutrals are disconnected, the worker should be aware that one of the disconnected neutrals could become energized.

Statement of Problem and Substantiation for Public Input

Neutrals becoming energized can come from two different scenarios. One is multiwire branch circuits that were installed before 2008 and don't have handle-ties. This is well known and taught in courses for electrical workers. The other source is miswired systems where a load is fed from one system and the neutral is connected to a different system. When all the conductors are connected, there is a neutral path from one system to another and so all the equipment functions. This will not be discovered until the neutral is disconnected and becomes energized from the other system. There is no way to know this upfront. The only mitigation is knowledge and awareness of the worker that this is always a possibility.

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Submittal Date: Fri Mar 12 11:35:04 EST 2021

Committee: EEW-AAA

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

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

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

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

Statement of Problem and Substantiation for Public Input

Add "(Arc-Resistant Equipment)" to definition title.

2.2.2.3.1 of the new 2020 NEC Style Manual requires defined terms that have subparts per 2.2.2.3 shall then appear in parentheses as it would be found in the document.

Submitter Information Verification

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Submittal Date: Sun May 23 10:25:10 EDT 2021

Committee: EEW-AAA

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

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

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

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

Statement of Problem and Substantiation for Public Input

Revised Informational Note to comply with new 2020 NEC Style Manual.

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

Submitter Information Verification

Submitter Full Name: Louis Barrios

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Submittal Date: Sun May 23 11:11:19 EDT 2021

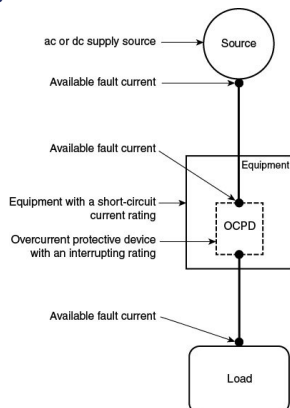
Committee: EEW-AAA

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

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

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

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 Input

Add "(Available Fault Current)" to definition title.

2.2.2.3.1 of the new 2020 NEC Style Manual requires defined terms that have subparts per 2.2.2.3 shall then appear in parentheses as it would be found in the document.

Submitter Information Verification

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Submittal Date: Sun May 23 10:26:44 EDT 2021

Committee: EEW-AAA



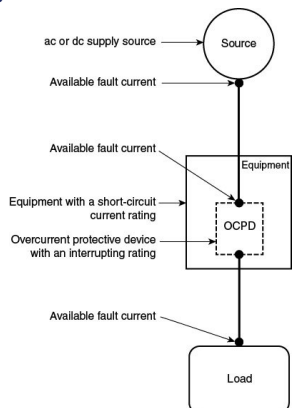
Public Input No. 161-NFPA 70E-2021 [Definition: Fault Current, Available.]

Fault Current, Available.

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

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

Figure 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 Input

Revised Informational Note to comply with new 2020 NEC Style Manual.

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

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Submittal Date: Sun May 23 11:16:47 EDT 2021
Committee: EEW-AAA

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

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

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

Statement of Problem and Substantiation for Public Input

Revised Informational Note to comply with new 2020 NEC Style Manual.

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

Submitter Information Verification

Submitter Full Name: Louis Barrios
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Submittal Date: Sun May 23 11:19:17 EDT 2021
Committee: EEW-AAA

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

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

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

Statement of Problem and Substantiation for Public Input

standards towards an ANSI standards development process.

Now, years later, a large majority of UL Standards are ANSI approved and follow the ANSI development and maintenance process. However, sometimes readers are confused because they don't understand the standards are actually UL standards, not developed by ANSI. There are many other references to standards promulgated by other standards development organizations where they are considered ANSI approved but do not include ANSI in the reference.

The terms "Standard for" or "Subject" are redundant and unnecessary. All references to UL are standards.

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 263-NFPA 70E-2021 [Section No. A.3.11]	

Submitter Information Verification

Submitter Full Name: Kelly Nicolello
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Submittal Date: Mon May 31 12:50:43 EDT 2021
Committee: EEW-AAA

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

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

Statement of Problem and Substantiation for Public Input

Add "(Solidly Grounded)" to definition title.

2.2.2.3.1 of the new 2020 NEC Style Manual requires defined terms that have subparts per 2.2.2.3 shall then appear in parentheses as it would be found in the document.

Submitter Information Verification

Submitter Full Name: Louis Barrios

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Submittal Date: Sun May 23 10:28:23 EDT 2021

Committee: EEW-AAA

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

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

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

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

Statement of Problem and Substantiation for Public Input

Add "(Equipment Grounding Conductor)" to definition title.

2.2.2.3.1 of the new 2020 NEC Style Manual requires defined terms that have subparts per 2.2.2.3 shall then appear in parentheses as it would be found in the document.

Submitter Information Verification

Submitter Full Name: Louis Barrios

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Submittal Date: Sun May 23 10:29:59 EDT 2021

Committee: EEW-AAA

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

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

Statement of Problem and Substantiation for Public Input

Add "(Condition of Maintenance)" to definition title.

2.2.2.3.1 of the new 2020 NEC Style Manual requires defined terms that have subparts per 2.2.2.3 shall then appear in parentheses as it would be found in the document.

Submitter Information Verification

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Submittal Date: Sun May 23 10:31:56 EDT 2021

Committee: EEW-AAA

**Public Input No. 23-NFPA 70E-2020 [Definition: Risk Assessment.]****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 *electric shock risk assessment* are types of risk assessments.

Statement of Problem and Substantiation for Public Input

"electric" is added before "shock" to read "electric shock" to correlate with the use of "electric shock" in the definition of "electrical hazard" and Boundary, Restricted Approach as well as to clarify that the type of shock hazard being addressed is a shock hazard rather than others forms of shock such as where one would go into shock due to a severe injury or a reaction associated with fright.

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.

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

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 15-NFPA 70E-2020 [Definition: Shock Hazard.]	Related issue.

Submitter Information Verification

Submitter Full Name: Palmer Hickman
Organization: Electrical Training Alliance
Street Address:
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Submittal Date: Tue Dec 22 14:37:12 EST 2020
Committee: EEW-AAA



Public Input No. 15-NFPA 70E-2020 [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 electric 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 Input

"electric" is added to correlate with the use of "electric shock" in the definition of "electrical hazard" and Boundary, Restricted Approach as well as to clarify that the type of shock hazard being defined is a shock hazard rather than others forms of shock such as acoustical shock in Article 360 and Informative Annex R as related to an arc blast hazard, where one would go into shock due to a severe injury, or a reaction associated with fright. See the existing definitions where the phrase being proposed is presently used:

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.

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

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 16-NFPA 70E-2020 [Section No. 130.4]	related issue
Public Input No. 39-NFPA 70E-2020 [Annex R]	related issue
Public Input No. 30-NFPA 70E-2020 [Chapter 3]	related issue
Public Input No. 28-NFPA 70E-2020 [Section No. 130.7]	related issue
Public Input No. 16-NFPA 70E-2020 [Section No. 130.4]	
Public Input No. 17-NFPA 70E-2020 [Section No. 130.1]	
Public Input No. 18-NFPA 70E-2020 [Section No. 130.7(D)(1)]	
Public Input No. 19-NFPA 70E-2020 [Section No. 130.2(B)]	
Public Input No. 20-NFPA 70E-2020 [Section No. 110.5(I)(1)]	
Public Input No. 21-NFPA 70E-2020 [Section No. 110.6(C)]	
Public Input No. 22-NFPA 70E-2020 [Definition: Boundary, Limited Approach.]	
Public Input No. 23-NFPA 70E-2020 [Definition: Risk Assessment.]	
Public Input No. 24-NFPA 70E-2020 [Section No. 120.5]	
Public Input No. 26-NFPA 70E-2020 [Section No. 130.5(G)]	
Public Input No. 27-NFPA 70E-2020 [Section No. 130.7]	
Public Input No. 28-NFPA 70E-2020 [Section No. 130.7]	
Public Input No. 29-NFPA 70E-2020 [Section No. 250.2(B)]	
Public Input No. 30-NFPA 70E-2020 [Chapter 3]	
Public Input No. 31-NFPA 70E-2020 [Section No. C.1.1]	
Public Input No. 32-NFPA 70E-2020 [Section No. E.1]	
Public Input No. 33-NFPA 70E-2020 [Annex F]	
Public Input No. 34-NFPA 70E-2020 [Section No. H.3]	
Public Input No. 35-NFPA 70E-2020 [Section No. J.1]	
Public Input No. 36-NFPA 70E-2020 [Section No. I.1]	
Public Input No. 37-NFPA 70E-2020 [Annex K]	
Public Input No. 38-NFPA 70E-2020 [Annex O]	
Public Input No. 39-NFPA 70E-2020 [Annex R]	

Submitter Information Verification

Submitter Full Name: Palmer Hickman

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Submittal Date:	Tue Dec 22 13:55:13 EST 2020
Committee:	EEW-AAA

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

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

Statement of Problem and Substantiation for Public Input

Add "(Isolating Switch)" to definition title.

2.2.2.3.1 of the new 2020 NEC Style Manual requires defined terms that have subparts per 2.2.2.3 shall then appear in parentheses as it would be found in the document.

Submitter Information Verification

Submitter Full Name: Louis Barrios
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Affiliation: American Petroleum Institute
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Submittal Date: Sun May 23 10:34:02 EDT 2021
Committee: EEW-AAA

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

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

Statement of Problem and Substantiation for Public Input

Add "(Metal-Clad Switchgear)" to definition title.

2.2.2.3.1 of the new 2020 NEC Style Manual requires defined terms that have subparts per 2.2.2.3 shall then appear in parentheses as it would be found in the document.

Submitter Information Verification

Submitter Full Name: Louis Barrios

Organization: Shell Global Solutions

Affiliation: American Petroleum Institute

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Zip:

Submittal Date: Sun May 23 10:35:36 EDT 2021

Committee: EEW-AAA

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

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

Statement of Problem and Substantiation for Public Input

Add "(Metal-Enclosed Switchgear)" to definition title.

2.2.2.3.1 of the new 2020 NEC Style Manual requires defined terms that have subparts per 2.2.2.3 shall then appear in parentheses as it would be found in the document.

Submitter Information Verification

Submitter Full Name: Louis Barrios

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Affiliation: American Petroleum Institute

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Submittal Date: Sun May 23 10:36:49 EDT 2021

Committee: EEW-AAA

**Public Input No. 356-NFPA 70E-2021 [Definition: Unqualified Person.]****Unqualified Person.**

A person who is not a qualified person

A person who, during the course of their normal daily work activity, may reasonably be expected to face risk of injury due to exposure to electrical hazards, that have little or no training in identifying the hazards and reduce the associated risk .

Statement of Problem and Substantiation for Public Input

The existing definition does not provide information on who the person is, only who they are not. The proposed definition is more useful in determining who an Unqualified Person is by more clearly stating the reason(s) for not being a Qualified Person.

Submitter Information Verification

Submitter Full Name: David Pace

Organization: Olin Corporation

Affiliation: Self

Street Address:

City:

State:

Zip:

Submittal Date: Tue Jun 01 15:58:01 EDT 2021

Committee: EEW-AAA

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

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

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

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

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

Statement of Problem and Substantiation for Public Input

Add "(Nominal Voltage)" to definition title.

2.2.2.3.1 of the new 2020 NEC Style Manual requires defined terms that have subparts per 2.2.2.3 shall then appear in parentheses as it would be found in the document.

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Submittal Date: Sun May 23 10:38:36 EDT 2021

Committee: EEW-AAA

**Public Input No. 88-NFPA 70E-2021 [Definition: Voltage, Nominal.]****Voltage, Nominal.**

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 Input

Informational Note 3 under the definition of "Voltage, Nominal" should be deleted to avoid conflicts and confusion with respect to Nominal Voltage definition for battery or cell systems in Section 320.2 (Definitions for Battery and Battery Rooms) where the following definition is found: -----

"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." -----

Such a change will also harmonize with current and proposed revisions for NFPA 70 (NEC).

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 90-NFPA 70E-2021 [Definition: Nominal Voltage.]	related definitions
Public Input No. 90-NFPA 70E-2021 [Definition: Nominal Voltage.]	

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Committee: EEW-AAA

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

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

Informational Note: - ~~Incident energy increases as the distance from the arc source decreases.~~ See 130.5(C)(1) for further information. - ~~Incident energy increases as the distance from the arc source decreases.~~

Statement of Problem and Substantiation for Public Input

TerraView error. Note the only change is relocating the reference to 130.5(C)(1) to the beginning of the Informational Note.

Revised Informational Note to comply with new 2020 NEC Style Manual.

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

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Committee: EEW-AAA

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

Intentionally coming in contact with energized electrical conductors or circuit parts with the hands, feet, or other body parts, with tools, probes, or with test equipment, regardless of the personal protective equipment (PPE) a person is wearing.- ~~There are two categories of "working on":~~ *Diagnostic (testing)* ~~is 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.~~ *Repair* ~~is any physical alteration of electrical equipment, conductors, or circuit parts (such as making or tightening connections, removing or replacing components, etc.).~~ _

Statement of Problem and Substantiation for Public Input

Only the first sentence is retained as it clear as written. The remainder of the definition is deleted as the "two categories" are unnecessary to the application of the definition. These "two categories" also introduce unnecessary confusion into the definition. These "two categories" also introduce requirements into the definition which is prohibited by 2.2.2.2 of the NEC Style Manual.

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Submittal Date: Mon Feb 22 11:51:30 EST 2021

Committee: EEW-AAA

**Public Input No. 251-NFPA 70E-2021 [New Definition after Definition: Electrically Safe Work Con...]****TITLE OF NEW CONTENT**

Employee (Person) In Charge: A qualified person responsible for completing an electrical task, and of the safety of assigned workers.

Statement of Problem and Substantiation for Public Input

The terms "Employee in Charge" (EIC) or "Person in Charge" (PIC) is used 28 times in 70E®. Even though it is used that much, 70E® does not define the term. Article 100, "Definitions" in 70E® states in the "Scope [that] [t]his article contains only those definitions essential to the proper application of this standard....only those terms that are used in two or more articles are defined in Article 100."

Since it is undefined in the standard, people tend to self-define or interpret the role as they may understand it in a situation which leads to varying notions of how the role is applied. Having a clear definition of the role of the "Employee in Charge" or "Person in Charge" will enhance the execution of electrical work in a safe manner, in various situations including hazardous energy control.

Because some may judge there are prolific definitions in the standard, I propose a clear and concise one:

Employee (Person) In Charge: A qualified person responsible for completing an electrical task, and of the safety of assigned workers.

In large electrical installations and in a lineup of identical equipment, it is easy to become overwhelmed with the size and breadth of the equipment and area as well as getting confused on which equipment to work on. To compensate, people may narrow their focus and lose touch with the big picture.

70E® states the following in Annex Q: "The amount of attentional resource required to perform a task satisfactorily defines the mental workload for an individual and is inversely proportional to the individual's familiarity with the task. An increase in knowledge, skill, and experience with a task decreases the level of attentional resources required to perform that task and therefore decreases the level of attentional resource allocated to that task....[On the other hand,] critical points in activities when risk is higher (increased likelihood of harm or increased severity of harm, or both) require an increased allocation of attentional and intentional resources."

This means that a Qualified Person possessing a great deal of familiarity with a task may not pay enough attention to the task to do it safely. A Qualified Person with little familiarity with a task may have an increased level of attentional resources required to perform the task. They may be so focused as to ignore the "bigger picture" of the environment or context of the task. Either person is likely to ignore an existing unsafe situation, which leads to the need for a person with an overall view of the work area and the workers' tasks.

Allison Haluik in her paper entitled "Risk Perception and Decision Making in Hazard Analysis: Improving Safety for the Next Generation of Electrical Workers" states the following:

"People tend to become focused on the task at hand and ignore outside information that they consciously or subconsciously feel is [ir]relevant. If a person is focused on the work to be done, it takes conscious effort to take a step back and identify all the hazards that may exist and take the appropriate measures to mitigate risk. People all too often will focus on the immediate task and may miss [pertinent] information."

"When completing a risk assessment....[a] person may believe they are consciously and analytically assessing risk based on available evidence, without realizing that their subconscious mind and emotions are coloring their perception."

"If a previously unidentified hazard is encountered during the planning or execution of a task...[there needs to be a] willingness [and obligation] to stop work, reevaluate the situation [to ensure no additional controls are needed, or develop a path forward incorporating new controls (when necessary) to be understood and implemented] by all people involved."

The above paragraphs highlight the need to have a person outside of those actively involved in the task while holding responsibility for the big picture, to be the "coach" providing guidance to the workers. It is all too common for people performing the work to develop "tunnel vision".

Many factors could be considered when evaluating risk. Certain factors could increase the severity of the actual hazard, whereas other factors could increase or decrease the likelihood of occurrence. This is key to keeping focus of the "big picture" If an EIC or PIC can assist the workers to breakdown factors that affect risk, three categories can be identified: Condition of the Work and Worker, Condition of the Environment, and Condition of the Equipment. See 70E® Annex Q for a sample of the essential factors to consider when performing risk assessment, both during the initial planning stages, validating the controls, and when re-evaluating change in conditions during the job. There needs to be an independent body, an EIC or a PIC, above the fray, without personal investment in actual work, to compliment and assist those with firsthand knowledge of the work activities.

Management personal concerned with the completion of the task may approach the work area to confirm the status of the work regarding completion. They may not have the appropriate controls in place needed to penetrate the various boundaries or are cognizant of the hierarchy to which electrical work should be performed. The EIC can make certain management personnel complies with controls identified and ensure proper personal protection equipment is available. This offers an environment where the workers can continue to perform their tasks without being distracted by others.

Only a fully qualified person can fill the role of an EIC. As stated above, an EIC oversees completing an electrical task and the safety of assigned workers. This means that a management supervisor who might NOT be a qualified person cannot act in the role of an EIC.

A team of electrical workers is much like a football team. Various tasks are assigned to different people on an electrical team, much like various tasks are assigned to each position on a football team. The coach has overall responsibility of how the game is played. The

coach is not involved with the field action, does not carry the ball, does not block or tackle, and yet, he influences the game by calling and directing the plays. The coach keeps the "big picture" in mind the whole game.

Just like the football coach, the EIC has overall responsibility of how the task is accomplished, with particular attention to safety. The EIC is not involved in work activities, does not handle tools, does not test the circuit for energy, among other activities, yet the task would not run safely without the EIC providing direction and guidance to the workers' actions.

The person that is functioning in the EIC role avoids being distracted. That means they avoid interacting with their mobile phone, handling tools and general chatting with others during the task, etc. Since the role of the EIC is much like the role of a football coach, they need to be focused on the task, identifying, and directing the appropriate steps to complete the task, paying attention to the changes in condition of the worker(s); equipment; the environment while reducing distraction.

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Committee: EEW-AAA

**Public Input No. 13-NFPA 70E-2020 [New Definition after Definition: Motor Control Center.]****Normal Operating Condition.**

A normal operating condition exists when all of the following conditions are satisfied:

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

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

Statement of Problem and Substantiation for Public Input

The term, normal operating condition, is a description of equipment operation. The term is defined by the explanation of what that means. Since the term is used in at least two articles (110,130) it meets the criteria for inclusion in Article 100 as a definition. The definition is in the description of what normal operation condition means.

Having the term defined in Article 100, means it would no longer be required to list what the term means in the text. The term electrical safe work condition is used in the standard, but it is not explained every time it is used that it means 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; because it is a definition. The same should be true for the term normal operating condition.

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Committee: EEW-AAA

**Public Input No. 298-NFPA 70E-2021 [New Definition after Definition: Outlet.]**

Normal operation. To cause electrical equipment to function within the manufacturer's and engineered system's specified design and operational parameters.

Informational note: An example of normal operation includes but is not limited to causing the current carrying contacts of electrical equipment such as a circuit breaker, switch, or contactor to open or close either manually or automatically by means of the equipment operating mechanism or controls.

Statement of Problem and Substantiation for Public Input

In accordance with 110.3(D) "Normal operation of electric equipment shall be permitted where a normal operating condition exists." The phrase "normal operation" is pivotal to the application of this requirement and without a definition or an informational note the user is left to subjectively interpret intent.

The proposed definition was adopted by and appears in CSA Z462-2021 Workplace electrical safety. The Z462 Technical Committee arrived at this definition by examining definitions of the two words and then by consulting other similar uses of the phrase

Definitions of "operate" and "normal":

Normal (adjective) – conforming to a type, standard, or regular pattern; according with, constituting, or not deviating from a norm, rule, or principle

Source: Merriam Webster [<https://www.merriam-webster.com/dictionary/normal>]

Operate (transitive verb) – to cause to function; to put or keep in operation

Source: Merriam Webster [<https://www.merriam-webster.com/dictionary/operate>]

Similar uses of the phrase "normal operation":

Normal operation (mechanical engineering) – The operation of a boiler or pressure vessel at or below the conditions of coincident pressure and temperature for which the vessel has been designed.

Source: McGraw-Hill Dictionary of Scientific & Technical Terms, 6E, Copyright © 2003 by The McGraw-Hill Companies, Inc.
<https://encyclopedia2.thefreedictionary.com/normal+operation>

"Normal operation" means functioning within ranges of pressure, temperature, flow, or other operating criteria required by this part.

Source: FEDERAL REGULATIONS AND PROCEDURES ADOPTED BY THE WISCONSIN DEPARTMENT OF TRANSPORTATION
https://docs.legis.wisconsin.gov/code/admin_code/trans/29_1.pdf

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Committee: EEW-AAA

**Public Input No. 10-NFPA 70E-2020 [New Definition after Definition: Panelboard.]****TITLE OF NEW CONTENT**

Type your content here ...

Add the following new definition:

Panelboard, Enclosed. A panelboard installed within a suitable cabinet, cutout box, or enclosure suitable for such an application.

Statement of Problem and Substantiation for Public Input

Panelboard is a defined term and is often misused to describe what is being proposed in this recommendation. For example, in the "Equipment" column in Table 130.7(C)(15)(a), the phrase "Panelboards or other equipment..." is actually referring to a panelboard installed inside the defined term "Cabinet" with a cover installed or a panelboard installed within an enclosure (also a defined term). This recommendation is based on the definition of "Enclosed Panelboard" from UL 67 and is intended to more accurately define what a panelboard installed inside an enclosure which is the intent of its meaning in Table 130.7(C)(15)(a), for example. A companion Public Input is being submitted to that table.

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 11-NFPA 70E-2020 [Section No. 130.7(C)(15)]	Related issue
Public Input No. 12-NFPA 70E-2020 [Section No. 130.5(C)]	Related issue
Public Input No. 11-NFPA 70E-2020 [Section No. 130.7(C)(15)]	
Public Input No. 12-NFPA 70E-2020 [Section No. 130.5(C)]	

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**Public Input No. 301-NFPA 70E-2021 [New Definition after Definition: Premises Wiring (System).]**

Procedure. A specified way to carry out an activity or a process.

Informational note: A procedure may be documented or not.

Statement of Problem and Substantiation for Public Input

Ensure consistent use throughout the document of a frequently used term. This definition is also found in ISO/FDIS 45001:2017(E) and in CSA Z462.

This is one of three parallel proposals to define the following frequently used terms in the document:

Procedure – 128 times

Process – 26 times

Program – 53 times

In previous editions of NFPA 70E these terms were used interchangeably. A 70E-2018 TC task force reviewed the use of these terms throughout the 2015 edition of NFPA 70E and provided 17 separate recommendations that were all acted on to align their use to be consistent with that found in other Standards.

During TC meetings for the 2021 edition, it was observed by the submitter that TC members were once again using the terms interchangeably, which caused several discussions about which term was correct given the context of the text being developed. Providing a definition for each term will guide the TC to make consistent use of these important terms.

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 302-NFPA 70E-2021 [New Definition after Definition: Premises Wiring (System).]	
Public Input No. 303-NFPA 70E-2021 [New Definition after Definition: Premises Wiring (System).]	
Public Input No. 302-NFPA 70E-2021 [New Definition after Definition: Premises Wiring (System).]	
Public Input No. 303-NFPA 70E-2021 [New Definition after Definition: Premises Wiring (System).]	

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Committee: EEW-AAA

**Public Input No. 302-NFPA 70E-2021 [New Definition after Definition: Premises Wiring (System).]**

Process. A set of interrelated or interacting activities which transforms inputs into outputs.

Statement of Problem and Substantiation for Public Input

Ensure consistent use throughout the document of a frequently used term. This definition is also found in ISO/FDIS 45001:2017(E) and in CSA Z462.

This is one of three parallel proposals to define the following frequently used terms in the document:

Procedure – 128 times

Process – 26 times

Program – 53 times

In previous editions of NFPA 70E these terms were used interchangeably. A 70E-2018 TC task force reviewed the use of these terms throughout the 2015 edition of NFPA 70E and provided 17 separate recommendations that were all acted on to align their use to be consistent with that found in other Standards.

During TC meetings for the 2021 edition, it was observed by the submitter that TC members were once again using the terms interchangeably, which caused several discussions about which term was correct given the context of the text being developed. Providing a definition for each term will guide the TC to make consistent use of these important terms.

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 301-NFPA 70E-2021 [New Definition after Definition: Premises Wiring (System).]	
Public Input No. 303-NFPA 70E-2021 [New Definition after Definition: Premises Wiring (System).]	
Public Input No. 301-NFPA 70E-2021 [New Definition after Definition: Premises Wiring (System).]	
Public Input No. 303-NFPA 70E-2021 [New Definition after Definition: Premises Wiring (System).]	

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Committee: EEW-AAA

**Public Input No. 303-NFPA 70E-2021 [New Definition after Definition: Premises Wiring (System).]**

Program. A documented set of interrelated requirements that direct activity toward a goal.

Statement of Problem and Substantiation for Public Input

Ensure consistent use throughout the document of a frequently used term. This definition is also found in CSA Z462 and in CSA Z1005. This is one of three parallel proposals to define the following frequently used terms in the document:

Procedure – 128 times

Process – 26 times

Program – 53 times

In previous editions of NFPA 70E these terms were used interchangeably. A 70E-2018 TC task force reviewed the use of these terms throughout the 2015 edition of NFPA 70E and provided 17 separate recommendations that were all acted on to align their use to be consistent with that found in other Standards.

During TC meetings for the 2021 edition, it was observed by the submitter that TC members were once again using the terms interchangeably, which caused several discussions about which term was correct given the context of the text being developed. Providing a definition for each term will guide the TC to make consistent use of these important terms.

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 301-NFPA 70E-2021 [New Definition after Definition: Premises Wiring (System).]	
Public Input No. 302-NFPA 70E-2021 [New Definition after Definition: Premises Wiring (System).]	
Public Input No. 301-NFPA 70E-2021 [New Definition after Definition: Premises Wiring (System).]	
Public Input No. 302-NFPA 70E-2021 [New Definition after Definition: Premises Wiring (System).]	

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Committee: EEW-AAA



Public Input No. 91-NFPA 70E-2021 [New Definition after Definition: Qualified Person.]

TASK QUALIFIED PERSON (New Definition)

One who has been trained in demonstrated skills and knowledge related to using equipment to verify the absence of voltage prior to diagnosing and/or locking out and tagging out a piece of electrical equipment.

Statement of Problem and Substantiation for Public Input

Currently, a qualified person is the only person that may confirm the absence of voltage per the procedures in Article 120 (and as stated in the definitions section and throughout the entire document). As the Technical Committee is likely aware, there are a number of devices that allow for checking and verifying absence of voltage from outside of a cabinet/panel. In fact, one manufacturer has a device in which a qualified person can simply press a button to verify absence of voltage. The process for verifying absence of voltage, especially with a device on the outside of a panel/cabinet, is the same every time. For this reason, it would be beneficial for a "task qualified" individual to be trained in the steps to use these devices to verify absence of voltage and therefore continue with their work.

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Committee: EEW-AAA

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

~~Chapter 4 covers electrical.~~ This article contains 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.

Statement of Problem and Substantiation for Public Input

Chapter 1 is changed to "This article".

2.2.1 of the new 2020 NEC Style Manual requires each article to have a scope, which shall be the first section of the article.

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Committee: EEW-AAA

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

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

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

Statement of Problem and Substantiation for Public Input

Revised Informational Note to comply with new 2020 NEC Style Manual.

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

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Submittal Date: Sun May 23 11:29:46 EDT 2021

Committee: EEW-AAA

**Public Input No. 59-NFPA 70E-2021 [Section No. 105.2]****105.2 Purpose.**

These practices and procedures are intended to provide a workplace that is essentially free from hazard for employee safety relative to electrical hazards in the workplace the employee .

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

Statement of Problem and Substantiation for Public Input

A workplace is never 'safe' and really should never be considered to be so. Electrocutions have occurred in 'electrically safe work conditions.' Workers who work on systems should always be aware that there are always risks. I have been a part of too many investigations where a worker got injured because the worker thought he/she was 'safe' and, in turn, was not looking for, or aware of, the hazards. The language i have proposed is in alignment with 90.1(B) of NFPA70.

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Submittal Date: Fri Mar 12 11:04:52 EST 2021

Committee: EEW-AAA



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

110.1 Scope

This article contains general requirements for electrical safety-related work practices including elements of an Electrical Safety Program.

Statement of Problem and Substantiation for Public Input

Add new section 110.1 Scope. Renumber subsequent sections.

2.2.1 of the new 2020 NEC Style Manual requires each article to have a scope, which shall be the first section of the article.

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Committee: EEW-AAA

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

Hazard elimination shall be the first priority in the implementation of safety-related work practices.

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 110.5(H)(3). ~~See Annex F for examples of hazard elimination.~~

Informational Note No. 2: ~~An~~ See 120.5 for requirements to establish an electrically safe work condition for the period of time for which the state is maintained. See Informative Annex F for information regarding the hierarchy of risk control and hazard elimination. An electrically safe work condition is a state wherein all hazardous electrical conductors or circuit parts to which a worker might be exposed are placed and maintained in a de-energized state, for the purpose of temporarily eliminating electrical hazards. ~~See Article 120 for requirements to establish an electrically safe work condition for the period of time for which the state is maintained. See Informative Annex F for information regarding the hierarchy of risk control and hazard elimination.~~

Statement of Problem and Substantiation for Public Input

TerraView error. The only change is to relocate references to the front of the Informational Notes.

Revised Informational Note to comply with new 2020 NEC Style Manual.

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

General reference to Article 120 is changed to a specific reference to 120.5.

4.1.4 of the new 2020 NEC Style Manual prohibits references to entire articles.

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Committee: EEW-AAA

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

Hazard elimination shall

Electrically Safe Work Condition Policy.

An employer shall establish, document, and implement an electrically safe work condition policy that:

- (1) Requires hazard elimination to be the first priority in the implementation of safety-related work practices; and
- (2) Complies with 110 .3.

Informational Note No. 1: Elimination is the risk control method listed first in the hierarchy of risk control identified in 110.5(H)(3). See Annex F for examples of hazard elimination.

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

Statement of Problem and Substantiation for Public Input

This proposal is one of two parallel proposes to relocate and incorporate the requirements of 110.5(K) into 110.1. Combining the requirements eliminates redundancy and harmonizes with a “policy first and program second” structure that is common in other documents such as ISO and CSA standards.

When used in a standard the term “policy” generally refers to a statement of the overall intentions and direction of an organization related to a specific risk. (See ISO 45001). As such, a policy requirement should precede the electrical safety program requirements to inform and provide direction for the program.

This proposed revision is organizational in nature as it does not change existing requirements.

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
<u>Public Input No. 310-NFPA 70E-2021 [Section No. 110.5(K)]</u>	
<u>Public Input No. 310-NFPA 70E-2021 [Section No. 110.5(K)]</u>	

Submitter Information Verification

Submitter Full Name: Daniel Roberts

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Submittal Date: Tue Jun 01 12:28:27 EDT 2021

Committee: EEW-AAA

**Public Input No. 348-NFPA 70E-2021 [Section No. 110.1]****110.1 Priority.**

Hazard elimination shall be the first priority in the implementation of safety-related work practices.

Informational Note No. 1: Elimination is the risk control method listed first in the hierarchy of risk control identified in 110.5(H)(3). See Annex F for examples of hazard elimination.

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

Statement of Problem and Substantiation for Public Input

Establishing an electrically safe work condition is more appropriately described as an administrative control method. It is very subject to human error and that needs to be considered and emphasized. In certain situations, tagout can be used without a lock to establish an electrically safe work condition.

Elimination is typically described in other documents as completely removing a hazard. An electrically safe work condition is a control method which can be compromised both during the process of establishing it and afterwards. Component failures, equipment malfunctions, etc. can result in exposure to electrical hazards even when using an electrically safe work condition. Temporarily controlling a hazard is not the same as completely removing it.

Deleting the wording as suggested will not decrease the need to establish an electrically safe work condition. It is an important method, just as is PPE which is used daily by many, even though it is the least effective method in the hierarchy. Aligning the concept that an electrically safe work condition is part of an administrative control method is a much better approach.

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 347-NFPA 70E-2021 [Definition: Electrically Safe Work Condition.]	
Public Input No. 368-NFPA 70E-2021 [Section No. F.3]	

Submitter Information Verification

Submitter Full Name: Paul Dobrowsky

Organization: Innovative Technology Services

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Submittal Date: Tue Jun 01 15:30:51 EDT 2021

Committee: EEW-AAA

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

Hazard elimination shall be the first priority in the implementation of safety-related work practices.

Informational Note No. 1: Elimination is the risk control method listed first in the hierarchy of risk control identified in 110.5(H)(3). See Informative Annex F for examples of hazard elimination.

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

Statement of Problem and Substantiation for Public Input

This recommendation revises "Annex F" to "Informative Annex F" to both make the informational note technically correct and clarify that this annex is informative only and therefore not mandatory per 90.4(D).

Submitter Information Verification

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Submittal Date: Mon Feb 22 13:19:28 EST 2021

Committee: EEW-AAA

**Public Input No. 64-NFPA 70E-2021 [Section No. 110.1]****110.1 Priority.**

Hazard elimination shall be the first priority in the implementation of safety-related work practices.

Informational Note No. 1: Elimination is the risk control method listed first in the hierarchy of risk control identified in 110.5(H)(3). See Annex F for examples of hazard elimination.

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

Statement of Problem and Substantiation for Public Input

This recommendation is to delete the first sentence of Informational Note No. 2 as it is a requirement or an interpretation and therefore prohibited. It very clearly states what an electrically safe work condition is and what the purpose of an electrically safe work condition is. This requirement or interpretation in this informational note is also unnecessary since the requirement and definition related to an electrically safe work condition is already clear without being restated in the informational note. Section 3.1.3 of the 2020 NEC Style Manual states: "Informational notes shall not be written in mandatory language and shall not contain requirements, make interpretations, or make recommendations."

Submitter Information Verification

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Submittal Date: Tue Mar 16 15:41:01 EDT 2021

Committee: EEW-AAA

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

Electrical conductors and circuit parts shall not be considered to be in an electrically safe work condition until all of the requirements of ~~Article 120 - have been met~~ .5 are met.

Safe work practices applicable to the circuit voltage and energy level shall be used ~~in accordance with Article 110 and Article 130~~ - until such time that electrical conductors and circuit parts are in an electrically safe work condition.

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

Statement of Problem and Substantiation for Public Input

General reference to Article 120 is changed to a specific reference to 120.5.
General references to Articles 110 and 130 are deleted.

4.1.4 of the new 2020 NEC Style Manual prohibits references to entire articles.

Submitter Information Verification

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Submittal Date: Sun May 23 16:18:29 EDT 2021
Committee: EEW-AAA

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

Electrical conductors and circuit parts shall not be considered to be in an electrically safe work condition until all of the requirements of Article 120- applicable steps of 120.5 have been met.

Safe work practices applicable to the circuit voltage and energy level shall be used in accordance with Article 110 and Article 130 until such time that electrical conductors and circuit parts are in an electrically safe work condition.

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

Statement of Problem and Substantiation for Public Input

By requiring all of Article 120 to have been met before circuit parts can be considered electrically safe to work on there has been some confusion as to whether or not certain employers can even meet this requirement. Currently, all of 120 must be met for an ESWC to be established, this includes how an employer's LOTO program is written. An employer's LOTO program must be unique to the type of work performed by that employer and a LOTO program might not need to meet all the requirements of Article 120 in order to be effective in controlling hazardous energy. A owner/operator electrical contractor might not have the need to develop the same type of complex LOTO program as a large industrial facility for example. Even though they follow a simple LOTO program to control the hazardous energy and accomplish all the applicable steps of 120.5, the equipment would not be considered in an electrically safe work state unless their LOTO program contained all the requirements for a complex LOTO procedure outlined in Article 120. It has been my understanding that an ESWC is about establishing a state in which the circuit parts have been de-energized, appropriate steps have been taken to ensure that re-energization doesn't take place without knowing, and the absence of voltage has been verified. As long as these three items are accomplished by meeting the steps in 120.5, the circuit parts are safe to work on. Also, this consideration should only apply to the steps in 120.5 that are applicable to the given situation. Not every switch permits easy visual verification of open blades and therefore should not be a required step in establishing an ESWC.

Submitter Information Verification

Submitter Full Name: Derek Vigstol

Organization: E Hazard

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Submission Date: Mon May 31 09:55:43 EDT 2021

Committee: EEW-AAA

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

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 have been met for placing the equipment in an electrically safe work condition based on the complexity and nature of each procedure to establish this condition .

Safe work practices applicable to the circuit voltage and energy level shall be used in accordance with Article 110 and Article 130 until such time that electrical conductors and circuit parts are in an electrically safe work condition.

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

Statement of Problem and Substantiation for Public Input

Not every procedure to establish an electrically safe work condition requires compliance with all of Article 120. For example, a simple LOTO procedure does not need to follow the rules for a complex LOTO. Yet, this requirement states that circuits parts are not considered to be in a safe condition to work on unless all of 120 is met. Does this mean that every LOTO procedure used to establish an ESWC must comply with the requirements for a complex LOTO? I don't believe that is the intent here. There has been confusion among those who must follow exactly what the words in the book say as to how they can comply with this statement. Clarifying how this is meant to apply can help eliminate confusion as to whether each individual LOTO procedure needs to comply with all of 120 or just the applicable requirements depending on the nature of the individual procedure.

Submitter Information Verification

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Submittal Date: Tue Jun 01 07:53:05 EDT 2021
Committee: EEW-AAA



Public Input No. 98-NFPA 70E-2021 [Section No. 110.2]

110.2– 2 please move back to section 130 referring to work involving electrical hazards for clarity. General.

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

Safe work practices applicable to the circuit voltage and energy level shall be used in accordance with Article 110 and Article 130 until such time that electrical conductors and circuit parts are in an electrically safe work condition.

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

Statement of Problem and Substantiation for Public Input

it is somewhat confusing to have moved the 130.1 section for work with electrical hazards into the general section 110.2. It had been in 130.1 I would recommend the General 110.2 in NFPA 70E-2021 and also 110.4 A thru D all be moved back to Section 130. Relocate 110.1-2021 work while exposed to electrical hazards back to 130 as well.

Submitter Information Verification

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Submittal Date: Sat May 08 11:47:40 EDT 2021

Committee: EEW-AAA

**Public Input No. 239-NFPA 70E-2021 [New Section after 110.3]**

110.3(3) Energized electrical work shall be performed in accordance with Article 130.

Statement of Problem and Substantiation for Public Input

Currently article 110.3 seems to slightly out of place since it speaks of energized work when an ESWC can't be established. By adding a new sub-step 110.3(3) that points the reader to article 130 for energized work specifics. This will direct readers from general requirements under article 110 to specifics under article 130 when an electrically safe work condition is not established.

Submitter Information Verification

Submitter Full Name: George Cole

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Submittal Date: Thu May 27 20:28:56 EDT 2021

Committee: EEW-AAA

**Public Input No. 111-NFPA 70E-2021 [Section No. 110.3]****110.3– Electrically Safe Work Condition.**

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.~~

Statement of Problem and Substantiation for Public Input

Section 110.3 is relocated to 110.4 as a general requirement with the existing content of 110.4 relocated as four exceptions to the general requirement.

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 110-NFPA 70E-2021 [Section No. 110.4]	Correlation
Public Input No. 110-NFPA 70E-2021 [Section No. 110.4]	

Submitter Information Verification

Submitter Full Name: Mark Christian
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Submission Date: Wed May 19 19:05:26 EDT 2021
Committee: EEW-AAA

**Public Input No. 252-NFPA 70E-2021 [Section No. 110.3]**

110.3 Electrically Safe Work Condition. This section needs to be moved to Article 130 under Work Involving Electrical Hazards to avoid confusion.

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.

Statement of Problem and Substantiation for Public Input

This section and section 110.4 must be moved to Article 130. This is because Electrically Safe Work Condition, Energized Work and Energized Electrical Work Permit is Work Involving Electrical Hazards and it is not general requirement. Above all, all three sections must be together under same Article so that it will not mis-lead. Right now, it looks like Electrical Safe Work Condition and Energized Work is just a General Requirement and does not require Energized Electrical Work Permit.

Submitter Information Verification

Submitter Full Name: Namgay Tshering

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Submittal Date: Mon May 31 04:22:07 EDT 2021

Committee: EEW-AAA

**Public Input No. 256-NFPA 70E-2021 [Section No. 110.3]****110.3 Electrically Safe Work Condition.**

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: Where it can be demonstrated that the work being performed is in accordance with 110.4, an electrically safe work condition shall not be required.

Statement of Problem and Substantiation for Public Input

There is confusion by some individuals trying to apply NFPA 70E in the field since 110.4 and 110.3 are separate sections from each other. 110.4 permits energized work when it can be demonstrated that the work involves one of the listed conditions, however, there is no permission to be within the limited approach boundary without establishing an electrically safe work condition. This exception will help to clarify that an ESWC is not required if, and only if, one of the conditions of 110.4 has been demonstrated.

Submitter Information Verification

Submitter Full Name: Derek Vigstol

Organization: E Hazard

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Submittal Date: Mon May 31 10:49:38 EDT 2021

Committee: EEW-AAA

**Public Input No. 354-NFPA 70E-2021 [Section No. 110.3]****110.3 Electrically Safe Work Condition.**

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.
- (3) Exception: An energized disconnecting means or isolating element shall be permitted to be operated, opened, closed, removed, or inserted to achieve an electrically safe work condition for connected equipment or to return connected 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 does not identify unacceptable risks for the task.

Statement of Problem and Substantiation for Public Input

The number (3) was automatically added by Terra and is not intended to be included.

A portion of the exception or some wording to allow equipment to be operated as part of establishing an electrically safe work condition needs to be added back into the standard. Ideally all equipment will be properly maintained but unfortunately that is often not the case. This leaves many in a situation where they would literally need to have a utility outage before being able to establish an electrically safe work condition. Most are ignoring that concept. When the exception was deleted, it was argued that that the normal operation concept could be used. Some equipment does not have doors or covers, and for others there is no documentation of maintenance.

Submitter Information Verification

Submitter Full Name: Paul Dobrowsky

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Submittal Date: Tue Jun 01 15:50:11 EDT 2021

Committee: EEW-AAA

**Public Input No. 61-NFPA 70E-2021 [Section No. 110.3]****110.3 Electrically Safe Work Condition.**

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 otherwise permitted in this Standard, 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.

Statement of Problem and Substantiation for Public Input

As written, 110.3 does not allow an absence of voltage test, diagnostic work, or work that requires an EEWP.

Submitter Information Verification

Submitter Full Name: Eric Stromberg

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Affiliation: Self

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Submittal Date: Fri Mar 12 11:54:48 EST 2021

Committee: EEW-AAA

**Public Input No. 110-NFPA 70E-2021 [Section No. 110.4]****110.4– Energized- 4 Electrically Safe Work Condition .****(A)– Additional Hazards or Increased Risk.**

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: 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.

(B)– Infeasibility.

Exception No. 2: 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.

(C)– Equipment Operating at Less Than 50 Volts.

Exception No. 3: 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.

(D)– Normal Operating Condition.

Exception No. 4: Normal operation of electric equipment shall be permitted where a normal operating condition exists. A normal operating condition exists when all of the following conditions are satisfied:

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

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

Statement of Problem and Substantiation for Public Input

The four conditions presently in 110.4 are exceptions to what is presently in 110.3. This editorial relocation of what is presently in 110.3 as parent text in 110.4 is intended to reinforce that establishing an electrically safe work condition is the primary safety-related work practice that is to be followed and that the four conditions where energized work is permitted are exceptions to the rule.

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 111-NFPA 70E-2021 [Section No. 110.3]	Correlation
Public Input No. 111-NFPA 70E-2021 [Section No. 110.3]	

Submitter Information Verification

Submitter Full Name: Mark Christian
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Submittal Date: Wed May 19 18:52:03 EDT 2021

Committee: EEW-AAA

**Public Input No. 240-NFPA 70E-2021 [Section No. 110.4]****110.4 Energized Work.****(A) Additional Hazards or Increased Risk.**

Energized work shall be permitted where the employer can demonstrate that de-energizing introduces additional hazards or increased risk.

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

(B) Infeasibility.

Energized work shall be permitted where the employer can demonstrate that the task to be performed is infeasible in a de-energized state due to equipment design or operational limitations.

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

(C) Equipment Operating at Less Than 50 Volts.

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

(D) Normal Operating Condition.

Normal operation of electric equipment shall be permitted where a normal operating condition exists. A normal operating condition exists when all of the following conditions are satisfied:

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

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

Statement of Problem and Substantiation for Public Input

The information in article 110.4 Energized Work is out of place where it is currently located. It contains specific information for energized electrical work which really needs to be located in article 130. The 2018 version of 70E was laid out in this form which made perfect sense. However by moving it to article 110 in the 2021 version is confusing and out of place.

Submitter Information Verification

Submitter Full Name: George Cole
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Submittal Date: Thu May 27 20:40:03 EDT 2021
Committee: EEW-AAA



Public Input No. 253-NFPA 70E-2021 [Section No. 110.4]

110.4 Energized Work. This section and section 110.3 must be moved to Article 130. This is because Electrically Safe Work Condition, Energized Work and Energized Electrical Work Permit is Work Involving Electrical Hazards and it is not general requirement. Above all, all three sections must be together under same Article so that it will not mis-lead. Right now, it looks like Electrical Safe Work Condition and Energized Work is just a General Requirement and does not require Energized Electrical Work Permit.

(A) Additional Hazards or Increased Risk.

Energized work shall be permitted where the employer can demonstrate that de-energizing introduces additional hazards or increased risk.

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

(B) Infeasibility.

Energized work shall be permitted where the employer can demonstrate that the task to be performed is infeasible in a de-energized state due to equipment design or operational limitations.

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

(C) Equipment Operating at Less Than 50 Volts.

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

(D) Normal Operating Condition.

Normal operation of electric equipment shall be permitted where a normal operating condition exists. A normal operating condition exists when all of the following conditions are satisfied:

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

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

Statement of Problem and Substantiation for Public Input

This section and section 110.3 must be moved to Article 130. This is because Electrically Safe Work Condition, Energized Work and Energized Electrical Work Permit is Work Involving Electrical Hazards and it is not general requirement. Above all, all three sections must be together under same Article so that it will not mis-lead. Right now, it looks like Electrical Safe Work Condition and Energized Work is just a General Requirement and does not require Energized Electrical Work Permit.

Submitter Information Verification

Submitter Full Name: Namgay Tshering

Organization: Tesco Controls, Inc.

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Submission Date: Mon May 31 04:36:33 EDT 2021

Committee: EEW-AAA

**Public Input No. 258-NFPA 70E-2021 [Section No. 110.4(A)]****(A) Additional Hazards or Increased Risk.**

Energized work shall be permitted where the employer can demonstrate that de-energizing introduces additional hazards or increased risk.

Informational Note No. 1 : 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.

Informational Note No. 2: Determining an emergency plan to mitigate the additional hazard or increased risk, if an unplanned shutdown due to an incident occurring during the course of energized work, often helps employers determine an alternate option to energized work.

Statement of Problem and Substantiation for Public Input

The justification for working on energized equipment because it would create an additional hazard or increased risk is often misapplied by those requesting the work. This puts contract employers and employees in a difficult position on whether or not to perform energized work. On one hand if they turn it down, they run the risk of the requester finding someone else to do the job that might not have the same safety mentality and culture within their organization. While I would love to see this justification removed completely as it has become very difficult these days to not find another way to do things, I feel that an informational note that promotes the idea of figuring out the back up plan first as it might show the way to do the work in an ESWC instead is a step in the right direction. For example, one reason that is often quoted as a need for energized work is the interruption of life support equipment in a healthcare setting. However, what happens when the employee drops a wrench and causes an arc flash? If the job planning stage did not identify what will be done should this happen, there will be an unplanned interruption of life support equipment and a massive scramble to save the individuals that were the reason for the energized work in the first place. However, if during the job planning stage, the question is asked about what do we do with these patients should there be an unplanned shutdown, a back up plan can be well thought out prior to the work beginning. That also raises the question, why couldn't that back up plan be put into action first? Then the work could be performed in an ESWC and it lowers the overall risk to all involved instead of putting the electrical workers at high risk and the patients at moderate risk. Giving guidance to workers that this back up plan could get them out of energized work would be a great step forward in clearing up the misapplication of this justification for energized work.

Submitter Information Verification

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Submittal Date: Mon May 31 11:03:07 EDT 2021

Committee: EEW-AAA

**Public Input No. 97-NFPA 70E-2021 [Section No. 110.4(A)]**

Move existing 110.4 (A) and (B) to new section 130.2 (B) and (C) and rename existing 130.2 (B) to (C) and existing 130.2 (C) to (D).

(A) Additional Hazards or Increased Risk.

Energized work shall be permitted where the employer can demonstrate that de-energizing introduces additional hazards or increased risk.

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

Statement of Problem and Substantiation for Public Input

All information related to allowing energized work should be located in the same section and 130.2 is the best location for requirements for energized work. It is not correct to have some information related to energized work in section 110.4 and some information related to energized work in section 130.2.

Submitter Information Verification

Submitter Full Name: Daryld Crow

Organization: DRC Consulting, Ltd.

Affiliation: DRC Consulting Inc.

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Submittal Date: Thu May 06 18:11:34 EDT 2021

Committee: EEW-AAA

**Public Input No. 273-NFPA 70E-2021 [Section No. 110.4(B)]****(B) Infeasibility.**

Energized work shall be permitted where the employer can demonstrate that the task to be performed is infeasible in a de-energized state due to equipment design or operational limitations.

Informational Note: Examples of work that might be performed within the limited approach boundary of exposed energized electrical conductors or circuit parts because of infeasibility due to equipment design or operational limitations include performing diagnostics and testing (for example, start-up or troubleshooting) of electric circuits that can only be performed with the circuit energized- ~~and work-~~ 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, and work on batteries or battery banks .

Statement of Problem and Substantiation for Public Input

Batteries and battery banks can not be worked on in an Electrically Safe Work Condition. We have expanded 70E, over the past few code cycles, to more fully include work on batteries. This change recognizes that it is infeasible to de-energize batteries.

Submitter Information Verification

Submitter Full Name: Lloyd Gordon

Organization: Los Alamos National Laboratory

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City:

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Submittal Date: Tue Jun 01 07:36:51 EDT 2021

Committee: EEW-AAA

**Public Input No. 114-NFPA 70E-2021 [Section No. 110.4(D)]****(D) Normal Operating Condition.**

Normal operation of electric equipment shall be permitted where a normal operating condition exists. A normal operating condition exists when all of the following conditions are satisfied:

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

Informational Note No. 1 : The phrase *properly installed* means that the equipment is installed in accordance with applicable industry codes and standards and the manufacturer's recommendations. The phrase *properly maintained* means that the equipment has been maintained in accordance with the manufacturer's recommendations and applicable industry codes and standards. The phrase *evidence of impending failure* means that there is evidence such as arcing, overheating, loose or bound equipment parts, visible damage, or deterioration.

Informational Note No. 2: Normal operation of some types of equipment might require qualified persons. See 110.6 (A)(1) through (4) for distinction between qualified and unqualified persons and required training.

Statement of Problem and Substantiation for Public Input

While it is fairly clear what constitutes a normal operating condition based on items (1) through (6) to 110.4(D), in the field there are very simple types of equipment that can be operated by both qualified and unqualified persons, such as some circuit breakers and disconnect switches. There are, however, other types of more sophisticated equipment that require much more knowledge and training to operate, which in some instances would necessitate a qualified person performing the "normal operation."

Submitter Information Verification

Submitter Full Name: Agnieszka Golriz

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Submittal Date: Thu May 20 14:23:26 EDT 2021

Committee: EEW-AAA

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

Normal operation of electric equipment shall be permitted where a normal operating condition exists. A normal operating condition exists when all of the following conditions are satisfied:

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

Informational Note: The phrase *properly installed* means that the equipment is installed in accordance with applicable industry codes and standards and the manufacturer's recommendations. The phrase *properly maintained* means that the equipment has been maintained in accordance with the manufacturer's recommendations and applicable industry codes and standards. The phrase *evidence of impending failure* means that there is evidence such as arcing, overheating, loose or bound equipment parts, visible damage, or deterioration. [Water contamination can also be a sign of impending failure.](#) [NEMA GD 1-2019, *Evaluating Water-Damaged Electrical Equipment*, is an example of a document that provides further information on evaluating electrical equipment that may have been exposed to water.](#)

Statement of Problem and Substantiation for Public Input

Water intrusion, and its resulting effects, are a leading contributor to premature electrical equipment failures and safety related issues. Clearly electrical equipment is not in a "normal operating condition" if it is, or has been, exposed to water contamination. Rather than create a new category, we propose additional guidance be added to the informational note that explains water contamination is evidence of "impending failure".

The readily available, free NEMA Publication titled "Evaluating Water-Damaged Electrical Equipment" includes guidelines and safety related information for working with electrical equipment that has been exposed to water, including visual observations, operational tests, and performance tests.

Submitter Information Verification

Submitter Full Name: Rodney West

Organization: Schneider Electric

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Submittal Date: Fri May 28 12:36:07 EDT 2021

Committee: EEW-AAA

**Public Input No. 343-NFPA 70E-2021 [Section No. 110.4(D)]****(D) Normal Operating Condition.**

~~Normal operation~~ Operation of electric equipment shall be permitted ~~where~~ under a normal operating condition ~~exists~~ . A normal operating condition exists when all of the following conditions are satisfied:

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

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

Statement of Problem and Substantiation for Public Input

Editorial corrections.

Submitter Information Verification

Submitter Full Name: Daleep Mohla

Organization: DCM Electrical Consulting Serv

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Submittal Date: Tue Jun 01 15:14:00 EDT 2021

Committee: EEW-AAA

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

Normal operation of electric equipment shall be permitted where a normal operating condition exists. A normal operating condition exists when all of the following conditions are satisfied:

- (1) The equipment is properly installed.
- (2) The equipment is properly maintained.
- (3) The equipment is rated for the available fault current and nominal voltage.
- (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: The phrase *properly installed* means that the equipment is installed in accordance with applicable industry codes and standards and the manufacturer's recommendations. The phrase *properly maintained* means that the equipment has been maintained in accordance with the manufacturer's recommendations and applicable industry codes and standards. The phrase *evidence of impending failure* means that there is evidence such as arcing, overheating, loose or bound equipment parts, visible damage, or deterioration.

Statement of Problem and Substantiation for Public Input

Insert a new list item (3) and reidentify the existing items as (4) through (7). No other changes are being proposed by this public input.

(3) The equipment is rated for the available fault current and nominal voltage

Equipment is often discovered as not being rated for the available fault current. Whether this is due to an improper initial installation, due to changes in energy sources, or any other reason it needs to be clear that it is not a normal operating condition. That concept might not be included in the manufacturers instructions or be considered under proper installation.

Submitter Information Verification

Submitter Full Name: Paul Dobrowsky

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Submittal Date: Tue Jun 01 15:58:20 EDT 2021

Committee: EEW-AAA

**Public Input No. 360-NFPA 70E-2021 [Section No. 110.4(D)]****(D) Normal Operating Condition.**

Normal operation of electric equipment shall be permitted where a normal operating condition exists. A normal operating condition exists when all of the following conditions are satisfied:

- (1) The equipment is properly installed.
- (2) The equipment is properly maintained.
- (3) The equipment is used in accordance with instructions included in the listing and labeling and in accordance with manufacturer's instructions.
- (4) The equipment doors are closed and secured.
- (5) All equipment covers are in place and secured.
- (6) There are no other factors that could affect the equipment condition such as age, operation outside of manufacturer's instructions or history of failures.
- (7) There is no evidence of impending failure.

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

Statement of Problem and Substantiation for Public Input

The factors included in the existing list are certainly important in determining normal operating condition but they do not include other important factors that are added by this PI. Failures have occurred under normal operating conditions due to these additional factors. Some examples are two at a site in Canada due to age, four at a site in Augusta, GA due to failures due to previous failures and many others due to operating outside manufacturer's instructions.

Submitter Information Verification

Submitter Full Name: David Pace

Organization: Olin Corporation

Affiliation: Self

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Submittal Date: Tue Jun 01 16:11:48 EDT 2021

Committee: EEW-AAA

**Public Input No. 62-NFPA 70E-2021 [Section No. 110.4(D)]****(D) Normal Operating Condition.**

Normal operation of electric equipment shall be permitted where a normal operating condition exists. A normal operating condition exists when all of the following conditions are satisfied:

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

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

Statement of Problem and Substantiation for Public Input

Replace "evidence" with "indications" and "impending" with "potential." Evidence has the connotation of something that has already occurred. "Impending" indicates something about to happen. This PI is simply looking for clarification as to the original intent.

Submitter Information Verification

Submitter Full Name: Eric Stromberg

Organization: Los Alamos National Laboratory

Affiliation: Self

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Submittal Date: Fri Mar 12 12:09:59 EST 2021

Committee: EEW-AAA

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

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

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

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

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

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

Statement of Problem and Substantiation for Public Input

Revised Informational Note to comply with new 2020 NEC Style Manual.

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

Submitter Information Verification

Submitter Full Name: Louis Barrios

Organization: Shell Global Solutions

Affiliation: American Petroleum Institute

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Submittal Date: Sun May 23 11:38:26 EDT 2021

Committee: EEW-AAA

**Public Input No. 63-NFPA 70E-2021 [Section No. 110.5(C)]****(C) Condition of Maintenance.**

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

Informational note: maintenance can be seen as having two categories: Safety related and reliability. Safety related maintenance is that which, if not performed and there is a resultant failure, will result in a shock or an arc flash event to the worker.

Statement of Problem and Substantiation for Public Input

Quite a bit of discussion took place at the last DOE EFCOG meeting concerning the scope of maintenance with which 70E was concerned. Fortunately, there was a former member of the 70E committee who was there and could explain to us the intent of 70E. It wasn't entirely clear before this. Chapter two indicates "...reducing the risk due to failure" but this does not explicitly point to shock or arc flash.

Submitter Information Verification

Submitter Full Name: Eric Stromberg
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Submittal Date: Fri Mar 12 12:28:27 EST 2021
Committee: EEW-AAA

**Public Input No. 167-NFPA 70E-2021 [Section No. 110.5(E)]****(E) Electrical Safety Program Principles.**

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

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

Statement of Problem and Substantiation for Public Input

Revised Informational Note to comply with new 2020 NEC Style Manual.

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

Submitter Information Verification

Submitter Full Name: Louis Barrios

Organization: Shell Global Solutions

Affiliation: American Petroleum Institute

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Submittal Date: Sun May 23 11:40:39 EDT 2021

Committee: EEW-AAA

**Public Input No. 168-NFPA 70E-2021 [Section No. 110.5(F)]****(F) Electrical Safety Program Controls.**

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

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

Statement of Problem and Substantiation for Public Input

Revised Informational Note to comply with new 2020 NEC Style Manual.

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

Submitter Information Verification

Submitter Full Name: Louis Barrios

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Submittal Date: Sun May 23 11:42:14 EDT 2021

Committee: EEW-AAA

**Public Input No. 169-NFPA 70E-2021 [Section No. 110.5(G)]****(G) Electrical Safety Program Procedures.**

An electrical safety program shall identify the procedures to be utilized before work is started by employees exposed to an electrical hazard.

Informational Note: - ~~For~~ See Informative Annex E for an example of a typical electrical safety program procedure, ~~see Informative Annex E~~ .

Statement of Problem and Substantiation for Public Input

Revised Informational Note to comply with new 2020 NEC Style Manual.

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

Submitter Information Verification

Submitter Full Name: Louis Barrios
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Submittal Date: Sun May 23 11:43:41 EDT 2021
Committee: EEW-AAA

**Public Input No. 170-NFPA 70E-2021 [Section No. 110.5(H)(1)]****(1) Elements of a Risk Assessment Procedure.**

The risk assessment procedure shall address employee exposure to electrical hazards and shall identify the process to be used before work is started to carry out the following:

- (1) Identify hazards
- (2) Assess risks
- (3) Implement risk control according to the hierarchy of risk control methods

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

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

Statement of Problem and Substantiation for Public Input

Revised Informational Note to comply with new 2020 NEC Style Manual.

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

Submitter Information Verification

Submitter Full Name: Louis Barrios
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Submittal Date: Sun May 23 11:45:24 EDT 2021
Committee: EEW-AAA

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

The risk assessment procedure shall address the potential for human error and its negative consequences on people, processes, the work environment, and equipment relative to the electrical hazards in the workplace.

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

Statement of Problem and Substantiation for Public Input

Revised Informational Note to comply with new 2020 NEC Style Manual.

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

Submitter Information Verification

Submitter Full Name: Louis Barrios
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Submittal Date: Sun May 23 11:46:48 EDT 2021
Committee: EEW-AAA

**Public Input No. 172-NFPA 70E-2021 [Section No. 110.5(l)(1)]****(1) Job Safety Planning.**

The job safety plan shall be in accordance with the following:

- (1) Be completed by a qualified person
- (2) Be documented
- (3) Include the following information:
 - (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

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

Statement of Problem and Substantiation for Public Input

TerraView error. The only change is to relocate reference in Informational Note to the front.

Revised Informational Note to comply with new 2020 NEC Style Manual.

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

Submitter Information Verification

Submitter Full Name: Louis Barrios

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Submittal Date: Sun May 23 11:54:12 EDT 2021

Committee: EEW-AAA



Public Input No. 20-NFPA 70E-2020 [Section No. 110.5(l)(1)]

(1) Job Safety Planning.

The job safety plan shall be in accordance with the following:

- (1) Be completed by a qualified person
- (2) Be documented
- (3) Include the following information:
 - (4) A description of the job and the individual tasks
 - (5) Identification of the electrical hazards associated with each task

A

- a. An electric shock risk assessment in accordance with 130.4 for tasks involving

a

- a. an electric shock hazard
- b. An arc flash risk assessment in accordance with 130.5 for tasks involving an arc flash hazard
- c. Work procedures involved, special precautions, and energy source controls

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

Statement of Problem and Substantiation for Public Input

"electric" is added before "shock" to read "electric shock" in two locations to correlate with the use of "electric shock" in the definition of "electrical hazard" and Boundary, Restricted Approach as well as to clarify that the type of shock hazard being addressed is a shock hazard rather than others forms of shock such as where one would go into shock due to a severe injury or a reaction associated with fright.

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.

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

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 15-NFPA 70E-2020 [Definition: Shock Hazard.]	Related issue.

Submitter Information Verification

Submitter Full Name: Palmer Hickman

Organization: Electrical Training Alliance

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City:

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Submittal Date: Tue Dec 22 14:30:47 EST 2020

Committee: EEW-AAA

**Public Input No. 259-NFPA 70E-2021 [Section No. 110.5(l)(1)]****(1) Job Safety Planning.**

The job safety plan shall be in accordance with the following:

- (1) Be completed by a qualified person
- (2) Be documented
- (3) Include the following information:
 - (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) Emergency response plan in the event of an incident occurrence

Informational Note No 1 : For an example of a job safety planning checklist see Figure I.2.

Informational Note No. 2: Emergency response plans help to minimize confusion during rescue operations for employees involved in electrical incidents as well as others that are affected by the results of an electrical incident, such as a patient on life support during an unplanned shutdown following an arc flash incident.

Statement of Problem and Substantiation for Public Input

Adding a new item (F) and informational note to require that during the job planning stage the plan includes an emergency response action plan. Often during energized work, the consideration for what action to take during an incident has not been accounted for. This leads to a state of confusion when things go wrong and employees have to make split second decisions that could mean life or death. Having a back up plan for what will happen if things go wrong helps the workers be prepared for the action they will take during a worst case scenario. This plan also helps them to propose alternative ways to accomplish the task as opposed to energized work. If a back up plan for what to do when there is no power is well thought out before the work begins, why not make that the primary plan and do the work in an ESWC? An emergency response plan also helps determine how to respond to an employee involved in an electrical incident and should be determined prior to the event.

Submitter Information Verification

Submitter Full Name: Derek Vigstol

Organization: E Hazard

Street Address:

City:

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Submittal Date: Mon May 31 11:32:32 EDT 2021

Committee: EEW-AAA

**Public Input No. 173-NFPA 70E-2021 [Section No. 110.5(l)(3)]****(3) Change in Scope.**

Additional job safety planning and job briefings shall be held if changes occur during the course of the work that might affect the safety of employees.

Informational Note: - For See Figure 1.1 for an example of a job briefing checklist, ~~see Figure 1.1.~~

Statement of Problem and Substantiation for Public Input

Revised Informational Note to comply with new 2020 NEC Style Manual.

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

Submitter Information Verification

Submitter Full Name: Louis Barrios

Organization: Shell Global Solutions

Affiliation: American Petroleum Institute

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City:

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Submittal Date: Sun May 23 11:56:18 EDT 2021

Committee: EEW-AAA

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

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

~~An electrical safety program shall include an electrically safe work condition policy that complies with 110.3 .~~

Statement of Problem and Substantiation for Public Input

This proposal is one of two parallel proposes to relocate and incorporate the requirements of 110.5(K) into 110.1. Combining the requirements eliminates redundancy and harmonizes with a “policy first and program second” structure that is common in other documents such as ISO and CSA standards.

When used in a standard the term “policy” generally refers to a statement of the overall intentions and direction of an organization related to a specific risk. (See ISO 45001). As such, a policy requirement should precede the electrical safety program requirements to inform and provide direction for the program.

This proposed revision is organizational in nature as it does not change existing requirements.

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 306-NFPA 70E-2021 [Section No. 110.1]	
Public Input No. 306-NFPA 70E-2021 [Section No. 110.1]	

Submitter Information Verification

Submitter Full Name: Daniel Roberts

Organization: Electrical Safety Solutions

Street Address:

City:

State:

Zip:

Submittal Date: Tue Jun 01 12:33:59 EDT 2021

Committee: EEW-AAA

**Public Input No. 264-NFPA 70E-2021 [New Section after 110.5(L)]****(M) Employee Training**

An electrical safety program shall identify the appropriate training and type of training that employers shall provide employees in accordance with 110.6 based on employee job function and risk exposure level.

Statement of Problem and Substantiation for Public Input

Section 110.6 requires an employer to provide training to employees and is divided between what training a qualified person must have and what training an unqualified person must have. However, there is no requirement to include this in an employer's electrical safety program. This often leads to a determination being made as to what training employees are given being made by human resource departments that have little to no knowledge of what electrical safety training needs to entail. By having a section within an electrical safety program list out the specific training that each employee needs to undergo based on their role within the company, HR personnel making this determination have a plan spelled out as to what training they must provide any given employee. This also helps to guide them as to what type of training to provide so as to avoid a situation where a decision is made that is not in alignment with what is required. For example, many companies have embraced self-paced online training as a way to deliver information to employees. While OSHA has stated that this type of training can be a valuable component, it can not be the only training provided when it comes to safety. There have been multiple OSHA letters of interpretation speaking to this issue. If an employer is unaware of this issue they often take the path of least resistance and only provide self-paced online training. Spelling this out in the ESP would provide a better level of training where it is needed.

Submitter Information Verification

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Submittal Date: Mon May 31 12:52:41 EDT 2021

Committee: EEW-AAA

**Public Input No. 219-NFPA 70E-2021 [Section No. 110.5(M)(3)]****(3) Lockout/Tagout Program and Procedure Audit.**

The lockout/tagout program and procedures required by ~~Article 120~~ - shall .1 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

Statement of Problem and Substantiation for Public Input

General reference to Article 120 is changed to a specific reference to 120.1

4.1.4 of the new 2020 NEC Style Manual prohibits references to entire articles.

Submitter Information Verification

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Submittal Date: Sun May 23 16:39:12 EDT 2021

Committee: EEW-AAA



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

(1) Qualified Person.

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

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

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

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

- (4) Skills and techniques necessary to distinguish exposed energized electrical conductors and circuit parts from other parts of electrical equipment
- (5) Skills and techniques necessary to determine the nominal voltage of exposed energized electrical conductors and circuit parts
- (6) 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
- (7) Decision-making process necessary to be able to do the following:
 - (8) Perform the job safety planning
 - (9) Identify electrical hazards
 - (10) Assess the associated risk
 - (11) Select the appropriate risk control methods from the hierarchy of controls identified in 110.5(H)(3), including PPE

(l) 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.

(m) 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.

(n) 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.

Statement of Problem and Substantiation for Public Input

Only the wording in (A)(1)(a) is proposed to be changed by this public input.

Many employers have "task qualified" individuals to perform specific jobs. They are not typically electricians, designers or engineers but if they are trained to have the necessary knowledge and possess the skills to specific tasks than can be considered qualified for that task. Many such individuals will never need to use insulating or shield materials, or test instruments. Relocating the word "applicable" as suggested improves the wording and makes it clear that not all qualified persons need to be familiar with techniques they will likely never need to use.

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Submission Date: Tue Jun 01 15:34:49 EDT 2021

Committee: EEW-AAA



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

(1) Qualified Person.

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

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

(b) A person ~~can shall~~ be considered qualified with respect to certain qualified for specific equipment and tasks ~~but still be unqualified for 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 110.5(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.

Statement of Problem and Substantiation for Public Input

This PI is submitted on behalf of the TC task group appointed by the chair of NFPA 70E. This PI addresses use of mandatory language in this section and makes edits to conform to the NEC Style Manual.

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Submission Date: Thu May 06 09:28:41 EDT 2021

Committee: EEW-AAA

**Public Input No. 271-NFPA 70E-2021 [Section No. 110.6(A)(4)]****(4) Type of Training.**

~~The training required by 110.6(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. The training required by 110.6(A) shall consist of one or a combination of the following types:~~

- ~~(1) Instructor-led classroom training~~
- ~~(2) On-the-job training~~
- ~~(3) Self-paced electronic training in combination with (1), (2), or both~~

Informational Note:

~~Classroom training can include interactive electronic or interactive web-based training components~~

~~Instructor-led classroom training includes in-person and live virtual training where learners have the ability to interact with the instructor in real time during the training event .~~

Statement of Problem and Substantiation for Public Input

The COVID-19 pandemic has forced many companies to find alternative solutions for employee training due to an inability to host in-person events. Many embraced both self-paced online training and live virtual instructor-led training during this time. While in-person instructor-led training has been the industry standard for many years and will continue to be for years to come, this standard needs to address the alternative methods of training as well. The informational note that was added last cycle has added confusion as to what "interactive" consists of. Those who want to push online learning often see their training as interactive as long as the learner is interacting with the program in some way such as an activity or a gamification type part of the program. Despite numerous OSHA interpretation letters to the contrary, many view self-paced online as being classroom training as long as it has an "interactive" component and therefore all they need to provide for electrical safety training. By clarifying that classroom training is instructor-led and that self paced electronic training is allowed only when used in combination with instructor-led classroom or on-the-job training or both, individuals responsible for providing employee training within a company will have clear direction as to what that training needs to be.

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Committee: EEW-AAA

**Public Input No. 313-NFPA 70E-2021 [Section No. 110.6(A)(4)]****(4) Type of Training.**

The training required by 110.6(A) shall be ~~classroom, on-the-job, or a combination of the two~~ designed to achieve specific measurable learning objectives and outcomes for the intended audience . The type and extent of the training provided shall be determined by the risk to the employee.

Informational Note: - ~~Classroom training can-~~ Training can be classroom, on the job, or a combination of the two, and can include interactive electronic or interactive web-based training components.

Statement of Problem and Substantiation for Public Input

Regardless of the training delivery methodology, any training should be designed to achieve specific measurable learning objectives and outcomes for the intended audience. When this becomes the stated requirement there is no need to specify the delivery methodology. A similar revision has already been implemented in CSA Z462-2021.

Submitter Information Verification

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Submittal Date: Tue Jun 01 12:40:51 EDT 2021

Committee: EEW-AAA

**Public Input No. 380-NFPA 70E-2021 [Section No. 110.6(A)(4)]****(4) Type of Training.**

The training required by 110.6(A) shall ~~be classroom,~~ be a combination of classroom and on-the-job, ~~or a combination of the two training~~. 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.

Statement of Problem and Substantiation for Public Input

The training will only be affective if both are done. Classroom for existing and new information, on-the-job for practical, hands-on experience with application of the requirements. People who have only one or the other are not capable of conveying the other. Both are necessary.

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Submittal Date: Tue Jun 01 17:14:53 EDT 2021

Committee: EEW-AAA

**Public Input No. 336-NFPA 70E-2021 [Section No. 110.6(A)(5)]****(5) Electrical Safety Training Documentation.**

The employer shall document that ~~each~~ each qualified employee has received the training required by 110.6 (A) , 110.6(A)(1) and additional training or retraining required in 110.6 (A)(3) . 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 as a qualified employee
- (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.

Statement of Problem and Substantiation for Public Input

The training documentation in 110.6 (5) is for qualified employees only. Employees who are not electrically qualified person is not required to undergo training listed in 110.6 (A)(1) and 110.6 (A)(3).

There is no need to keep electrical training records for employees for duration of their employment if they are no longer associated with electrical work.

The parent text has been corrected by adding "qualified" and listing the sections providing training details for qualified employee. 110.6 (A)(5)(2) has been modified to make it clear that retention of training records is only required to be kept of qualified employee

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Submittal Date: Tue Jun 01 14:47:42 EDT 2021

Committee: EEW-AAA

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

The training requirements contained in 110.6(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: - ~~For~~ See NFPA 70 , National Electrical Code ~~f or~~ further information concerning installation requirements, ~~see NFPA 70~~ , National Electrical Code .

Statement of Problem and Substantiation for Public Input

Revised Informational Note to comply with new 2020 NEC Style Manual.

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

Submitter Information Verification

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Committee: EEW-AAA

**Public Input No. 21-NFPA 70E-2020 [Section No. 110.6(C)]****(C) Emergency Response Training.****(1) Contact Release.**

Employees exposed to electric 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 110.6(C) is current.

(4) Documentation.

The employer shall document that the training required by 110.6(C) has occurred.

Statement of Problem and Substantiation for Public Input

"electric" is added before "shock" to read "electric shock" to correlate with the use of "electric shock" in the definition of "electrical hazard" and Boundary, Restricted Approach as well as to clarify that the type of shock hazard being addressed is a shock hazard rather than others forms of shock such as where one would go into shock due to a severe injury or a reaction associated with fright.

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.

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

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 15-NFPA 70E-2020 [Definition: Shock Hazard.]	Related issue.

Submitter Information Verification

Submitter Full Name: Palmer Hickman
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Submission Date: Tue Dec 22 14:32:49 EST 2020
Committee: EEW-AAA

**Public Input No. 274-NFPA 70E-2021 [Section No. 110.6(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.~~ Training shall occur ~~annually~~ at a frequency that satisfies the requirements of the certifying body .

Statement of Problem and Substantiation for Public Input

When the requirement for First Aid, Emergency Response, and Resuscitation was changed from annually to "at a frequency that satisfies the requirements of the certifying body", this "annual" training for contact release was left dangling. Contact release training is typically part of Emergency Response and Resuscitation training, and to have that one part annual, with everything else determined by the certifying body is out-of-sync, and awkward to implement.

Submitter Information Verification

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Submittal Date: Tue Jun 01 07:41:15 EDT 2021

Committee: EEW-AAA

**Public Input No. 353-NFPA 70E-2021 [Section No. 110.6(C)(3)]****(3) Training Verification.**

Employers shall verify ~~at least annually~~ that employee training required by 110.6(C) is current.

Statement of Problem and Substantiation for Public Input

Delete the phrase "at least annually" in 110.6(C)(3). This seems to be related to the requirement for emergency response training to occur annually in previous editions of this standard. If the certifying body requires training every 2 years and the employer complies with that, they should not need to confirm it annually? This proposed change is also more consistent with 110.6(C)(2)(d).

Submitter Information Verification

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Submittal Date: Tue Jun 01 15:46:03 EDT 2021

Committee: EEW-AAA

**Public Input No. 369-NFPA 70E-2021 [Section No. 110.7(A)]****(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.

(3) The host employer shall evaluate the contract employer to ensure their employees meet all of the Host Employer's requirements for being considered a Qualified Person. This evaluation shall be made periodically, not to exceed one year, or when new contract employees are employed.

Statement of Problem and Substantiation for Public Input

Contract employees must be determined to be Qualified before being allowed to start work. Contract employees change fairly often so this evaluation must be done periodically or when people change.

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Submittal Date: Tue Jun 01 16:29:18 EDT 2021

Committee: EEW-AAA

**Public Input No. 57-NFPA 70E-2021 [Section No. 110.7(C)]****(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. The documentation shall include the name of the qualified person responsible for coordinating any Lock-out/Tag-out conditions.

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.

Statement of Problem and Substantiation for Public Input

Many construction sites have several different contractors at different times. Sometimes the general contractor has no qualified electrical people on site at the time of construction work of other trades. The other trades are unqualified people depending upon the word of another unqualified general contractor person that the equipment is in an electrically safe condition.

In one case a digging machine operator was assured by the general contractor that the utility had de-energized the site. He was injured by the electricity.

In another case a HVAC pipe insulator was assured by the general contractor that the room was made safe by an electrical contractor. One circuit was still alive, and the worker was injured.

These injuries could have been prevented by better coordination between the qualified person responsible for the LO/TO and the unqualified workers.

This simple addition is intended to require an electrically qualified person to tell unqualified people if the work is safe from electrical hazards.

Submitter Information Verification

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Submittal Date: Wed Feb 24 15:11:40 EST 2021

Committee: EEW-AAA



Public Input No. 115-NFPA 70E-2021 [Section No. 110.8]

110.8 Test Instruments and Equipment.

(A) Testing.

Only qualified persons shall perform tasks such as testing, troubleshooting, and voltage measuring on electrical equipment ~~where~~ ~~an~~ if 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~~ Identified for the purpose
- (3) Used in accordance with any instructions, including all safety warnings and precautions provided by the manufacturer

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

(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.

(F) Testing such as cable and equipment high potential insulation tests shall be performed using the appropriate personal protective equipment rated for the output voltage of the test equipment. The charged cable or equipment shall be fully discharged upon completion of the high potential dielectric testing. Suitable barricades and safety warning signs in accordance with 130.7(E) shall be placed to prevent unqualified persons from being exposed to electrical hazards related to the high potential electrical testing process.

Informational Note: See ANSI/NETA ATS 2021, Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems

Statement of Problem and Substantiation for Public Input

In subdivision (A) the word “where” (meaning a location) was changed to “if” (meaning a condition) to comply with Section 3.3.4 of the 2020 NEC Style Manual. In Subdivision (B)(2) the word “approved” was changed to the word “identified” for context and to align with the definition of the term “approved” which is acceptable to the authority having jurisdiction. This section appears to be seeking test instruments or equipment that is identified for the specific use. In (B)(3) the additional text is related to safety instructions and precautions related to high voltage output of high potential test equipment. New Subdivision (F) is being added to specifically address the electrical hazards present during high potential insulation (hi-pot) testing of cables and equipment. The informational note is intended to reference an ANSI standard that addresses requirements for high potential electrical insulation acceptance testing of electrical power equipment and systems, which may need to be refined.

Submitter Information Verification

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Submission Date: Thu May 20 14:24:50 EDT 2021

Committee: EEW-AAA

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

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

- (1) Rated for circuits and equipment where they are utilized
- (2) Approved for the purpose
- (3) Used in accordance with any instructions provided by the manufacturer

Informational Note: See UL 61010-1, *Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use – Part 1: General Requirements*, for rating and design requirements for voltage measurement and test instruments intended for use on electrical systems 1000 volts and below and 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~~ - Voltage for rating and design requirements for voltage measurement and test instruments intended for use on electrical systems 1000 volts and below .*

Statement of Problem and Substantiation for Public Input

Revised Informational Note to comply with new 2020 NEC Style Manual.

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

Submitter Information Verification

Submitter Full Name: Louis Barrios

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Submittal Date: Sun May 23 12:03:12 EDT 2021

Committee: EEW-AAA

**Public Input No. 265-NFPA 70E-2021 [Section No. 110.8(B)]****(B) Rating.**

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

- (1) Rated for circuits and equipment where they are utilized
- (2) ~~Approved~~ Listed for the purpose
- (3) Used in accordance with any instructions provided by the manufacturer

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

Statement of Problem and Substantiation for Public Input

Approved is defined in NFPA 70E as "Acceptable to the authority having jurisdiction." AHJ's generally don't have the knowledge or equipment to adequately examine equipment for safety such as test instruments. Therefore, AHJ's will rely on equipment that has been listed by a nationally recognized testing laboratory to the appropriate product safety standards for the basis of approval. Replacing "approved" with "listed" will clarify that test instruments must be evaluated and listed to the appropriate product safety standards by a nationally recognized testing laboratory.

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 266-NFPA 70E-2021 [Section No. 110.10(A)]	

Submitter Information Verification

Submitter Full Name: Kelly Nicoletto
Organization: UL LLC
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Submission Date: Mon May 31 12:54:48 EDT 2021
Committee: EEW-AAA

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

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

Statement of Problem and Substantiation for Public Input

Ground-Fault Circuit-Interrupter protection is critical for electrical safety. All GFCI's should be listed GFCI's not just those that are incorporated into a cord set or identified for portable use.

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 265-NFPA 70E-2021 [Section No. 110.8(B)]	

Submitter Information Verification

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Submittal Date: Mon May 31 12:56:11 EDT 2021

Committee: EEW-AAA

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

GFCI protection shall be provided where an employee is operating or using cord sets (extension cords) or cord- and plug-connected tools related to maintenance and construction activity supplied by 125-volt, 15-, 20-, or 30-ampere circuits. 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: See Informative Annex O for further information. Where an assured equipment grounding conductor program is used, a special purpose ground-fault circuit interrupter may provide additional protection. - ~~See Informative Annex O.~~

Statement of Problem and Substantiation for Public Input

Revised Informational Note to comply with new 2020 NEC Style Manual.

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

Submitter Information Verification

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Submittal Date: Sun May 23 12:06:44 EDT 2021

Committee: EEW-AAA

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

GFCI protection shall be provided where an employee is operating or using cord sets (extension cords) or cord- and plug-connected tools related to maintenance and construction activity supplied by 125-volt, 15-, 20-, or 30-ampere circuits. 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 **in accordance with NFPA 70, article 590.6(B)(2)**.

Informational Note: Where an assured equipment grounding conductor program is used, a special purpose ground-fault circuit interrupter may provide additional protection. See Informative Annex O.

Statement of Problem and Substantiation for Public Input

NFPA 70E has mentioned the assured equipment grounding conductor program (AEGCP) as an alternative for GFCI protection in the previous editions of 70E. While 70E directs the reader to the AEGCP in articles 110.10(B) and 110.10(C), nowhere in the entire standard is the reader provided instructions on how to correctly implement the AEGCP. 70E as currently written assumes the reader knows the specific requirements for an AEGCP which is very presumptuous to say the least. However if the reader is directed to NFPA 70 (NEC) article 590.6(B)(2) for the specifics of the AEGCP then this completely eliminates the confusion of what it is and how to correctly implement it.

Submitter Information Verification

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Submittal Date: Thu May 27 21:10:51 EDT 2021

Committee: EEW-AAA

**Public Input No. 370-NFPA 70E-2021 [Sections 110.10(B), 110.10(C)]****Sections 110.10(B), 110.10(C)****(B) Maintenance and Construction.**

GFCI protection shall be provided where an employee is operating or using cord sets (extension cords) or cord- and plug-connected tools related to maintenance and construction activity supplied by 125-volt, 15-, 20-, or 30-ampere circuits. 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: Where an assured equipment grounding conductor program is used, a special purpose ground-fault circuit interrupter may provide additional protection. See Informative Annex Q.~~

(C) Outdoors.

GFCI protection shall be provided when an employee is outdoors and operating or using cord sets (extension cords) or cord- and plug-connected equipment supplied by 125-volt, 15-, 20-, or 30-ampere circuits. Where employees working outdoors 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: Where an assured equipment grounding conductor program is used, a special purpose ground-fault circuit interrupter may provide additional protection. See Informative Annex Q.~~

Statement of Problem and Substantiation for Public Input

Where an AEGCP is used, a special purpose GFCI is of no value or use. There is no additional protection realized by additionally using the SPGFCI. The SPGFCI device is only useful when no AEGCP exists, and even then only limited protection for personnel..

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Committee: EEW-AAA

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

GFCI protection shall be provided where an employee is operating or using cord sets (extension cords) or cord- and plug-connected tools related to maintenance and construction activity supplied by 425 120 -volt, 15-, 20-, or 30-ampere circuits. Where employees operate or use equipment supplied by greater than 425 120 -volt, 15-, 20-, or 30-ampere circuits, GFCI protection or an assured equipment grounding conductor program shall be implemented.

Informational Note: Where an assured equipment grounding conductor program is used, a special purpose ground-fault circuit interrupter may provide additional protection. See Informative Annex O.

(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 425 120 -volt, 15-, 20-, or 30-ampere circuits. Where employees working outdoors operate or use equipment supplied by greater than 425 120 -volt, 15-, 20-, or 30-ampere circuits, GFCI protection or an assured equipment grounding conductor program shall be implemented.

Informational Note: Where an assured equipment grounding conductor program is used, a special purpose ground-fault circuit interrupter may provide additional protection. See Informative Annex O.

Statement of Problem and Substantiation for Public Input

The sections refer to circuits, not devices. The circuits are 120 volts, the devices are 125 volts.

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Submittal Date: Wed Mar 31 11:08:02 EDT 2021

Committee: EEW-AAA

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

GFCI protection shall be provided when an employee is outdoors and operating or using cord sets (extension cords) or cord- and plug-connected equipment supplied by 125-volt, 15-, 20-, or 30-ampere circuits. Where employees working outdoors 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: See Informative Annex O for further information. Where an assured equipment grounding conductor program is used, a special purpose ground-fault circuit interrupter may provide additional protection. - ~~See Informative Annex O -~~

Statement of Problem and Substantiation for Public Input

Revised Informational Note to comply with new 2020 NEC Style Manual.

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

Submitter Information Verification

Submitter Full Name: Louis Barrios

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Submittal Date: Sun May 23 12:08:32 EDT 2021

Committee: EEW-AAA

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

GFCI protection shall be provided when an employee is outdoors and operating or using cord sets (extension cords) or cord- and plug-connected equipment supplied by 125-volt, 15-, 20-, or 30-ampere circuits. Where employees working outdoors 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 **in accordance with NFPA 70, article 590.6(B)(2).**

Informational Note: Where an assured equipment grounding conductor program is used, a special purpose ground-fault circuit interrupter may provide additional protection. See Informative Annex O.

Statement of Problem and Substantiation for Public Input

NFPA 70E has mentioned the assured equipment grounding conductor program (AEGCP) as an alternative for GFCI protection in the previous editions of 70E. While 70E directs the reader to the AEGCP in articles 110.10(B) and 110.10(C), nowhere in the entire standard is the reader provided instructions on how to correctly implement the AEGCP. 70E as currently written assumes the reader knows the specific requirements for an AEGCP which is very presumptuous to say the least. However if the reader is directed to NFPA 70 (NEC) article 590.6(B)(2) for the specifics of the AEGCP then this completely eliminates the confusion of what it is and how to correctly implement it.

Submitter Information Verification

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Submittal Date: Thu May 27 21:38:07 EDT 2021

Committee: EEW-AAA

**Public Input No. 178-NFPA 70E-2021 [Section No. 110.11]****110.11** Overcurrent Protection Modification.

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

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

Statement of Problem and Substantiation for Public Input

Revised Informational Note to comply with new 2020 NEC Style Manual.

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

Submitter Information Verification

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Submittal Date: Sun May 23 12:10:30 EDT 2021

Committee: EEW-AAA

**Public Input No. 50-NFPA 70E-2021 [Article 120]****Article 120** Establishing an Electrically Safe Work Condition**120.1** Lockout/Tagout Program.**(A)** General.

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

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

(B) Employer Responsibilities.

The employer shall be responsible for the following:

- (1) Providing the equipment necessary to execute lockout/tagout procedures
- (2) Providing lockout/tagout training to workers in accordance with 110.6(B)
- (3) Auditing the lockout/tagout program in accordance with 110.5(M)(3)
- (4) Auditing execution of the lockout/tagout procedures in accordance with 110.5(M)(3)

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

120.2 Lockout/Tagout Principles.**(A)** Employee Involvement.

Each person who could be exposed directly or indirectly to a source of electrical energy shall be involved in the lockout/tagout procedure.

Informational Note: An example of direct exposure is the qualified electrician who works on the motor starter control, the power circuits, or the motor. An example of indirect exposure is the person who works on the coupling between the motor and compressor.

(B) Lockout/Tagout Procedure.

A lockout/tagout procedure shall be developed on the basis of the existing electrical equipment and system and shall use suitable documentation including up-to-date drawings and diagrams. The procedure shall meet the requirements of applicable codes, standards, and regulations for lockout and tagging of electrical sources.

(C) Control of Energy.

All sources of electrical energy shall be controlled in such a way as to minimize employee exposure to electrical hazards.

(D) Electrical Circuit Interlocks.

Documentation, including up-to-date drawings and diagrams, shall be reviewed to ensure that no electrical circuit interlock operation can result in re-energizing the circuit being worked on.

(E) Control Devices.

Locks/tags shall be installed only on circuit disconnecting means. Control devices, such as push buttons or selector switches, shall not be used as the primary isolating device.

(F) Identification.

The lockout/tagout device shall be unique and readily identifiable as a lockout/tagout device.

(G) Coordination.

The following items are necessary for coordinating the lockout/tagout procedure:

- (1) The electrical lockout/tagout procedure shall be coordinated with all other employer's procedures for control of exposure to electrical energy sources such that all employer's procedural requirements are adequately addressed on a site basis.
- (2) The procedure for control of exposure to electrical hazards shall be coordinated with other procedures for control of other hazardous energy based on similar or identical concepts.
- (3) Electrical lockout/tagout devices shall be permitted to be similar to lockout/tagout devices for control of other hazardous energy sources, such as pneumatic, hydraulic, thermal, and mechanical, if such devices are used only for control of hazardous energy and for no other purpose.

(H)– Forms of Control of Hazardous Electrical Energy.

Two forms of hazardous electrical energy control shall be permitted: simple lockout/tagout and complex lockout/tagout. *[see 120.4 J]*. For the simple lockout/tagout, the qualified person shall be in charge. For the complex lockout/tagout, the person in charge shall have overall responsibility.

120.3– Lockout/Tagout Equipment.**(A)– Lock Application.**

Energy isolation devices for machinery or equipment installed after January 2, 1990, shall be capable of accepting a lockout device.

(B)– Lockout/Tagout Device.

Each employer shall supply, and employees shall use, lockout/tagout devices and equipment necessary to execute the requirements of 120.3. Locks and tags used for control of exposure to electrical hazards shall be unique, shall be readily identifiable as lockout/tagout devices, and shall be used for no other purpose.

(C)– Lockout Device.

The lockout device shall meet the following requirements:

- (1) A lockout device shall include a lock — either keyed or combination.
- (2) The lockout device shall include a method of identifying the individual who installed the lockout device.
- (3) A lockout device shall be permitted to be only a lock, if the lock is readily identifiable as a lockout device, in addition to having a means of identifying the person who installed the lock, provided that all of the following conditions exist:
 - (4) Only one circuit or piece of equipment is de-energized.
 - (5) The lockout period does not extend beyond the work shift.
 - (6) Employees exposed to the hazards associated with re-energizing the circuit or equipment are familiar with this procedure.
- (7) Lockout devices shall be attached to prevent operation of the disconnecting means without resorting to undue force or the use of tools.
- (8) Where a tag is used in conjunction with a lockout device, the tag shall contain a statement prohibiting unauthorized operation of the disconnecting means or unauthorized removal of the device.
- (9) Lockout devices shall be suitable for the environment and for the duration of the lockout.
- (10) Whether keyed or combination locks are used, the key or combination shall remain in the possession of the individual installing the lock or the person in charge, when provided by the established procedure.

(D)– Tagout Device.

The tagout device shall meet the following requirements:

- (1) A tagout device shall include a tag together with an attachment means.
- (2) The tagout device shall be readily identifiable as a tagout device and suitable for the environment and duration of the tagout.
- (3) A tagout device attachment means shall be capable of withstanding at least 224.4 N (50 lb) of force exerted at a right angle to the disconnecting means surface. The tag attachment means shall be nonreusable, attachable by hand, self-locking, nonreleasable, and equal to an all-environmental tolerant nylon cable tie.
- (4) Tags shall contain a statement prohibiting unauthorized operation of the disconnecting means or removal of the tag.
- (5) A hold card tagging tool on an overhead conductor in conjunction with a hotline tool to install the tagout device safely on a disconnect that is isolated from the work(s) shall be permitted. Where a hold card is used, the tagout procedure shall include the method of accounting for personnel who are working under the protection of the hold card.

120.4– Lockout/Tagout Procedures.

The employer shall maintain a copy of the procedures required by this section and shall make the procedures available to all employees.

(A)– Planning.

The procedure shall require planning, including the requirements of 120.4(A)(1) through 120.4(B)(14).

(1)– Locating Sources.

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

(2)– Exposed Persons.

The plan shall identify persons who might be exposed to an electrical hazard and the PPE required during the execution of the job or task.

~~(3) Person in Charge.~~

The plan shall identify the person in charge and his or her responsibility in the lockout/tagout.

~~(4) Simple Lockout/Tagout Procedure.~~

All lockout/tagout procedures that involve only a qualified person(s) de-energizing one set of conductors or circuit part source for the sole purpose of safeguarding employees from exposure to electrical hazards shall be considered to be a simple lockout/tagout. Simple lockout/tagout procedures shall not be required to be written for each application. Each worker shall be responsible for his or her own lockout/tagout.

Exception: Lockout/tagout is not 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.

~~(5) Complex Lockout/Tagout.~~

(a) A complex lockout/tagout procedure shall be permitted 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.

~~(B) Elements of Control.~~

The procedure shall identify elements of control.

~~(1) De-energizing Equipment (Shutdown).~~

The procedure shall establish the person who performs the switching and where and how to de-energize the load.

~~(2) Stored Energy.~~

The procedure shall include requirements for releasing stored electric or mechanical energy that might endanger personnel. All capacitors shall be discharged, and high-capacitance elements shall also be short-circuited and grounded before the associated equipment is touched or worked on. Springs shall be released or physical restraint shall be applied when necessary to immobilize mechanical equipment and pneumatic and hydraulic pressure reservoirs. Other sources of stored energy shall be blocked or otherwise relieved.

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

~~(3) Disconnecting Means.~~

The procedure shall identify how to verify that the circuit is de-energized (open).

~~(4) Responsibility.~~

The procedure shall identify the person who is responsible for verifying that the lockout/tagout procedure is implemented and who is responsible for ensuring that the task is completed prior to removing locks/tags. A mechanism to accomplish lockout/tagout for multiple (complex) jobs/tasks where required, including the person responsible for coordination, shall be included.

~~(5) Verification.~~

The procedure shall verify that equipment cannot be restarted. The equipment operating controls, such as push-buttons, selector switches, and electrical interlocks, shall be operated or otherwise it shall be verified that the equipment cannot be restarted.

(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~~

(7)– Grounding.

~~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 needs or requirements shall be permitted to be covered in other work rules and might not be part of the lockout/tagout procedure.~~

(8)– Shift Change.

~~A method shall be identified in the procedure to transfer responsibility for lockout/tagout to another person or to the person in charge when the job or task extends beyond one shift.~~

(9)– Coordination.

~~The procedure shall establish how coordination is accomplished with other jobs or tasks in progress, including related jobs or tasks at remote locations as well as the person responsible for coordination.~~

(10)– Accountability for Personnel.

~~A method shall be identified in the procedure to account for all persons who could be exposed to hazardous energy during the lockout/tagout.~~

(11)– Lockout/Tagout Application.

~~The procedure shall clearly identify when and where lockout applies, in addition to when and where tagout applies, and shall address the following:~~

- (1) ~~Lockout shall be defined as installing a lockout device on all sources of hazardous energy such that operation of the disconnecting means is prohibited, and forcible removal of the lock is required to operate the disconnecting means.~~
- (2) ~~Tagout shall be defined as installing a tagout device on all sources of hazardous energy, such that operation of the disconnecting means is prohibited. The tagout device shall be installed in the same position available for the lockout device.~~
- (3) ~~Where it is not possible to attach a lock to existing disconnecting means, the disconnecting means shall not be used as the only means to put the circuit in an electrically safe work condition.~~
- (4) ~~The use of tagout procedures without a lock shall be permitted only in cases where equipment design precludes the installation of a lock on an energy isolation device(s). When tagout is employed, at least one additional safety measure shall be employed. In such cases, the procedure shall clearly establish responsibilities and accountability for each person who might be exposed to electrical hazards.~~

~~Informational Note:– Examples of additional safety measures include the removal of an isolating circuit element such as fuses, blocking of the controlling switch, or opening an extra disconnecting device to reduce the likelihood of inadvertent energization.~~

(12)– Removal of Lockout/Tagout Devices.

~~The procedure shall identify the details for removing locks or tags when the installing individual is unavailable. When locks or tags are removed by someone other than the installer, the employer shall attempt to locate that person prior to removing the lock or tag. When the lock or tag is removed because the installer is unavailable, the installer shall be informed prior to returning to work.~~

(13)– Release for Return to Service.

~~The procedure shall identify steps to be taken when the job or task requiring lockout/tagout is completed. Before electric circuits or equipment are re-energized, tests and visual inspections shall be conducted to verify that all tools, mechanical restraints and electrical jumpers, short circuits, and temporary protective grounding equipment have been removed, so that the circuits and equipment are in a condition to be safely energized. When applicable, the employees responsible for operating the machines or process shall be notified when circuits and equipment are ready to be energized, and such employees shall provide assistance as necessary to safely energize the circuits and equipment. The procedure shall contain a statement requiring the area to be inspected to ensure that nonessential items have been removed. One such step shall ensure that all personnel are clear of exposure to dangerous conditions resulting from re-energizing the service and that blocked mechanical equipment or grounded equipment is cleared and prepared for return to service.~~

(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.~~

~~Informational Note:– See 110.8 for requirements when using test instruments and equipment.~~

120.5 – Process for Establishing and Verifying**120.1 . Process for Establishing 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 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: For additional information on rating and design requirements for permanently mounted absence of voltage testers, refer to UL 1436, *Outlet Circuit Testers and Other Similar Indicating Devices*.

Informational Note No. 3: For additional information on rating and design requirements for voltage detectors, refer to 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*.

- (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: ASTM F855, *Standard Specification for Temporary Protective Grounds to be Used on De-energized Electric Power Lines and Equipment*, 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 Input

There are many that consider the requirements of 120.5 to be equal to or greater than OSHA's requirements in 1910.333(b)(2). It is regularly taught as such and has been published in numerous publications as such. Accordingly, this recommendation requests that the NFPA Technical Committee create a First Revision that recognizes that compliance with 120.5 (now renumbered as 120.1) at least meets or exceeds the requirements of 1910.333(b)(2) by deleting the existing requirements of 120.1, 120.2, 120.3 and 120.4 and modifying 120.5 by removing "and verifying" in two locations to make it clear that a consensus of the NFPA 70E Technical Committee considers the existing requirements of 120.5, as modified by this recommendation, to meet what is required by existing last sentence of 120.2(B) in the 2021 edition of NFPA 70E.

Submitter Information Verification**Submitter Full Name:** Palmer Hickman**Organization:** Electrical Training Alliance**Street Address:****City:****State:****Zip:****Submittal Date:** Tue Feb 23 10:02:12 EST 2021**Committee:** EEW-AAA

**Public Input No. 51-NFPA 70E-2021 [Article 120]****Article 120– Informative Annex B** Establishing an Electrically Safe Work Condition**120 B .1** Lockout/Tagout Program.**(A)** General.

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

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

(B) Employer Responsibilities.

The employer shall be responsible for the following:

- (1) Providing the equipment necessary to execute lockout/tagout procedures
- (2) Providing lockout/tagout training to workers in accordance with 110.6(B)
- (3) Auditing the lockout/tagout program in accordance with 110.5(M)(3)
- (4) Auditing execution of the lockout/tagout procedures in accordance with 110.5(M)(3)

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

120 B .2– 2 Lockout/Tagout Principles.**(A)** Employee Involvement.

Each person who could be exposed directly or indirectly to a source of electrical energy shall be involved in the lockout/tagout procedure.

Informational Note: An example of direct exposure is the qualified electrician who works on the motor starter control, the power circuits, or the motor. An example of indirect exposure is the person who works on the coupling between the motor and compressor.

(B) Lockout/Tagout Procedure.

A lockout/tagout procedure shall be developed on the basis of the existing electrical equipment and system and shall use suitable documentation including up-to-date drawings and diagrams. The procedure shall meet the requirements of applicable codes, standards, and regulations for lockout and tagging of electrical sources.

(C) Control of Energy.

All sources of electrical energy shall be controlled in such a way as to minimize employee exposure to electrical hazards.

(D) Electrical Circuit Interlocks.

Documentation, including up-to-date drawings and diagrams, shall be reviewed to ensure that no electrical circuit interlock operation can result in re-energizing the circuit being worked on.

(E) Control Devices.

Locks/tags shall be installed only on circuit disconnecting means. Control devices, such as push-buttons or selector switches, shall not be used as the primary isolating device.

(F) Identification.

The lockout/tagout device shall be unique and readily identifiable as a lockout/tagout device.

(G) Coordination.

The following items are necessary for coordinating the lockout/tagout procedure:

- (1) The electrical lockout/tagout procedure shall be coordinated with all other employer's procedures for control of exposure to electrical energy sources such that all employer's procedural requirements are adequately addressed on a site basis.
- (2) The procedure for control of exposure to electrical hazards shall be coordinated with other procedures for control of other hazardous energy based on similar or identical concepts.
- (3) Electrical lockout/tagout devices shall be permitted to be similar to lockout/tagout devices for control of other hazardous energy sources, such as pneumatic, hydraulic, thermal, and mechanical, if such devices are used only for control of hazardous energy and for no other purpose.

(H) Forms of Control of Hazardous Electrical Energy.

Two forms of hazardous electrical energy control shall be permitted: simple lockout/tagout and complex lockout/tagout [see 120.4]. For the simple lockout/tagout, the qualified person shall be in charge. For the complex lockout/tagout, the person in charge shall have overall responsibility.

120 B .3 Lockout/Tagout Equipment.

(A) Lock Application.

Energy isolation devices for machinery or equipment installed after January 2, 1990, shall be capable of accepting a lockout device.

(B) Lockout/Tagout Device.

Each employer shall supply, and employees shall use, lockout/tagout devices and equipment necessary to execute the requirements of 120.3. Locks and tags used for control of exposure to electrical hazards shall be unique, shall be readily identifiable as lockout/tagout devices, and shall be used for no other purpose.

(C) Lockout Device.

The lockout device shall meet the following requirements:

- (1) A lockout device shall include a lock — either keyed or combination.
- (2) The lockout device shall include a method of identifying the individual who installed the lockout device.
- (3) A lockout device shall be permitted to be only a lock, if the lock is readily identifiable as a lockout device, in addition to having a means of identifying the person who installed the lock, provided that all of the following conditions exist:
 - (4) Only one circuit or piece of equipment is de-energized.
 - (5) The lockout period does not extend beyond the work shift.
 - (6) Employees exposed to the hazards associated with re-energizing the circuit or equipment are familiar with this procedure.
- (7) Lockout devices shall be attached to prevent operation of the disconnecting means without resorting to undue force or the use of tools.
- (8) Where a tag is used in conjunction with a lockout device, the tag shall contain a statement prohibiting unauthorized operation of the disconnecting means or unauthorized removal of the device.
- (9) Lockout devices shall be suitable for the environment and for the duration of the lockout.
- (10) Whether keyed or combination locks are used, the key or combination shall remain in the possession of the individual installing the lock or the person in charge, when provided by the established procedure.

(D) Tagout Device.

The tagout device shall meet the following requirements:

- (1) A tagout device shall include a tag together with an attachment means.
- (2) The tagout device shall be readily identifiable as a tagout device and suitable for the environment and duration of the tagout.
- (3) A tagout device attachment means shall be capable of withstanding at least 224.4 N (50 lb) of force exerted at a right angle to the disconnecting means surface. The tag attachment means shall be nonreusable, attachable by hand, self-locking, nonreleasable, and equal to an all-environmental tolerant nylon cable tie.
- (4) Tags shall contain a statement prohibiting unauthorized operation of the disconnecting means or removal of the tag.
- (5) A hold card tagging tool on an overhead conductor in conjunction with a hotline tool to install the tagout device safely on a disconnect that is isolated from the work(s) shall be permitted. Where a hold card is used, the tagout procedure shall include the method of accounting for personnel who are working under the protection of the hold card.

120 B.4 Lockout/Tagout Procedures.

The employer shall maintain a copy of the procedures required by this section and shall make the procedures available to all employees.

(A) Planning.

The procedure shall require planning, including the requirements of 120.4(A)(1) through 120.4(B)(14).

(1) Locating Sources.

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

(2) Exposed Persons.

The plan shall identify persons who might be exposed to an electrical hazard and the PPE required during the execution of the job or task.

(3) Person in Charge.

The plan shall identify the person in charge and his or her responsibility in the lockout/tagout.

(4) Simple Lockout/Tagout Procedure.

All lockout/tagout procedures that involve only a qualified person(s) de-energizing one set of conductors or circuit part source for the sole purpose of safeguarding employees from exposure to electrical hazards shall be considered to be a simple lockout/tagout. Simple lockout/tagout procedures shall not be required to be written for each application. Each worker shall be responsible for his or her own lockout/tagout.

Exception: Lockout/tagout is not 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.

(5) Complex Lockout/Tagout.

(a) A complex lockout/tagout procedure shall be permitted 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.

(B) Elements of Control.

The procedure shall identify elements of control.

(1) De-energizing Equipment (Shutdown).

The procedure shall establish the person who performs the switching and where and how to de-energize the load.

(2) Stored Energy.

The procedure shall include requirements for releasing stored electric or mechanical energy that might endanger personnel. All capacitors shall be discharged, and high-capacitance elements shall also be short-circuited and grounded before the associated equipment is touched or worked on. Springs shall be released or physical restraint shall be applied when necessary to immobilize mechanical equipment and pneumatic and hydraulic pressure reservoirs. Other sources of stored energy shall be blocked or otherwise relieved.

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

(3) Disconnecting Means.

The procedure shall identify how to verify that the circuit is de-energized (open).

(4) Responsibility.

The procedure shall identify the person who is responsible for verifying that the lockout/tagout procedure is implemented and who is responsible for ensuring that the task is completed prior to removing locks/tags. A mechanism to accomplish lockout/tagout for multiple (complex) jobs/tasks where required, including the person responsible for coordination, shall be included.

(5) Verification.

The procedure shall verify that equipment cannot be restarted. The equipment operating controls, such as push-buttons, selector switches, and electrical interlocks, shall be operated or otherwise it shall be verified that the equipment cannot be restarted.

(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

(7) Grounding.

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 needs or requirements shall be permitted to be covered in other work rules and might not be part of the lockout/tagout procedure.

(8) Shift Change.

A method shall be identified in the procedure to transfer responsibility for lockout/tagout to another person or to the person in charge when the job or task extends beyond one shift.

(9) Coordination.

The procedure shall establish how coordination is accomplished with other jobs or tasks in progress, including related jobs or tasks at remote locations as well as the person responsible for coordination.

(10) Accountability for Personnel.

A method shall be identified in the procedure to account for all persons who could be exposed to hazardous energy during the lockout/tagout.

(11) Lockout/Tagout Application.

The procedure shall clearly identify when and where lockout applies, in addition to when and where tagout applies, and shall address the following:

- (1) Lockout shall be defined as installing a lockout device on all sources of hazardous energy such that operation of the disconnecting means is prohibited, and forcible removal of the lock is required to operate the disconnecting means.
- (2) Tagout shall be defined as installing a tagout device on all sources of hazardous energy, such that operation of the disconnecting means is prohibited. The tagout device shall be installed in the same position available for the lockout device.
- (3) Where it is not possible to attach a lock to existing disconnecting means, the disconnecting means shall not be used as the only means to put the circuit in an electrically safe work condition.
- (4) The use of tagout procedures without a lock shall be permitted only in cases where equipment design precludes the installation of a lock on an energy isolation device(s). When tagout is employed, at least one additional safety measure shall be employed. In such cases, the procedure shall clearly establish responsibilities and accountability for each person who might be exposed to electrical hazards.

Informational Note: Examples of additional safety measures include the removal of an isolating circuit element such as fuses, blocking of the controlling switch, or opening an extra disconnecting device to reduce the likelihood of inadvertent energization.

(12) Removal of Lockout/Tagout Devices.

The procedure shall identify the details for removing locks or tags when the installing individual is unavailable. When locks or tags are removed by someone other than the installer, the employer shall attempt to locate that person prior to removing the lock or tag. When the lock or tag is removed because the installer is unavailable, the installer shall be informed prior to returning to work.

(13) Release for Return to Service.

The procedure shall identify steps to be taken when the job or task requiring lockout/tagout is completed. Before electric circuits or equipment are re-energized, tests and visual inspections shall be conducted to verify that all tools, mechanical restraints and electrical jumpers, short circuits, and temporary protective grounding equipment have been removed, so that the circuits and equipment are in a condition to be safely energized. When applicable, the employees responsible for operating the machines or process shall be notified when circuits and equipment are ready to be energized, and such employees shall provide assistance as necessary to safely energize the circuits and equipment. The procedure shall contain a statement requiring the area to be inspected to ensure that nonessential items have been removed. One such step shall ensure that all personnel are clear of exposure to dangerous conditions resulting from re-energizing the service and that blocked mechanical equipment or grounded equipment is cleared and prepared for return to service.

(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.

Informational Note: See 110.8 for requirements when using test instruments and equipment.

120.5 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 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: For additional information on rating and design requirements for permanently mounted absence of voltage testers, refer to UL 1436, *Outlet Circuit Testers and Other Similar Indicating Devices*.

Informational Note No. 3: For additional information on rating and design requirements for voltage detectors, refer to 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*.

- (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: ASTM F855, *Standard Specification for Temporary Protective Grounds to be Used on De-energized Electric Power Lines and Equipment*, 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 Input

There are many that consider the requirements of 120.5 to be equal to or greater than OSHA's requirements in 1910.333(b)(2). It is regularly taught as such and has been published in numerous publications as such. Accordingly, this recommendation requests that the NFPA Technical Committee create a First Revision that recognizes that compliance with 120.5 (now renumbered as 120.1) at least meets or exceeds the requirements of 1910.333(b)(2) by relocating the existing requirements of 120.1, 120.2, 120.3 and 120.4 into Informative Annex B where they can be referenced as nonmandatory information rather than requirements that do not in and of themselves a lockout/tagout program or process but rather a list of considerations much like Informative Annex C is to the requirements of 110.5 (E), (F)

and (G). Relatedly, although through a separate Public Input, the existing 120.5 is recommended to be modifies by removing "and verifying" in two locations to make it clear that a consensus of the NFPA 70E Technical Committee considers the existing requirements of 120.5, as modified by that recommendation, to meet what is required by by existing last sentence of 120.2(B) in the 2021 edition of NFPA 70E.

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

120.1 Scope

This article contains the requirements for a lockout/tagout program and establishing an electrically safety work condition.

Statement of Problem and Substantiation for Public Input

Add new section 120.1 Scope. Renumber subsequent sections.

2.2.1 of the new 2020 NEC Style Manual requires each article to have a scope, which shall be the first section of the article.

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

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

- (1) Be applicable to the experience and training of the workers and conditions in the workplace
- (2) Meet the requirements of ~~Article 120~~ 120.1 through 120.4
- (3) Apply to fixed, permanently installed equipment, temporarily installed equipment, and portable equipment

Statement of Problem and Substantiation for Public Input

General reference to Article 120 is changed to a specific references to 120.1 through 120.4.

4.1.4 of the new 2020 NEC Style Manual prohibits references to entire articles.

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Committee: EEW-AAA

**Public Input No. 76-NFPA 70E-2021 [Section No. 120.1(A)]****(A) General.**

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

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

Statement of Problem and Substantiation for Public Input

As written, LOTO applies to all fixed equipment. But if the fixed equipment is cord and plug connected, LOTO would not apply if the plug is under the exclusive control of the authorized worker. This section also currently applies to portable equipment. But portable equipment must be cord and plug connected or it is not portable. LOTO should only apply to equipment which is connected to a system.

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**Public Input No. 77-NFPA 70E-2021 [Section No. 120.1(A)]****(A) General.**

Each employer shall establish, document, and implement a lockout/tagout program. The lockout/tagout program shall specify lockout/tagout procedures to safeguard 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 Article 120
- (3) Apply to fixed, permanently installed equipment, temporarily installed equipment, and portable equipment

Statement of Problem and Substantiation for Public Input

LOTO only protects authorized workers. It is not there to protect affected or other workers. This is part of the requirements of Article 120. If a worker could be exposed, the worker becomes an authorized worker and must be on the LOTO plan.

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Committee: EEW-AAA

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

The employer shall be responsible for the following:

- (1) Providing the equipment necessary to execute lockout/tagout procedures
- (2) Providing lockout/tagout training to workers in accordance with 110.6(B)
- (3) Auditing the lockout/tagout program in accordance with 110.5(M)(3)
- (4) Auditing execution of the lockout/tagout procedures in accordance with 110.5(M)(3)

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

Statement of Problem and Substantiation for Public Input

Revised Informational Note to comply with new 2020 NEC Style Manual.

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

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Committee: EEW-AAA

**Public Input No. 113-NFPA 70E-2021 [Section No. 120.3(A)]****(A) Lock Application.**

Energy isolation devices for machinery or equipment installed after January 2, 1990, ~~shall~~ shall either include provisions for adding a lock or shall be capable of accepting a lockout device.

Statement of Problem and Substantiation for Public Input

Some older switches and circuit breakers, and even newer ones, can include provisions for adding a lock that is inherent to the equipment or is installed as an accessory feature. The key is that those provisions for adding the lock remain with the switch or circuit breaker whether the lock is installed or not. This section also appears to cover lockout devices that are carried to a switch or circuit breaker and installed manually and then a lock can be inserted. The revisions address both field situations, recognizing the many different equipment configurations that exist, some with provisions for adding a lock, some without.

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Committee: EEW-AAA

**Public Input No. 316-NFPA 70E-2021 [Section No. 120.3(A)]****(A) Lock Application.**

Energy isolation devices for machinery or equipment installed after January 2, 1990, shall be capable of accepting a lockout device.

Informational Note: See Annex O for guidance on location of the Energy Isolation Devices to reduce human error potential.

Statement of Problem and Substantiation for Public Input

Installation of energy isolating devices within sight from the equipment and machinery reduces potential of error for establishing electrically safe work condition.

A new definition of Within in sight from NEC is being proposed for addition to 70E separately

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 320-NFPA 70E-2021 [Article 100]	

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Public Input No. 56-NFPA 70E-2021 [Section No. 120.3(C)]

(C) Lockout ~~Device~~ Devices .

The ~~lockout device- devices~~ shall meet the following requirements:

- (1) A lockout device shall include both a ~~lock~~ tagout device complying with 120.3(D) and a lock. The lock shall be permitted to be either keyed or combination.
- (2) The lockout device shall include a method of identifying the individual who installed the lockout device such as a tagout device complying with 120.3(D).
- (3) A lockout device shall be permitted to be ~~only~~ a lock without a tagout device , if the lock is readily identifiable as a lockout device, in addition to having a means of identifying the person who installed the lock, provided that all of the following conditions exist:
 - (4) Only one circuit or piece of equipment is de-energized.
 - (5) The lockout period does not extend beyond the work shift.
 - (6) Employees exposed to the hazards associated with re-energizing the circuit or equipment are familiar with this procedure.
- (7) Lockout devices shall be attached to prevent operation of the disconnecting means without resorting to undue force or the use of tools.
- (8) ~~Where a tag is-~~ A tagout device used in conjunction with a lockout device ~~, the tag-~~ shall contain a statement prohibiting unauthorized operation of the disconnecting means or unauthorized removal of the ~~device devices~~ .
- (9) ~~Lockout devices- Devices~~ shall be suitable for the environment and for the duration of the lockout.
- (10) Whether keyed or combination locks are used, the key or combination shall remain in the possession of the individual installing the lock or the person in charge, when provided by the established procedure.

Statement of Problem and Substantiation for Public Input

Terra underlined more than what is recommended in this Public Input.

This recommendation an attempt to clarify the application of 120.3(C)(3) where it is stated since at least the 2012 through 2021 editions that a lockout device shall be permitted to be only a lock. The requirements of 120.3(C)(5) which state, in part, that "[w]here a tag is used in conjunction with a lockout device..." in the 2012 through 2021 (and perhaps more) editions makes it clear that the term "lockout device" does not presently mean a lock and a tag. "Tagout devices" in accordance with 120.3(D) were added in what were deemed appropriate locations to clarify that the application of the phrase "...shall be permitted to be only a lock" is an allowance for something other than a lock and a tagout device - "only a lock."

This is an educated guess by the submitter that the application of the rule was meant to be both a lock and a tag based on the committee statement for the First Revision 39 modifying 120.3(C)(3) which stated: "This change brings this section in alignment with OSHA 1910.333(b)(2)(iii)(E)." Note that 1910.333(b)(2)(iii)(E) states "A lock may be placed without a tag only...". This recommendation incorporates the concept of both a lock and a tag into 120.3(C).

In the event that the submitter is incorrect in the assumptions and recommendations made, an explanation or an example of what a "lockout device" is beyond only a lock and what the phrase "a lockout device shall be permitted to be only a lock" means related to what the lock would be used in conjunction with for it to be considered a "lockout device" would be very much appreciated in a resolve statement so that the requirement as it is presently written is made clear (at least to the submitter) through such an explanation in a resolve statement.

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

The tagout device shall meet the following requirements:

- (1) A tagout device shall include a tag together with an attachment means.
- (2) The tagout device shall be readily identifiable as a tagout device and suitable for the environment and duration of the tagout.
- (3) A tagout device attachment means shall be capable of withstanding at least ~~224~~ 222 .4 N (50 lb) of force exerted at a right angle to the disconnecting means surface. The tag attachment means shall be nonreusable, attachable by hand, self-locking, nonreleasable, and equal to an all-environmental tolerant nylon cable tie.
- (4) Tags shall contain a statement prohibiting unauthorized operation of the disconnecting means or removal of the tag.
- (5) A hold card tagging tool on an overhead conductor in conjunction with a hotline tool to install the tagout device safely on a disconnect that is isolated from the work(s) shall be permitted. Where a hold card is used, the tagout procedure shall include the method of accounting for personnel who are working under the protection of the hold card.

Statement of Problem and Substantiation for Public Input

50 pounds does not equal 224.4 N. The correct value is 222.4 N.

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Committee: EEW-AAA

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

The procedure shall include requirements for releasing stored electric or mechanical energy that might endanger personnel. All capacitors shall be discharged, and high-capacitance elements shall also be short-circuited and grounded before the associated equipment is touched or worked on. Springs shall be released or physical restraint shall be applied when necessary to immobilize mechanical equipment and pneumatic and hydraulic pressure reservoirs. Other sources of stored energy shall be blocked or otherwise relieved.

Informational Note: ~~For See 360.3 , 360.5 , and Informative Annex R , Working with Capacitors for more information on methods and procedures to place capacitors in an electrically safe work condition, see 360 . 3, 360.5 , and Informative Annex R , Working with Capacitors.~~

Statement of Problem and Substantiation for Public Input

Revised Informational Note to comply with new 2020 NEC Style Manual.

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

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Submittal Date: Sun May 23 12:16:14 EDT 2021
Committee: EEW-AAA

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

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

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

Statement of Problem and Substantiation for Public Input

The scope of NFPA 70E is about electrical hazards per 90.2(A). Many other energy sources often exist in workplaces such as compressed air or liquids, potential energy related to gravity, etc. that employers need to address. Those rules do not belong in this standard unless they are related to reenergizing electric circuit parts. Significantly more detail is necessary to deal with those other energy sources and already exists in hazardous energy control standards. This proposed change is also consistent with the revision of 120.5(5) for the 2021 edition of NFPA 70E.

Submitter Information Verification

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Submittal Date: Tue Jun 01 16:04:32 EDT 2021

Committee: EEW-AAA

**Public Input No. 245-NFPA 70E-2021 [Section No. 120.4(B)(7)]****(7)– Temporary Protective Grounding.**

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 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 Input

The title of article 120.4(B)(7) needs to be changed from "Grounding" to "Temporary Protective Grounding" to distinguish it from the general grounding and bonding of non-current carrying metal parts according to the NEC article 210. Temporary protective grounding is a very specialized task that grounds/bonds the normally energized line, bus or equipment under the conditions of an electrically safe work condition and is completely different than general grounding/bonding under article 210. Temporary protective grounding practices contains many electrical hazards for the workers applying and removing the temporary grounding equipment.

Submitter Information Verification

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Submittal Date: Thu May 27 21:46:11 EDT 2021

Committee: EEW-AAA

**Public Input No. 367-NFPA 70E-2021 [New Section after 120.5]****TITLE OF NEW CONTENT**

Add Exception No.2 to 7 : An adequately rated permanently mounted door mounted accessory or extended test points that are listed and labeled to UL 61010 for voltage testing purpose and used in conjunction with a portable test instrument.

And, change the current text of "Exception No. 2 of 7 to read as Exception No. 3 to 7" in the sequence of exceptions.

Statement of Problem and Substantiation for Public Input

Current method of performing live-dead-live will expose electrical workers to shock and arc flash incidents when it is done inside the electrical cabinet as defined in Article 120.5 (7). Use of UL 61010 listed and labeled Permanently mounted door mounted accessories for voltage testing will eliminate this risk to the personnel performing electrical LOTO tasks. The inclusion of this method will allow the qualified electrical personnel to use their portable test instruments and verify the voltage inside the electrical cabinet from outside the door while under normal operation when the max fault current at the door is limited to less than 3.5mA. Significantly reduces the exposure of electrical hazard to the personnel working on live-dead-live test process.

Submitter Information Verification

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Committee: EEW-AAA



Public Input No. 119-NFPA 70E-2021 [Section No. 120.5]

120.5 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 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: For additional information on rating and design requirements for permanently mounted absence of voltage testers, refer to UL 1436, *Outlet Circuit Testers and Other Similar Indicating Devices*.

Informational Note No. 3: For additional information on rating and design requirements for voltage detectors, refer to 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*.

Exception No.3 to 7: On electrical systems powered by a constant current regulator a true RMS clamp-on ammeter should be used to verify the circuit is de-energized.

Informational Note No.1: See Federal Aviation Administration (FAA) Advisory Circular (AC) 150/5340-26C, *Maintenance of Airport Visual Aid Facilities*, June 20, 2014.

Informational Note No. 2: Airfield lighting series circuits are analogous to the old series circuits used for street lighting. The power source, a constant current regulator, is designed to raise or lower its output voltage to maintain a specific current throughout the load. A constant current regulator output is an ungrounded system. Voltage measurement, up to 4,545 volts, is typically not performed in the field since a shorted output would read zero volts and still have normal current flow. Airfield lighting series circuits should never be open circuited, an open circuit voltage can be double nominal circuit voltage. Airfield lighting series circuits are used at most airports, especially airports with runway or taxiway systems longer than 2,500 feet.

Informational Note No. 3: The constant current regulator output current is measured to determine the proper operation of the circuit and to determine if the circuit is de-energized. Troubleshooting and testing of an airfield lighting series circuit is performed with an ammeter. Due to the output waveform of some constant current regulator technologies a true RMS ammeter is required to accurately measure the output current.

- (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: ASTM F855, *Standard Specification for Temporary Protective Grounds to be Used on De-energized Electric Power Lines and Equipment*, 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 Input

Step 7 adequately addresses the majority of electrical systems. However, measuring voltage to determine if an airfield lighting series circuit is de-energized is an unsafe action. A clamp-on ammeter is the only safe way to determine if the output of a constant current regulator has been de-energized. The additional information provided by this proposed exception is a critical step in the creation of an electrically safe work condition involving a constant current regulator as a power source.

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Committee: EEW-AAA



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

120.5 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 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:

~~For~~

~~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,~~

~~refer to UL 1436, *Outlet Circuit Testers and Other Similar Indicating Devices*~~

~~:~~

Informational Note No. 3:

~~For additional information on rating and design requirements for voltage detectors, refer to~~

~~See IEC 61243-1, *Live Working — Voltage Detectors — Part 1: Capacitive type to be used for voltages exceeding 1kV a.c.*, or IEC 61243-2, *Live Working — Voltage Detectors — Part 2: Resistive type to be used for voltages of 1kV to 36 kV a.c.*, or IEC 61243-3, *Live Working — Voltage Detectors — Part 3: Two-pole low voltage*~~

~~type.~~

~~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:

~~-~~

a.

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.

- b. 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 Input

TerraView error. Note only change is to relocate references to standards to front of each Informational Note.

Revised Informational Note to comply with new 2020 NEC Style Manual.

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

Submitter Information Verification

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Submittal Date: Sun May 23 12:19:58 EDT 2021

Committee: EEW-AAA



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

120.5 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 the 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: For additional information on rating and design requirements for permanently mounted absence of voltage testers, refer to UL 1436, *Outlet Circuit Testers and Other Similar Indicating Devices*.

Informational Note No. 3: For additional information on rating and design requirements for voltage detectors, refer to 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*.

- (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: ASTM F855, *Standard Specification for Temporary Protective Grounds to be Used on De-energized Electric Power Lines and Equipment*, 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 Input

Exception 1 specifies that a permanently-mounted test instrument shall test the conductor or circuit part at the point of work. The same should be true for a portable test instrument. This is particularly important for situations where a permanently-mounted accessory such as a portal is being used in conjunction with a portable test instrument. Although portals often are impedance protected at the door to prevent shock hazards when troubleshooting and measuring voltage presence, they are unreliable for determining the absence of voltage. Testing for the absence of voltage at a portal is not the same as testing at the point of work because there is no guarantee the portal is in fact in direct electrical contact with the source conductor or circuit part. Additionally, because the portals are essentially an extension of the

conductor or circuit part, they bring hazardous voltage to the door. Because of this, overcurrent protection for test portals with leads longer than 12 inches are often required by AHJs to meet requirements in the NEC and UL 508A (40.3.3, Exception 2). If a fuse on the test portal lead is present and open, a test with the portable test instrument at the portal will not accurately determine if the conductor or circuit part is indeed de-energized. Additional wording is necessary to make it clear that using a portable tester at an accessory such as a test portal or other location is not the same as directly testing the circuit part or conductor for absence of voltage at the point of work.

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Submittal Date: Mon May 24 13:24:50 EDT 2021

Committee: EEW-AAA



Public Input No. 225-NFPA 70E-2021 [Section No. 120.5]

120.5 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 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; (5) Contact between the tester and test point is verified 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: For additional information on rating and design requirements for permanently mounted absence of voltage testers, refer to UL 1436, *Outlet Circuit Testers and Other Similar Indicating Devices*.

Informational Note No. 3: For additional information on rating and design requirements for voltage detectors, refer to 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*.

- (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: ASTM F855, *Standard Specification for Temporary Protective Grounds to be Used on De-energized Electric Power Lines and Equipment*, 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 Input

When testing for absence of voltage, adequate contact is required between the test instrument and the circuit part of conductor. If there is not good contact between the test instrument (whether portable or permanently mounted) and circuit part or conduct at the time of test, voltage will not be detected, regardless of whether or not it is energized. With a portable tester this can be visually verified. However, when testing for absence of voltage with a permanently-mounted tester, installation must be verified as part of the absence of voltage test to ensure reliability of the test result. Installation verification is a critical step for permanently mounted testers and should be explicitly

stated.

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Committee: EEW-AAA



Public Input No. 227-NFPA 70E-2021 [Section No. 120.5]

120.5 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 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: For additional information on rating and design requirements for permanently mounted absence of voltage testers, refer to UL 1436, *Outlet Circuit Testers and Other Similar Indicating Devices*.

Informational Note No. 3: For additional information on rating and design requirements for voltage detectors, refer to 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*.

- (8) The use of temporary protective grounding equipment
- (9) (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:
- (10) a. After a capacitor has been discharged, connect a grounding wire across the terminals of the capacitor to prevent the capacitor from recharging internally.
- (11) b. 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) (20) 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., 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.
- (14) 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: ASTM F855, *Standard Specification for Temporary Protective Grounds to be Used on De-energized Electric Power Lines and Equipment*, is an example of a standard that contains information on capacity of temporary protective grounding equipment.

- (15) 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 Input

As currently written, "temporary protective grounding" refers to two different situations. The first is induced voltage and stored energy. The second is re-energization from a source of electricity. The intention of this public input is to separate the two. Control of static, induction, or recharging capacitors only requires small conductors that can even be clipped onto the conductive surfaces with small clamps. It does not require what is commonly referred to in the industry as Personal Protective Grounds (PPGs). Personal Protective Grounds, on the other hand, must be engineered for the application. They must be capable of carrying the available fault current if the circuit is accidentally re-connected to its source of energy. It is also recommended to test PPGs on a periodic basis.

I have submitted an abstract, concerning this subject, to the IEEE safety workshop in 2022.

Submitter Information Verification

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Committee: EEW-AAA



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

120.5 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.

Informational Note No. 1: Determining sources of supply could include identifying situations where a neutral conductor could continue to carry current after phase conductors have been placed in an electrically safe work condition. This could occur if single or three phase loads remain energized or could become energized and are fed from an alternative source with a shared neutral connection within the work location.

- (1) After properly interrupting the load current, open the disconnecting device(s) for each source.
- (2) 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.
- (3) Release stored electrical energy.
- (4) Block or relieve stored nonelectrical energy in devices to the extent the circuit parts cannot be unintentionally energized by such devices.
- (5) Apply lockout/tagout devices in accordance with a documented and established procedure.
- (6) Use an adequately rated portable test instrument to test each phase conductor or circuit 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 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: For additional information on rating and design requirements for permanently mounted absence of voltage testers, refer to UL 1436, Outlet Circuit Testers and Other Similar Indicating Devices.

Informational Note No. 3: For additional information on rating and design requirements for voltage detectors, refer to 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.

- (7) 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:
 - (8) 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.
 - (9) 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: ASTM F855, Standard Specification for Temporary Protective Grounds to be Used on De-energized Electric Power Lines and Equipment, is an example of a standard that contains information on capacity of temporary protective grounding equipment.
 - (10) 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 Input

The neutral is an electrical conductor and circuit part but is not considered in Article 120.5(1). This conflicts with Article 110.2 General

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

Article 120.5(7) has no requirement to verify that the neutral is de-energized. It states: Use an adequately rated portable test instrument to test each phase conductor or circuit part to verify it is de-energized.

There is no reference in NFPA 70E-2021 to the potential shock hazard of opening a neutral conductor inside an electrically safe work location.

ANSI/NETA MTS-2019 recommends electrical testing of the Ground Fault system every year (on average). Section 7.14.B.2 States: Measure the system neutral-to-ground insulation resistance with the neutral disconnect link temporarily removed. Replace neutral disconnect link after testing.

The shock hazard of an open neutral has been documented in incident reports for fatalities, injuries and near misses. This hazard has been published in a recent IEEE paper: CASE STUDY OF HAZARDS ASSOCIATED WITH NEUTRAL CONDUCTORS, IEEE Paper No. ESW2019-30

Article 110.6(A)(1) Training Requirements of qualified persons states:

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.

The general requirements for training of qualified persons in NFPA 70E-2021 requires the qualified worker to be trained to identify and avoid electrical hazards. In situations where an electrically safe work condition has been established and verified, there is a potential shock hazard on the neutral conductor that is not currently addressed in the standard.

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 238-NFPA 70E-2021 [Article 100]	

Submitter Information Verification

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Committee: EEW-AAA



Public Input No. 24-NFPA 70E-2020 [Section No. 120.5]

120.5 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 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: For additional information on rating and design requirements for permanently mounted absence of voltage testers, refer to UL 1436, *Outlet Circuit Testers and Other Similar Indicating Devices*.

Informational Note No. 3: For additional information on rating and design requirements for voltage detectors, refer to 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*.

- (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

- a. an electric shock hazard (i.e., hazardous differences in electrical potential). The location, sizing, and application of temporary protective grounding equipment shall be identified as part of the employer's job planning.
- b. Capacity. Temporary protective grounding equipment shall be capable of conducting the maximum fault current that could flow at the point of grounding for the time necessary to clear the fault.

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

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

Statement of Problem and Substantiation for Public Input

"electric" is added before "shock" to read "electric shock" to correlate with the use of "electric shock" in the definition of "electrical hazard" and Boundary, Restricted Approach as well as to clarify that the type of shock hazard being addressed is a shock hazard rather than others forms of shock such as where one would go into shock due to a severe injury or a reaction associated with fright.

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.

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

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 15-NFPA 70E-2020 [Definition: Shock Hazard.]	Related issue.

Submitter Information Verification

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Committee: EEW-AAA



Public Input No. 25-NFPA 70E-2020 [Section No. 120.5]

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

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

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 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: For additional information on rating and design requirements for permanently mounted absence of voltage testers, refer to UL 1436, *Outlet Circuit Testers and Other Similar Indicating Devices*.

Informational Note No. 3: For additional information on rating and design requirements for voltage detectors, refer to 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*.

- (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: ASTM F855, *Standard Specification for Temporary Protective Grounds to be Used on De-energized Electric Power Lines and Equipment*, 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 Input

The sentence added is located in 110.2 in the 2021 edition of NFPA 70E. Is is being added here so that it is clear that compliance with 120.5 alone does not establish and verify an electrically safe work condition. Reading the existing text of 120.5, without this added sentence, misleads the user of NFPA 70E into believing that they have both established and verified an electrically safe work condition by

following 120.5 alone without all of the requirements of Article 120 having been met as required by the text of 110.2 being added here..

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Committee: EEW-AAA



Public Input No. 276-NFPA 70E-2021 [Section No. 120.5]

120.5 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 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: For additional information on rating and design requirements for permanently mounted absence of voltage testers, refer to UL 1436, Outlet Circuit Testers and Other Similar Indicating Devices.

Informational Note No. 3: For additional information on rating and design requirements for voltage detectors, refer to 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.

- (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: ASTM F855, Standard Specification for Temporary Protective Grounds to be Used on De-energized Electric Power Lines and Equipment, 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 Input

It is not logical or safe to remove stored energy BEFORE applying a lock, as the system can be turned back on and accumulate energy between the time that you remove stored energy and the time you apply a lock. This error was likely stimulated by the order in 29CFR1910.333(b)(2) (ii) and (iii), where energy removal is discussed before application of a lock. Note that This section of Subpart S is not defining the order, but discussing major steps. The statement in 70E is "...the following steps, which shall be performed in the order

presented, if feasible." It is not feasible to safely remove energy before applying a lock. The correct order should be the rule, not the exception.

NOTE that 29CFR1910.147(d) Application of Control in Control of Hazardous Energy, has the correct order: Preparation, shutdown, LOTO, removal of stored energy, verification.

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Submittal Date: Tue Jun 01 07:56:14 EDT 2021

Committee: EEW-AAA



Public Input No. 278-NFPA 70E-2021 [Section No. 120.5]

120.5 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 if doing so does not expose employees to hazards in addition to those present in 120.5(7).
- (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 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: For additional information on rating and design requirements for permanently mounted absence of voltage testers, refer to UL 1436, Outlet Circuit Testers and Other Similar Indicating Devices.

Informational Note No. 3: For additional information on rating and design requirements for voltage detectors, refer to 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.

- (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: ASTM F855, Standard Specification for Temporary Protective Grounds to be Used on De-energized Electric Power Lines and Equipment, 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 Input

The only change here is to list item (3). There has been confusion over the phrase "Wherever possible" when it comes to visually verifying that disconnect blades have fully opened. It is possible to open the cover of a disconnect switch and remove safety shields and guards to visually check that the blades have opened, it is possible. Some in the industry have taken this statement to mean that if you can, you must. This exposes employees to hazards in addition to the normal process for establishing an electrically safe work condition where the risk to employees is during the absence of voltage test. Employees will be exposed to the hazards during this test, there is no need to

expose them to additional hazards by requiring them to disassemble equipment because it is possible to visually verify open contacts. Yet, this is happening in many places due to the interpretation of "Wherever possible." This PI seeks to clarify that visual verification of open contacts should be performed as long as this step does not expose an employee to additional hazards in order to do so.

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Committee: EEW-AAA



Public Input No. 281-NFPA 70E-2021 [Section No. 120.5]

120.5 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 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: For additional information on rating and design requirements for permanently mounted absence of voltage testers, refer to UL 1436, *Outlet Circuit Testers and Other Similar Indicating Devices*.

Informational Note No. 3: For additional information on rating and design requirements for voltage detectors, refer to 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*.

- (8) Where the possibility of induced voltages or stored electrical energy exists, ground all circuit conductors and circuit parts before touching them. Where it could be reasonably anticipated that the conductors or circuit parts being de-energized could contact other exposed energized conductors or circuit parts, apply temporary protective grounding equipment in accordance with the following:
 - a. *Placement.* Temporary protective grounding equipment shall be placed at such locations and arranged in such a manner as to prevent each employee from being exposed to a shock hazard (i.e., hazardous differences in electrical potential). The location, sizing, and application of temporary protective grounding equipment shall be identified as part of the employer's job planning.
 - b. *Capacity.* Temporary protective grounding equipment shall be capable of conducting the maximum fault current that could flow at the point of grounding for the time necessary to clear the fault.

Informational Note: ASTM F855, *Standard Specification for Temporary Protective Grounds to be Used on De-energized Electric Power Lines and Equipment*, is an example of a standard that contains information on capacity of temporary protective grounding equipment.
 - c. *Impedance.* Temporary protective grounding equipment and connections shall have an impedance low enough to cause immediate operation of protective devices in case of unintentional energizing of the electric conductors or circuit parts.

Additional Proposed Changes

<u>File Name</u>	<u>Description</u>	<u>Approved</u>
PI_281.docx	Revision in word to avoid Terra issue with numbered lists	

Statement of Problem and Substantiation for Public Input

This public input seeks to simply move the release of stored electrical energy until after the verification of the absence of voltage. If these steps are to be performed in the order as presented, the possibility of an employee attempting to discharge a capacitor bank that is still energized exists if the employee de-energizes the wrong circuit. Similar to why temporary grounds are applied after the circuit has been verified to be at 0 volts, the same approach should be taken during the process to discharge capacitors. In the event that the employee de-energizes the incorrect circuit, a verification of absence of voltage test prior to discharging stored electrical energy would make the

employee aware that the circuit is still energized. If for instance a hard grounding procedure for discharging capacitors were to be performed on a circuit that is still energized it would achieve the same result as applying temporary grounding equipment on an energized circuit. By moving this step to after the verification of 0 volts, it will prevent potential injury caused by human error.

Submitter Information Verification

Submitter Full Name: Derek Vigstol

Organization: E Hazard

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City:

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Submittal Date: Tue Jun 01 08:41:43 EDT 2021

Committee: EEW-AAA

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

~~(6)~~(5) Apply lockout/tagout devices in accordance with a documented and established procedure.

~~(7)~~(6) Use an adequately rated portable test instrument to test each phase conductor or circuit 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 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: For additional information on rating and design requirements for permanently mounted absence of voltage testers, refer to UL 1436, Outlet Circuit Testers and Other Similar Indicating Devices.

Informational Note No. 3: For additional information on rating and design requirements for voltage detectors, refer to 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.

(7) Release stored electrical energy.

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

a. Placement. Temporary protective grounding equipment shall be placed at such locations and arranged in such a manner as to prevent each employee from being exposed to a shock hazard (i.e., hazardous differences in electrical potential). The location, sizing, and application of temporary protective grounding equipment shall be identified as part of the employer's job planning.

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

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

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

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Public Input No. 372-NFPA 70E-2021 [Section No. 120.5]

120.5 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 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: For additional information on rating and design requirements for permanently mounted absence of voltage testers, refer to UL 1436, *Outlet Circuit Testers and Other Similar Indicating Devices*.

Informational Note No. 3: For additional information on rating and design requirements for voltage detectors, refer to 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*.

- (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: ASTM F855, *Standard Specification for Temporary Protective Grounds to be Used on De-energized Electric Power Lines and Equipment*, 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.
 - (12) Testing. Temporary protective grounding equipment shall be tested according to the requirements of applicable codes and standards as found in Table 130.7(G), to ensure they will perform as designed and intended during a fault condition.

Statement of Problem and Substantiation for Public Input

Temporary protective grounding equipment is required to be tested as per applicable standards. This requirement is not currently in this section.

Submitter Information Verification**Submitter Full Name:** David Pace**Organization:** Olin Corporation**Affiliation:** Self**Street Address:****City:****State:****Zip:****Submittal Date:** Tue Jun 01 16:46:41 EDT 2021**Committee:** EEW-AAA

**Public Input No. 116-NFPA 70E-2021 [Section No. 130.1]****130.1 General.**

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

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

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

- (1) Only qualified persons shall be permitted to work on electrical conductors or circuit parts that have not been put into an electrically safe work condition.
- (2) An energized electrical work permit shall be completed as required by 130.2.
- (3) A shock risk assessment shall be performed ~~as~~ and documented as required by 130.4.
- (4) An arc flash risk assessment shall be performed and documented as required by 130.5.

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

Statement of Problem and Substantiation for Public Input

The requirement to perform an arc flash risk assessment and a shock risk assessment has increased emphasis as it is included in 110.1 general requirements. Although the documentation requirements are included in Subdivision (D) to both 130.4 and 130.5, including it here reinforces this for employers (contractors) as a responsibility.

Submitter Information Verification

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Submittal Date: Thu May 20 14:28:11 EDT 2021

Committee: EEW-AAA

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

Article 130 covers

Scope

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

130.2 General

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

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

- (1) Only qualified persons shall be permitted to work on electrical conductors or circuit parts that have not been put into an electrically safe work condition.
- (2) An energized electrical work permit shall be completed as required by 130.2.
- (3) A shock risk assessment shall be performed as required by 130.4.
- (4) An arc flash risk assessment shall be performed as required by 130.5.

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

Statement of Problem and Substantiation for Public Input

Subdivide section 130.1 General into 130.1 Scope and 130.2 General as shown. Renumber subsequent sections.

2.2.1 of the new 2020 NEC Style Manual requires each article to have a scope, which shall be the first section of the article.

Submitter Information Verification

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Submission Date: Sat May 22 18:39:24 EDT 2021

Committee: EEW-AAA

**Public Input No. 17-NFPA 70E-2020 [Section No. 130.1]****130.1 General.**

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

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

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

- (1) Only qualified persons shall be permitted to work on electrical conductors or circuit parts that have not been put into an electrically safe work condition.
- (2) An energized electrical work permit shall be completed as required by 130.2.
- (3) A- An electric shock risk assessment shall be performed as required by 130.4.
- (4) An arc flash risk assessment shall be performed as required by 130.5.

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

Statement of Problem and Substantiation for Public Input

"electric" is added before "shock" to read "electric shock" to correlate with the use of "electric shock" in the definition of "electrical hazard" and Boundary, Restricted Approach as well as to clarify that the type of shock hazard being addressed is a shock hazard rather than others forms of shock such as where one would go into shock due to a severe injury or a reaction associated with fright.

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.

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

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 15-NFPA 70E-2020 [Definition: Shock Hazard.]	Related issue

Submitter Information Verification

Submitter Full Name: Palmer Hickman

Organization: Electrical Training Alliance

Street Address:

City:

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Submittal Date: Tue Dec 22 14:18:47 EST 2020

Committee: EEW-AAA

**Public Input No. 221-NFPA 70E-2021 [Section No. 130.1]****130.1 General.**

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

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

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

- (1) Only qualified persons shall be permitted to work on electrical conductors or circuit parts that have not been put into an electrically safe work condition.
- (2) An energized electrical work permit shall be completed as required by 130.2.
- (3) A shock risk assessment shall be performed as required by 130.4.
- (4) An arc flash risk assessment shall be performed as required by 130.5.

All requirements of ~~Article 130 shall~~ 130.2 through 130.7 shall apply whether an incident energy analysis is completed or if Table 130.7(C)(15)(a), Table 130.7(C)(15)(b), and Table 130.7(C)(15)(c) are used in lieu of an incident energy analysis.

Statement of Problem and Substantiation for Public Input

General reference to Article 130 is changed to a specific reference to 130.2 through 130.7.

4.1.4 of the new 2020 NEC Style Manual prohibits references to entire articles.

Submitter Information Verification

Submitter Full Name: Louis Barrios

Organization: Shell Global Solutions

Affiliation: American Petroleum Institute

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Submittal Date: Sun May 23 16:51:20 EDT 2021

Committee: EEW-AAA

**Public Input No. 359-NFPA 70E-2021 [Section No. 130.2(A)]****(A) When Required.**

When work is performed as permitted in accordance with 110.4 (A) and 110.4(B) , 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

Statement of Problem and Substantiation for Public Input

Replace "110.4" with "110.4(A) and 110.4(B)"

Some believe an energized electrical work permit is required for normal operation and for equipment operating at less than 50 volts. Normal operation of equipment in a normal operating condition should not result in an increased likelihood of injury based on the wording in 130.2(A)(2) but it is part of 110.4. The restricted approach boundary for less than 50 volts is described as "not specified" in the tables to 130.4, not that none exists. This change will make it clear that an energized electrical work permit is only required for 110.4(A) and 110.4(B).

Submitter Information Verification

Submitter Full Name: Paul Dobrowsky

Organization: Innovative Technology Services

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City:

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Submittal Date: Tue Jun 01 16:09:57 EDT 2021

Committee: EEW-AAA

**Public Input No. 65-NFPA 70E-2021 [Section No. 130.2(A)]****(A) When Required.**

When work is performed as permitted in accordance with 110.4, 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) Two people shall be required for work to take place when an energized electrical work permit has been issued. One person shall be a qualified person with the knowledge to complete the energized work in a safe manner. The second person shall receive a job briefing by the qualified person in charge of the work before start of work, understand the possible electrical hazards associated with the task, the action to take if an uninspected event occurs and stand back out of harm's way while observing the qualified person perform the required energized work.

Statement of Problem and Substantiation for Public Input

To provide additional safety for the qualified person performing the energized work in case an unexpected event occurs.

Submitter Information Verification

Submitter Full Name: Daryld Crow

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Affiliation: DRC Consulting Inc

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Submittal Date: Fri Mar 26 12:34:27 EDT 2021

Committee: EEW-AAA

**Public Input No. 72-NFPA 70E-2021 [Section No. 130.2(A)]****(A) When Required.**

When work is performed as permitted in accordance with 110.4, an energized electrical work permit shall be required and ~~documented under any of the following conditions: When~~ when energized work 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 Input

(2) could include pretty much anything, even the operation of circuit breakers. As such, electrically energized work permits could be seen as required for any interaction with electrical equipment. This cannot be the intent. Electrically energized work permits should be restricted to the context of performing energized work per the definition of 'working on' in Article 100.

(1) appears to only refer to 'energized work.' This is inferred from "...work in accordance with 110.4..." Is an EEWP required for pushing a reset button that happens to be within the restricted approach boundary of a 277 volt part? Of course, the appropriate PPE is required and all other requirements are in force. But does it require an EEWP? I don't believe so, at least the way i read the section. But this has been a topic of a good deal of discussion. Adding the word 'energized' would clarify this significantly.

Submitter Information Verification

Submitter Full Name: Eric Stromberg

Organization: Los Alamos National Laboratory

Affiliation: Self

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Submittal Date: Wed Mar 31 12:08:32 EDT 2021

Committee: EEW-AAA



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

(B) Elements of Work Permit.

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

- (1) Description of the circuit and equipment to be worked on and their location
- (2) Description of the work to be performed
- (3) Justification for why the work must be performed in an energized condition *[see 110.4]*
- (4) Description of the safe work practices to be employed *(see 130.1)*
- (5) Results of the shock risk assessment *[see 130.4(A)]*
 - (6) Voltage to which personnel will be exposed
 - (7) Limited approach boundary *[see 130.4(F), Table 130.4(E)(a), and Table 130.4(E)(b)]*
 - (8) Restricted approach boundary *[see 130.4(G), Table 130.4(E)(a), and Table 130.4(E)(b)]*
 - (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)(16), and 130.7(D)]*
- (10) Results of the arc flash risk assessment *[see 130.5]*
 - (11) Available incident energy at the working distance or arc flash PPE category *(see 130.5)*
 - (12) Personal and other protective equipment required by this standard to protect against the arc flash hazard *[see 130.5(F), 130.7(C)(1) through (C)(16), Table 130.7(C)(15)(c), and 130.7(D)]*
 - (13) Arc flash boundary *[see 130.5(E)]*
- (14) Means employed to restrict the access of unqualified persons from the work area *[see 130.7(E)]*
- (15) Evidence of completion of a job briefing, including a discussion of any job-specific hazards *[see 110.5(I)]*
- (16) Energized work approval (authorizing or responsible management, safety officer, or owner, etc.) signature(s)

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

Statement of Problem and Substantiation for Public Input

TerraView error. Only change is to relocate reference to front of Informational Note.

Revised Informational Note to comply with new 2020 NEC Style Manual.

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

Submitter Information Verification

Submitter Full Name: Louis Barrios
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Affiliation: American Petroleum Institute
Street Address:
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Submittal Date: Sun May 23 12:26:54 EDT 2021
Committee: EEW-AAA



Public Input No. 19-NFPA 70E-2020 [Section No. 130.2(B)]

(B) Elements of Work Permit.

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

- (1) Description of the circuit and equipment to be worked on and their location
- (2) Description of the work to be performed
- (3) Justification for why the work must be performed in an energized condition *[see 110.4]*
- (4) Description of the safe work practices to be employed *(see 130.1)*
- (5) Results of the electric shock risk assessment *[see 130.4(A)]*
 - (6) Voltage to which personnel will be exposed
 - (7) Limited approach boundary *[see 130.4(F), Table 130.4(E)(a), and Table 130.4(E)(b)]*
 - (8) Restricted approach boundary *[see 130.4(G), Table 130.4(E)(a), and Table 130.4(E)(b)]*
 - (9) Personal and other protective equipment required by this standard to safely perform the assigned task and to protect against the electric shock hazard *[see 130.4(F), 130.7(C)(1) through (C)(16), and 130.7(D)]*
- (10) Results of the arc flash risk assessment *[see 130.5]*
 - (11) Available incident energy at the working distance or arc flash PPE category *(see 130.5)*
 - (12) Personal and other protective equipment required by this standard to protect against the arc flash hazard *[see 130.5(F), 130.7(C)(1) through (C)(16), Table 130.7(C)(15)(c), and 130.7(D)]*
 - (13) Arc flash boundary *[see 130.5(E)]*
- (14) Means employed to restrict the access of unqualified persons from the work area *[see 130.7(E)]*
- (15) Evidence of completion of a job briefing, including a discussion of any job-specific hazards *[see 110.5(I)]*
- (16) Energized work approval (authorizing or responsible management, safety officer, or owner, etc.) signature(s)

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

Statement of Problem and Substantiation for Public Input

"electric" is added before "shock" to read "electric shock" in two locations to correlate with the use of "electric shock" in the definition of "electrical hazard" and Boundary, Restricted Approach as well as to clarify that the type of shock hazard being addressed is a shock hazard rather than others forms of shock such as where one would go into shock due to a severe injury or a reaction associated with fright.

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.

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

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 15-NFPA 70E-2020 [Definition: Shock Hazard.]	Related issue

Submitter Information Verification

Submitter Full Name: Palmer Hickman

Organization: Electrical Training Alliance

Street Address:

City:

State:

Zip:

Submission Date: Tue Dec 22 14:27:24 EST 2020

Committee: EEW-AAA



Public Input No. 80-NFPA 70E-2021 [Section No. 130.2(B)]

(B) Elements of Work Permit.

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

- (1) Description of the circuit and equipment to be worked on and their location
- (2) Description of the work to be performed
- (3) Justification for why the work must be performed in an energized condition *[see 110.4]*
- (4) Description of the safe work practices to be employed *(see 130.1)*
- (5) Results of the shock risk assessment *[see 130.4(A)]*
 - (6) Voltage to which personnel will be exposed
 - (7) Limited approach boundary *[see 130.4(F) , Table 130.4(E)(a) , and Table 130.4(E)(b)]*
 - (8) Restricted approach boundary *[see 130.4(G) , Table 130.4(E)(a) , and Table 130.4(E)(b)]*
 - (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)(16) , and 130.7(D)]*
 - (10) Additional protective measures identified *[110.5(H)(3)]*
- (11) Results of the arc flash risk assessment *[see 130.5]*
 - (12) Available incident energy at the working distance or arc flash PPE category *(see 130.5)*
 - (13) Personal and other protective equipment required by this standard to protect against the arc flash hazard *[see 130.5(F) , 130.7(C)(1) through (C)(16) , Table 130.7(C)(15)(c) , and 130.7(D)]*
 - (14) Arc flash boundary *[see 130.5(E)]*
 - (15) Additional protective measures identified *[see 110.5(H)(3)]*
- (16) Means employed to restrict the access of unqualified persons from the work area *[see 130.7(E)]*
- (17) Evidence of completion of a job briefing, including a discussion of any job-specific hazards *[see 110.5(I)]*
- (18) Energized work approval (authorizing or responsible management, safety officer, or owner, etc.) signature(s)

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

Statement of Problem and Substantiation for Public Input

Although Terra shows more underlined, this recommendation only adds a new 130.2(B)(5)(e) and (6)(d). This change is recommended since determining "additional protective measures identified in 110.5(H)(3)" is required as part of both the shock and arc flash risk assessment per 130.5(C) and must be documented per 130.5(D). These are part of their respective risk assessments and should therefore be documented along with the rest of the risk assessments which are already required to be included on the permit and discussed during the job briefing.

Submitter Information Verification

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City:

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Submission Date: Mon Apr 05 18:22:54 EDT 2021

Committee: EEW-AAA

**Public Input No. 1-NFPA 70E-2020 [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 Input

It is my opinion that exemption 130.2 (C)(1) "Testing, troubleshooting, or voltage measuring" - is in direct conflict with 130.2 (A)(1) and should be eliminated from the list of exemptions to the Energized Electrical Work Permit. In most cases it would not be possible to remove/open covers to allow for testing, troubleshooting or voltage measuring without crossing the restricted approach boundary. Also, use of standard length meter leads or conventional clamp on ammeter would put the qualified person inside the restricted approach boundary while in the process of testing, troubleshooting or voltage measuring. Completing an EEWP for these tasks takes time but it will help to assure that the qualified person has identified all risks and is planning to use appropriate safe work practices and PPE.

Submitter Information Verification

Submitter Full Name: Shannon Buck

Organization: Dell Technologies

Street Address:

City:

State:

Zip:

Submittal Date: Wed Oct 21 10:25:19 EDT 2020

Committee: EEW-AAA

**Public Input No. 101-NFPA 70E-2021 [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 Input

The item is redundant to 130.2(A)(1) regarding a shock hazard and is unnecessary for shock. The activity described in the item is non-contact and the employee is not interacting with the equipment physically. If the risk assessment determines an arc flash hazard exists, because the equipment is not in normal operating condition or some other unusual circumstance, the employer should be authorizing this task if it would expose a worker to an increased likelihood of injury due to arc flash.

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 102-NFPA 70E-2021 [Section No. 130.2(C)]	Common justification
Public Input No. 103-NFPA 70E-2021 [Section No. 130.2(C)]	Common justification
Public Input No. 102-NFPA 70E-2021 [Section No. 130.2(C)]	
Public Input No. 103-NFPA 70E-2021 [Section No. 130.2(C)]	

Submitter Information Verification

Submitter Full Name: Bobby Gray
Organization: Hoydar/Buck, Inc.
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Submittal Date: Thu May 13 13:26:50 EDT 2021
Committee: EEW-AAA

**Public Input No. 102-NFPA 70E-2021 [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 Input

The item is redundant to 130.2(A)(1) regarding a shock hazard and is unnecessary for shock. The activity described in the item is non-contact and the employee is not interacting with the equipment physically. If the risk assessment determines an arc flash hazard exists, because the equipment is not in normal operating condition or some other unusual circumstance, the employer should be authorizing this task if it would expose a worker to an increased likelihood of injury due to arc flash.

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 101-NFPA 70E-2021 [Section No. 130.2(C)]	Common justification
Public Input No. 103-NFPA 70E-2021 [Section No. 130.2(C)]	Common justification
Public Input No. 101-NFPA 70E-2021 [Section No. 130.2(C)]	
Public Input No. 103-NFPA 70E-2021 [Section No. 130.2(C)]	

Submitter Information Verification

Submitter Full Name: Bobby Gray
Organization: Hoydar/Buck, Inc.
Affiliation: Self
Street Address:
City:
State:
Zip:
Submittal Date: Thu May 13 13:31:06 EDT 2021
Committee: EEW-AAA

**Public Input No. 103-NFPA 70E-2021 [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 Input

The item is redundant to 130.2(A)(1) regarding a shock hazard and is unnecessary for shock. The activity described in the item is non-contact and the employee is not interacting with the equipment physically. If the risk assessment determines an arc flash hazard exists, because the equipment is not in normal operating condition or some other unusual circumstance, the employer should be authorizing this task if it would expose a worker to an increased likelihood of injury due to arc flash.

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 101-NFPA 70E-2021 [Section No. 130.2(C)]	Common justification
Public Input No. 102-NFPA 70E-2021 [Section No. 130.2(C)]	Common justification
Public Input No. 101-NFPA 70E-2021 [Section No. 130.2(C)]	
Public Input No. 102-NFPA 70E-2021 [Section No. 130.2(C)]	

Submitter Information Verification

Submitter Full Name: Bobby Gray
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Submittal Date: Thu May 13 13:35:16 EDT 2021
Committee: EEW-AAA

**Public Input No. 104-NFPA 70E-2021 [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) Operating a switch or circuit breaker for the purpose of establishing an electrically safe work condition

Statement of Problem and Substantiation for Public Input

Many employers have a conservative policy that operating a switch or circuit breaker that is in normal operating condition requires arc flash protection. Other employers have a position that normal operation does not present an arc flash hazard. As currently written, the conservative employer is obligated to apply the rigor of an Energized Electrical Work Permit to justify self-imposed protection, while a less-conservative employer would not. The standard should not incentivize a lower risk tolerance threshold.

Submitter Information Verification

Submitter Full Name: Bobby Gray

Organization: Hoydar/Buck, Inc.

Affiliation: Self

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City:

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Submittal Date: Thu May 13 13:52:57 EDT 2021

Committee: EEW-AAA

**Public Input No. 105-NFPA 70E-2021 [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) Removing or reinstalling cables from or to battery terminals for the purpose of establishing an electrically safe work condition or returning a system to service from an electrically safe work condition

Statement of Problem and Substantiation for Public Input

Battery systems without overcurrent between the energy source and worker where the system equals or exceeds 50 volts, or battery systems less than 50 volts that have the capacity to cause an electrical burn injury, may require the worker to remove cables from battery terminals to create an electrically safe work condition. This activity requires the worker to work within the restricted approach boundary and it would be infeasible to complete the task in a de-energized condition. Currently the task requires an Energized Electrical Work Permit, even though the task meets the same criteria for risk as testing and troubleshooting if all the requirements of Article 130 are followed. No additional safety protection is provided by requiring an EEWP to remove battery cables if the purpose is to establish an electrically safe work condition.

Submitter Information Verification

Submitter Full Name: Bobby Gray

Organization: Hoydar/Buck, Inc.

Affiliation: Self

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Submittal Date: Thu May 13 14:00:47 EDT 2021

Committee: EEW-AAA

**Public Input No. 269-NFPA 70E-2021 [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) Disconnecting battery terminals to establish an electrically safe work condition where no isolating device is available

Statement of Problem and Substantiation for Public Input

Current wording requires an EEWP to disconnect battery terminals if no isolating device is available to establish an electrically safe work condition. The committee statement when the EEWP was made a requirement for the 2004 edition makes it clear the purpose was to force the employer to consider establishing an electrically safe work condition before directing workers to perform work energized. By requiring an EEWP where de-energizing is not practicable except through crossing the restricted approach boundary, such as batteries, the requirement is diluted. So long as an adequate risk assessment is performed and applicable controls incorporated, the EEWP adds no safety margin to the task of making the workplace electrically safe.

Submitter Information Verification

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Organization: Hoydar/Buck, Inc.

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Street Address:

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State:

Zip:

Submittal Date: Mon May 31 14:31:30 EDT 2021

Committee: EEW-AAA

**Public Input No. 288-NFPA 70E-2021 [Section No. 130.2(C)]****(C) Exemptions to Work Permit.**

Electrical work shall. ~~Testing, troubleshooting, or voltage measuring 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 4~~ 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~~

this standard.

Statement of Problem and Substantiation for Public Input

Items (2), (3), and (4) are not needed to be listed as exemptions from the EEWP since they are not tasks that require one in the first place. The requirement for an EEWP is based on if the employee crosses the restricted approach boundary or interacts with equipment in a manner that poses an arc flash hazard. Since none of these items do either of those things, they are not needed as exemptions. Also, having them listed led some to believe that all thermography or housekeeping activities are exempt. Which would not be the case if the restricted approach boundary was crossed. Is it better to have an EEWP when not needed or no EEWP when one is?

Submitter Information Verification

Submitter Full Name: Derek Vigstol

Organization: E Hazard

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City:

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Zip:

Submittal Date: Tue Jun 01 09:15:18 EDT 2021

Committee: EEW-AAA

**Public Input No. 346-NFPA 70E-2021 [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 and does not require opening of doors or removal of covers with expose bare energized conductors or circuit parts inside
- (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 Input

Currently there are different stipulations in Table 130.5 (C) for similar tasks. This revised text aligns the requirements of 130.2 (C) with similar tasks in Table 130.5 (C)

Submitter Information Verification

Submitter Full Name: Daleep Mohla

Organization: DCM Electrical Consulting Serv

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City:

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Submittal Date: Tue Jun 01 15:21:45 EDT 2021

Committee: EEW-AAA

**Public Input No. 66-NFPA 70E-2021 [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) E lectrical _ equipment _ designed _ and _ intended _ to _ be _ installed _ or _ removed _ while _ energized _ (such _ as _ fused _ cutouts, racking _ type _ circuit _ breakers _ or _ racking _ type _ starters). _ Arc _ flash _ PPE _ shall _ be _ required _ as _ specified _ on _ the _ arc _ flash label or the NFPA 70E PPE tables.

Statement of Problem and Substantiation for Public Input

This equipment is designed to be installed and removed while energized

Submitter Information Verification

Submitter Full Name: Daryld Crow

Organization: DRC Consulting, Inc.

Affiliation: DRC Consulting Inc.

Street Address:

City:

State:

Zip:

Submittal Date: Fri Mar 26 12:42:50 EDT 2021

Committee: EEW-AAA

**Public Input No. 73-NFPA 70E-2021 [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 Input

Bullet (4) seems out of place. An EEWP is only required when work is done in accordance with 110.4. 110.4 is titled "energized work." Housekeeping is not energized work and so it is already excluded from needing an EEWP. Non-electrical tasks, by definition, are not energized work so they are also excluded.

Submitter Information Verification

Submitter Full Name: Eric Stromberg

Organization: Los Alamos National Laboratory

Affiliation: Self

Street Address:

City:

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Submittal Date: Wed Mar 31 12:32:34 EDT 2021

Committee: EEW-AAA

**Public Input No. 16-NFPA 70E-2020 [Section No. 130.4]****130.4– 4 _ Electric Shock Risk Assessment.****(A) General.**

A- An electric shock risk assessment shall be performed:

- (1) To identify electric shock hazards
- (2) To estimate the likelihood of occurrence of injury or damage to health and the potential severity of injury or damage to health
- (3) To determine if additional protective measures are required, including the use of PPE

(B) Estimate of Likelihood and Severity.

The estimate of likelihood of occurrence of injury or damage to health and the potential severity of injury or damage to health shall take into consideration all of the following:

- (1) The design of the electrical equipment
- (2) The electrical equipment operating condition and the condition of maintenance

(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 110.5(H)(3). When the additional protective measures include the use of PPE, the following shall be determined:

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

(D) Documentation.

The results of the electric shock risk assessment shall be documented.

(E)– Electric Shock Protection Boundaries.

The electric 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 electric shock protection boundaries and the arc flash boundary are independent of each other.

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

(1)	(2)	(3)	(4)
<u>Nominal System Voltage Range, Phase to Phase^a</u>	<u>Exposed Movable Conductor^c</u>	<u>Limited Approach Boundary^b</u> <u>Exposed Fixed Circuit Part</u>	<u>Restricted Approach Boundary^b; Includes Inadvertent Movement Adder</u>
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.

^aFor 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.

^bSee 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.

^dThis includes circuits where the exposure does not exceed 120 volts nominal.

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

(1)	(2)	(3)	(4)
<u>Nominal Potential</u>	<u>Limited Approach Boundary</u>	<u>Restricted Approach Boundary; Includes</u>	

<u>Difference</u>	<u>Exposed Movable Conductor*</u>	<u>Exposed Fixed Circuit Part</u>	<u>Inadvertent Movement Adder</u>
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 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.

(F) Limited Approach Boundary.

(1) Approach by Unqualified Persons.

Unless permitted by 130.4(F)(3), no unqualified person shall be permitted to approach nearer than the limited approach boundary of energized conductors and circuit parts.

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

Where one or more unqualified persons are working at or close to the limited approach boundary, the alerting methods in 130.7(E) shall be applied to advise the unqualified person(s) of the electrical hazard and warn him or her to stay outside of the limited approach boundary.

(3) Entering the Limited Approach Boundary.

Where there is a need for an unqualified person(s) to cross the limited approach boundary, a qualified person shall advise the unqualified person(s) of the possible hazards and continuously escort the unqualified person(s) while inside the limited approach boundary. Under no circumstance shall unqualified person(s) be permitted to cross the restricted approach boundary.

(G) Restricted Approach Boundary.

No qualified person shall approach or take any conductive object closer to exposed energized electrical conductors or circuit parts than the restricted approach boundary set forth in Table 130.4(E)(a) and Table 130.4(E)(b), unless one of the following conditions applies:

- (1) The qualified person is insulated or guarded from energized electrical conductors or circuit parts operating at 50 volts or more. Insulating gloves and sleeves are considered insulation only with regard to the energized parts upon which work is performed.
- (2) The energized electrical conductors or circuit parts are insulated from the qualified person and from any other conductive object at a different potential.

Statement of Problem and Substantiation for Public Input

"electric" is added before "shock" to read "electric shock" to correlate with the use of "electric shock" in the definition of "electrical hazard" and Boundary, Restricted Approach as well as to clarify that the type of shock hazard being addressed is a shock hazard rather than others forms of shock such as where one would go into shock due to a severe injury or a reaction associated with fright.

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.

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

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 15-NFPA 70E-2020 [Definition: Shock Hazard.]	
Public Input No. 15-NFPA 70E-2020 [Definition: Shock Hazard.]	

Submitter Information Verification

Submitter Full Name: Palmer Hickman

Organization: Electrical Training Alliance

Street Address:

City:

State:

Zip:	
Submittal Date:	Tue Dec 22 14:04:32 EST 2020
Committee:	EEW-AAA

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

A shock risk assessment shall be performed:

- (1) To identify shock hazards
- (2) To estimate the likelihood of occurrence of injury or damage to health and the potential severity of injury or damage to health
- (3) To determine if additional protective measures are required, ~~including the use of PPE~~

Statement of Problem and Substantiation for Public Input

When additional protective measures includes PPE is addressed in 130.4(C) and should not be repeated here. Also, we should not emphasize PPE over other protective measures.

Submitter Information Verification

Submitter Full Name: David Pace

Organization: Olin Corporation

Affiliation: Self

Street Address:

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Zip:

Submittal Date: Tue Jun 01 17:07:44 EDT 2021

Committee: EEW-AAA



Public Input No. 270-NFPA 70E-2021 [Section No. 130.4(E)]

(E) Shock Protection Boundaries.

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

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

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

(1)	(2)	(3)	(4)
<u>Nominal System Voltage Range, Phase to Phase^a</u>	<u>Exposed Movable Conductor^c</u>	<u>Limited Approach Boundary^b</u>	
		<u>Exposed Fixed Circuit Part</u>	<u>Restricted Approach Boundary^b; Includes Inadvertent Movement Adder</u>
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.) Phase to Phase — — — Phase to Ground
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.) 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 6 in.) 0.8 m (2 ft 6 in.)
36.1 kV–46 kV	3.0 m (10 ft 0 in.)	2.5 m (8 ft 0 in.)	1.0 m (3 ft 3 in.) 0.8 m (2 ft 6 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 3 in.) 1.0 m (3 ft 3 in.)
72.6 kV–121 kV	3.3 m (11 ft 0 in.)	2.5 m (8 ft 0 in.)	1.0 m (3 ft 3 in.) 1.1 m (3 ft 6 in.)
121 kV–145 kV	3.4 m (11 ft 2 in.)	3.0 m (10 ft 0 in.)	1.2 m (4 ft 0 in.) 1.3 m (4 ft 3 in.)
145 kV–161 kV	3.6 m (11 ft 8 in.)	3.6 m (11 ft 8 in.)	1.4 m (4 ft 6 in.) 1.4 m (4 ft 6 in.)
161 kV–230 kV	4.0 m (13 ft 0 in.)	4.0 m (13 ft 0 in.)	1.7 m (5 ft 6 in.) 2.0 m (6 ft 6 in.)
230 kV–345 kV	4.6 m (15 ft 1 in.)	4.7 m (15 ft 5 in.)	1.8 m (5 ft 9 in.) 3.4 m (11 ft 2 in.)
345 kV–500 kV	5.8 m (19 ft 0 in.)	5.8 m (19 ft 0 in.)	2.0 m (6 ft 6 in.) 5.1 m (16 ft 7 in.)
500 kV–765 kV	7.2 m (23 ft 6 in.)	7.2 m (23 ft 6 in.)	6.9 m (22 ft 6 in.) 6.9 m (22 ft 6 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.

^aFor 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.

^bSee definition in Article 100 and text in 130.4(D)(2) and Informative Annex C for elaboration.

^cExposed 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.

^dThis 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)
<u>Nominal Potential Difference</u>	<u>Limited Approach Boundary</u>		<u>Restricted Approach Boundary; Includes Inadvertent Movement Adder</u>
	<u>Exposed Movable Conductor*</u>	<u>Exposed Fixed Circuit Part</u>	
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 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 Input

Table 130.4(E)(a) does not comply with OSHA 1910.269 Tables R6 and R7. The OSHA tables are more conservative. In addition, Tables R6 and R7 include a column labeled "Phase To Ground Exposure". 70E's Table only lists "Nominal System Voltage Range, Phase to Phase". This discrepancy prones to confuse people when they compare the 70E Table to OSHA Tables. Also, OSHA Regulations are US Law. Therefore, OSHA Tables are prioritized over the 70E Table. Trainers have to make the case that when establishing shock boundaries, they state, "Ignore the distances in 70E and comply with the distances in the OSHA Tables". It makes sense to conform the 70E Table to OSHA's Tables. Having the same distances and exposures in both tables will reduce confusion.

Submitter Information Verification

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Submittal Date: Mon May 31 15:32:58 EDT 2021

Committee: EEW-AAA



Public Input No. 277-NFPA 70E-2021 [Section No. 130.4(E)]

(E) Shock Protection Boundaries.

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

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

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

(1)	(2)	(3)	(4)
		<u>Limited Approach Boundary^b</u>	
<u>Nominal System Voltage Range, Phase to Phase^a</u>	<u>Exposed Movable Conductor^c</u>	<u>Exposed Fixed Circuit Part</u>	<u>Restricted Approach Boundary^b; Includes Inadvertent Movement Adder</u>
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.

^aFor 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.

^bSee 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.

^dThis 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^a 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 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–121 kV 3.3 m (10 ft 8 in.) 2.5 m (8 ft 0 in.) 1.0 m (3 ft 6 in.) 121 kV–138 kV 3.4 m (11 ft 0 in.) 3.0 m (10 ft 0 in.) 1.2 m (3 ft 10 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.) 145 kV–161 kV 3.6 m (11 ft 8 in.) 3.6 m (11 ft 8 in.) 1.3 m (4 ft 3 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.) 169 kV–230 kV 4.0 m (13 ft 0 in.) 4.0 m (13 ft 0 in.) 1.7 m (5 ft 8 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.) 242 kV–345 kV 4.7 m (15 ft 4 in.) 4.7 m (15 ft 4 in.) 2.8 m (9 ft 2 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.) 362 kV–500 kV 5.8 m (19 ft 0 in.) 5.8 m (19 ft 0 in.) 3.6 m (11 ft 8 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.) 550 kV–765 kV 7.2 m (23 ft 9 in.) 7.2 m (23 ft 9 in.) 4.9 m (15 ft 11 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.)

(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 Input

Historically Chapter 1 was written for safe work practices for those workers that work on systems defined by NFPA 70, the NEC. Thus, historically, the hazards addressed were shock and arc flash on 60 Hz, ac systems. As the Scope of 70E has grown to cover all Qualified Electrical Workers in all work places, Chapter 3 - Safety Requirements for Special Equipment has continued to grow to embrace specialized equipment beyond the original intent of Chapter 1. This includes dc, batteries, capacitors, the thermal hazard, and more. Initially (2012 edition), the dc Approach Boundary Table was placed in Chapter 1, next to the ac Approach Boundary Table. The threshold for dc shock hazard was set at 100 V based on multiple publications analyzing research and accidents on dc shock. This held for 6 years, in the 2012 and 2015 versions of NFPA 70E. Then, the threshold for dc was moved back down to 50 V dc in the 2018 version. One reason was the confusion of having two thresholds in Chapter 1, one for ac and one for dc. Approximately 15 times throughout this chapter, for various requirements, the phrase, "for 50 V and greater", is used, to indicate at what voltage the requirement is invoked. To fix these 15 locations to "50 V and greater for ac and 100 V and great for dc" would have been confusing for many users of Chapter 1.

Chapter 1 sets the basic core requirements and the Chapter 3 Scope "covers special electrical equipment in the workplace and modifies the general requirements of Chapter 1."

Since dc is covered in Articles 310 (Electrolytic Cells), 320 (Batteries), 330 (Lasers), 340 (Power Electronics), 350 (R&D Laboratories), and 360 (Capacitors) it is appropriate to move the dc Approach Boundary to Chapter 3. It would likely go in Article 300, or perhaps create a new article.

The threshold of 100 V for dc shock injury is used throughout Chapter 3. Moving the dc Approach Boundary Table to Chapter 3 would allow the threshold for shock to be moved back to 100 V in the Table and would make Chapters 1 and Chapter 3 consistent throughout.

Submitter Information Verification

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Submittal Date: Tue Jun 01 08:15:28 EDT 2021

Committee: EEW-AAA



Public Input No. 74-NFPA 70E-2021 [Section No. 130.4(E)]

(E) Shock Protection Boundaries.

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

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

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

(1)	(2)	(3)	(4)
<u>Nominal System Voltage Range, Phase to Phase^a</u>	<u>Exposed Movable Conductor^c</u>	<u>Limited Approach Boundary^b</u> <u>Exposed Fixed Circuit Part</u>	<u>Restricted Approach Boundary^b, Includes Inadvertent Movement Adder</u>
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 ^e	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.

^aFor 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.

^bSee 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.

^dThis includes circuits where the exposure does not exceed 120 volts nominal, line to neutral.

^e This includes 120/240 volt systems

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)

<u>Nominal Potential Difference</u>	<u>Limited Approach Boundary</u>		<u>Restricted Approach Boundary; Includes Inadvertent Movement Adder</u>
	<u>Exposed Movable Conductor*</u>	<u>Exposed Fixed Circuit Part</u>	
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 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 Input

The column heading for systems voltages is "Phase to Phase." This constrains this table to three phase systems, or 'single-phase' systems fed from two phases of a three phase system. Single winding systems, such as 120/240, do not have phase conductors they have line conductors, so are inadvertently excluded from this table. There is a note on the table that gives direction for single phase systems where the phase to neutral is 250 volts or more. But what about when the voltage is less than 250?

The addition to note (d) is necessary because the intent is to include 120 line to neutral, even though the column heading is phase to phase.

Without the added note (e), 120/240 volt systems are excluded from this table because these systems do not have phase conductors. But since this is a table for shock hazards, these systems should be included.

Another possibility would be to change the column heading to "line to line." This would include both single winding systems and three phase systems.

Submitter Information Verification

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Submittal Date: Wed Mar 31 12:51:48 EDT 2021

Committee: EEW-AAA



Public Input No. 94-NFPA 70E-2021 [Section No. 130.4(E)]

(E) Shock Protection Boundaries.

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

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

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

(1)	(2)	(3)	(4)	
<u>Nominal System Voltage Range, Phase to Phase^a</u>	<u>Exposed Movable Conductor^c</u>	<u>Limited Approach Boundary^b</u>		<u>Restricted Approach Boundary^b; Includes Inadvertent Movement Adder</u>
		<u>Exposed Fixed Circuit Part</u>		
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–300 V	3.0 m (10 ft 0 in.)	1.0 m (3 ft 6 in.)	0.3 m (1 ft 0 in.)	
Avoid contact				
301 V–750 V	3.0 m (10 ft 0 in.)	1.0 m (3 ft 6 in.)	.32 m (1 ft 1 in.)	
751 V–15 kV	3.0 m (10 ft 0 in.)	1.5 m (5 ft 0 in.)	0.7 m (2 ft 3 in.)	
15.1 kV–36 kV	3.0 m (10 ft 0 in.)	1.8 m (6 ft 0 in.)	.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.)	1.8 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.)	
121.1 kV–145 kV	3.4 m (11 ft 0 in.)	3.0 m (10 ft 0 in.)	1.2 m (3 ft 10 in.)	
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.)	
169.1 kV–242 kV	4.0 m (13 ft 0 in.)	4.0 m (13 ft 0 in.)	2.7 m (9 ft 0 in.)	
242.1 kV–362 kV	4.7 m (15 ft 4 in.)	4.7 m (15 ft 4 in.)	3.8 m (12 ft 6 in.)	
362.1 kV–420 kV	5.8 m (19 ft 0 in.)	5.8 m (19 ft 0 in.)	4.55 m (14 ft 11 in.)	
420.1 kV–550 kV	5.8 m (19 ft 0 in.)	5.8 m (19 ft 0 in.)	5.6 m (18 ft 5 in.)	
550.1 kV–800 kV	7.2 m (23 ft 9 in.)	7.2 m (23 ft 9 in.)	7.9 m (26 ft 1 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.

^aFor 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.

^bSee 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.

^dThis 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)

<u>Nominal Potential Difference</u>	<u>Limited Approach Boundary</u>		<u>Restricted Approach Boundary; Includes Inadvertent Movement Adder</u>
	<u>Exposed Movable Conductor*</u>	<u>Exposed Fixed Circuit Part</u>	
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 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.

Additional Proposed Changes

<u>File Name</u>	<u>Description</u>	<u>Approved</u>
70E_130.4_Shock_Approach_Tables_TG_2_Revised.docx	Word version of the revised table and substantiation for the changes.	

Statement of Problem and Substantiation for Public Input

This public input 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 2017 National Electrical Safety Code (NESC) Table 431-1, Communication work minimum approach distances. (This public input leaves the limited approach boundaries unchanged.) As a consequence of this correlation, the nominal system voltage ranges have been adjusted to also align with Table 431-1.

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-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. The comparison is included as an attached Excel spreadsheet. After reviewing those other tables, the Task Group chose to correlate Table 130.4(E)(a) with NESC Table 431-1.

The Task Group determined that the distances in NESC Table 431-1 were the most protective and most comparable to work practices within the scope of NFPA 70E.

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. OSHA Tables R-2 and S-5 apply to telecommunications work and general electrical safe work practices, respectively, and contain identical minimum approach distances (the equivalent of restricted approach boundaries). OSHA Table S-5 is most directly comparable to the restricted approach boundaries in NFPA 70E Table 130.4(E)(a) since the 1983 edition of NFPA 70E formed the basis for 29 CFR 1910.333. However, the minimum approach distances in those two OSHA standards (29 CFR 1910.268 and 1910.333) are substantially out of date. Table R-2 was promulgated in 1975, and Table S-5 was promulgated in 1990. Since that time, OSHA promulgated revisions of 29 CFR 1910.269 and 29 CFR Part 1926, Subpart V that adopted minimum approach distances 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.

NESC Table 431-1 represents a more conservative basis for setting approach distances for general electrical (as opposed to electric-power-specific) approach distances. The substantiation for this table, at the time it was adopted, generally is as follows:

- 1) For voltages below 72 kV, Table 431-1 uses phase-to-phase MAD distances from Table 441-1 as a conservative approach since phase-to-phase distances are larger than phase-to-ground distances.
- 2) Above 72 kV, the values for phase-to-ground exposure were used to better represent the actual hazard condition for telecommunication workers.
- 3) MAD values for each voltage range used the maximum voltage value of the range.
- 4) At the higher voltage ranges, whole-foot numbers (rounded up to next higher whole foot) were used as a more conservative approach.
- 5) Above 72kV, an additional 1 foot or 2 feet was added for the communications workers over the electrical worker value calculated from OSHA Table R-7.

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. Additional distance to OSHA Table R-7 is added to account for lack of utility control over transient overvoltages and to account for the general lack of training relative to electric power workers.

This approach yields conservative restricted approach boundaries for communications workers and, by extension, other nonpower workers. The Task Group concluded that this is an appropriate approach to use for setting restricted approach boundaries in Table 431-1.

The table included in the attached Word document should be used for this PI. Although an attempt was made to revise the Table in TerraView, it appears the changes were incomplete.

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Submittal Date: Tue May 04 07:04:53 EDT 2021

Committee: EEW-AAA

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

(1) Nominal System Voltage Range, Phase to Phase ^a	(2) Limited Approach Boundary ^b		(4) Restricted Approach Boundary ^b ; Includes Inadvertent Movement Adder
	Exposed Movable Conductor ^c	Exposed Fixed Circuit Part	
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–300 V~~	~~3.0 m (10 ft 0 in.)~~	~~1.0 m (3 ft 6 in.)~~	~~Avoid contact~~
~~454~~ 301 V–750 V	3.0 m (10 ft 0 in.)	1.0 m (3 ft 6 in.)	~~0.30.32~~ m (1 ft ~~01~~ in.)
751 V–15 kV	3.0 m (10 ft 0 in.)	1.5 m (5 ft 0 in.)	~~0.70.69~~ m (2 ft ~~23~~ in.)
15.1 kV–36 kV	3.0 m (10 ft 0 in.)	1.8 m (6 ft 0 in.)	~~0.80.91~~ m (~~23~~ ft ~~9.0~~ in.)
36.1 kV–46 kV	3.0 m (10 ft 0 in.)	2.5 m (8 ft 0 in.)	~~0.81.07~~ m (~~23~~ ft ~~96~~ in.)
46.1 kV–72.5 kV	3.0 m (10 ft 0 in.)	2.5 m (8 ft 0 in.)	~~4.01.22~~ m (~~34~~ ft ~~60~~ in.)
72.6 kV–121 kV	3.3 m (10 ft 8 in.)	2.5 m (8 ft 0 in.)	~~4.01.43~~ m (~~34~~ ft ~~69~~ in.)
~~438~~ 121.1 kV–145 kV	3.4 m (11 ft 0 in.)	3.0 m (10 ft 0 in.)	~~4.21.60~~ m (~~35~~ ft ~~104~~ in.)
~~464~~ 145.1 kV–169 kV	3.6 m (11 ft 8 in.)	3.6 m (11 ft 8 in.)	~~4.31.78~~ m (~~45~~ ft ~~310~~ in.)
~~230~~ 169.1 kV–242 kV	4.0 m (13 ft 0 in.)	4.0 m (13 ft 0 in.)	~~4.72.29~~ m (~~57~~ ft 8 in.)
~~345~~ 242.1 kV–362 kV	4.7 m (15 ft 4 in.)	4.7 m (15 ft 4 in.)	~~2.83.70~~ m (~~912~~ ft ~~23~~ in.)
~~362.1~~ kV–420 kV	~~5.8 m (19 ft 0 in.)~~	~~5.8 m (19 ft 0 in.)~~	~~4.55 m (14 ft 11 in.)~~
~~500~~ 420.1 kV–550 kV	5.8 m (19 ft 0 in.)	5.8 m (19 ft 0 in.)	~~3.65.38~~ m (~~4117~~ ft 8 in.)
~~765~~ 550.1 kV–800 kV	7.2 m (23 ft 9 in.)	7.2 m (23 ft 9 in.)	~~4.97.19~~ m (~~4523~~ ft ~~448~~ 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.

Substantiation:

This public input 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 2017 *National Electrical Safety Code* (NESC) Table 431-1, Communication work minimum approach distances. (This public input leaves the limited approach boundaries unchanged.) As a consequence of this correlation, the nominal system voltage ranges have been adjusted to also align with Table 431-1.

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-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. The comparison is included as an attached Excel spreadsheet. After reviewing those other tables, the Task Group chose to correlate Table 130.4(E)(a) with NESC Table 431-1.

The Task Group determined that the distances in NESC Table 431-1 were the most protective and most comparable to work practices within the scope of NFPA 70E.

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. OSHA Tables R-2 and S-5 apply to telecommunications work and general electrical safe work practices, respectively, and contain identical minimum approach distances (the equivalent of restricted approach boundaries). OSHA Table S-5 is most directly comparable to the restricted approach boundaries in NFPA 70E Table 130.4(E)(a) since the 1983 edition of NFPA 70E formed the basis for 29 CFR 1910.333. However, the minimum approach distances in those two OSHA standards (29 CFR 1910.268 and 1910.333) are substantially out of date. Table R-2 was promulgated in 1975, and Table S-5 was promulgated in 1990. Since that time, OSHA promulgated revisions of 29 CFR 1910.269 and 29 CFR Part 1926, Subpart V that adopted minimum approach distances 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.

NESC Table 431-1 represents a more conservative basis for setting approach distances for general electrical (as opposed to electric-power-specific) approach distances. The substantiation for this table, at the time it was adopted, generally is as follows:

- 1) For voltages below 72 kV, Table 431-1 uses phase-to-phase MAD distances from Table 441-1 as a conservative approach since phase-to-phase distances are larger than phase-to-ground distances.
- 2) Above 72 kV, the values for phase-to-ground exposure were used to better represent the actual hazard condition for telecommunication workers.
- 3) MAD values for each voltage range used the maximum voltage value of the range.
- 4) At the higher voltage ranges, whole-foot numbers (rounded up to next higher whole foot) were used as a more conservative approach.
- 5) Above 72kV, an additional 1 foot or 2 feet was added for the communications workers over the electrical worker value calculated from OSHA Table R-7.

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. Additional distance to OSHA Table R-7 is added to account for lack of utility control over transient overvoltages and to account for the general lack of training relative to electric power workers.

This approach yields conservative restricted approach boundaries for communications workers and, by extension, other nonpower workers. The Task Group concluded that this is an appropriate approach to use for setting restricted approach boundaries in Table 431-1.



Public Input No. 95-NFPA 70E-2021 [Section No. 130.4(E)]

(E) Shock Protection Boundaries.

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

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

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

(1)	(2)	(3)	(4)
<u>Nominal System Voltage Range, Phase to Phase^a</u>	<u>Exposed Movable Conductor^c</u>	<u>Limited Approach Boundary^b</u> <u>Exposed Fixed Circuit Part</u>	<u>Restricted Approach Boundary^b ; Includes Inadvertent Movement Adder</u>
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.

^aFor 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.

^dThis 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)
<u>Nominal Potential</u>	<u>Limited Approach Boundary</u>	<u>Restricted Approach Boundary; Includes</u>	

<u>Difference</u>	<u>Exposed Movable Conductor*</u>	<u>Exposed Fixed Circuit Part</u>	<u>Inadvertent Movement Adder</u>
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 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 Input

The Table Note points to a section that does not exist [130.4(D)(2)], and referring the reading to Article 100 does not help unless the text indicates which definition(s) the user should be reading.

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Committee: EEW-AAA

**Public Input No. 117-NFPA 70E-2021 [Section No. 130.4(F)(2)]****(2) Working at or Close to the Limited Approach Boundary.**

Where one or more unqualified persons are working at or close to the limited approach boundary, the alerting methods in 130.7(E) shall be applied to ~~advise the~~ warn the unqualified person(s) of the electrical hazard ~~and warn him or her to~~ (s) and provide a clear warning to stay outside of the limited approach boundary.

Statement of Problem and Substantiation for Public Input

The proposed revisions are primarily editorial in nature for clarity. The word “advise” is removed as this standard should not advise within mandatory rules.

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Committee: EEW-AAA

**Public Input No. 352-NFPA 70E-2021 [Section No. 130.5(A)]****(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~~ additional protective measures are required, including the use of PPE

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).

Statement of Problem and Substantiation for Public Input

A common misconception is that even in non- arc resistance equipment closed doors remove the need for PPE. This Informational note relocated from 130.7 (C) (15) (b) clarifies that closed doors do not provide enough protection to eliminate need for PPE

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
<u>Public Input No. 350-NFPA 70E-2021 [Section No. 130.7(C)(15)]</u>	Information Note No.2 relocated
<u>Public Input No. 355-NFPA 70E-2021 [Section No. 130.7(C)(15)]</u>	

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Committee: EEW-AAA



Public Input No. 12-NFPA 70E-2020 [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 110.5(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

<u>Task</u>	<u>Equipment Condition^a</u>	<u>Likelihood of Occurrence^b</u>
Reading a panel meter while operating a meter switch.	Any	No
Performing infrared thermography and other non-contact 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).	-	-
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
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 ~~Opening an enclosed~~ panelboard hinged door or cover to access dead front overcurrent devices.	-	-
Removal of battery nonconductive intercell connector covers.	-	-
Maintenance and testing on individual battery cells or individual multi-cell units in an open rack	Abnormal	Yes
Insertion or removal of individual cells or multi-cell units of a battery system in an open rack.	-	-
Arc-resistant equipment with the DOORS CLOSED and SECURED, and where the available fault current and fault clearing time does not exceed that of the arc-resistant rating of the equipment in one of the following conditions:	-	-
(1) Insertion or removal of individual starter buckets	-	-

<u>Task</u>	<u>Equipment Condition^a</u>	<u>Likelihood of Occurrence^b</u>
(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	-	-
-	-	-

^aEquipment is considered to be in a “normal operating condition” if all of the conditions in 110.4(D) are satisfied.

^bAs 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: An example of a standard that provides information for arc-resistant equipment referred to in Table 130.5(C) is IEEE C37.20.7, *Guide for Testing Switchgear Rated Up to 52 kV for Internal Arcing Faults*.

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

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

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

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

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

Statement of Problem and Substantiation for Public Input

"enclosed" is added ahead of "panelboard" to read "enclosed panelboard."Panelboard is a defined term and is often misused to describe what is being proposed in this recommendation. For example, in the "Equipment" column in Table 130.7(C)(15)(a), the phrase "Panelboards or other equipment..." is actually referring to a panelboard installed inside the defined term "Cabinet" with a cover installed or a panelboard installed within an enclosure (also a defined term). This recommendation is based on the definition of "Enclosed Panelboard" from UL 67 and is intended to more accurately define what a panelboard installed inside an enclosure which is the intent of its meaning in Table 130.7(C)(15)(a), for example. A companion Public Input was submitted to add a definition of "Panelboard, Enclosed" in Article 100.

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 10-NFPA 70E-2020 [New Definition after Definition: Panelboard.]	Related issue.
Public Input No. 11-NFPA 70E-2020 [Section No. 130.7(C)(15)]	Related issue
Public Input No. 10-NFPA 70E-2020 [New Definition after Definition: Panelboard.]	
Public Input No. 11-NFPA 70E-2020 [Section No. 130.7(C)(15)]	

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Public Input No. 14-NFPA 70E-2020 [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 110.5(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

<u>Task</u>	<u>Equipment Operating Condition^a</u>	<u>Likelihood of Occurrence^b</u>
Reading a panel meter while operating a meter switch.	Any	No
Performing infrared thermography and other non-contact 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).	-	-
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
Voltage testing on individual battery cells or individual multi-cell units.	-	-
Removal or installation of covers for equipment such as wireways, junction boxes, and cable trays that does not expose bare, energized electrical conductors and circuit parts.	-	-
Opening a panelboard hinged door or cover to access dead front overcurrent devices.	-	-
Removal of battery nonconductive intercell connector covers.	-	-
Maintenance and testing on individual battery cells or individual multi-cell units in an open rack	Abnormal	Yes
Insertion or removal of individual cells or multi-cell units of a battery system in an open rack.	-	-
Arc-resistant equipment with the DOORS CLOSED and SECURED, and where the available fault current and fault clearing time does not exceed that of the arc-resistant rating of the equipment in one of the following conditions:	-	-

<u>Task</u>	<u>Equipment Operating Condition^a</u>	<u>Likelihood of Occurrence^b</u>
(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	-	-
-	-	-

^aEquipment is considered to be in a "normal operating condition" if all of the conditions in 110.4(D) are satisfied.

^bAs 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: An example of a standard that provides information for arc-resistant equipment referred to in Table 130.5(C) is IEEE C37.20.7, *Guide for Testing Switchgear Rated Up to 52 kV for Internal Arcing Faults*.

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

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

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

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

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

Statement of Problem and Substantiation for Public Input

On Table 130.5(C), propose changing the term "Equipment Condition" to "Operating Condition". At the bottom of the table, 110.4(D) is referenced for clarity, which uses the term "normal operating condition" three times. The term "Equipment Condition" is not found in 110.4(D). Also, 110.4(D)(3) says that if equipment is not used in accordance with manufacturer's instructions, then it would be considered not normal. In that instance, the electrical equipment could be brand new and in perfect condition, but the way in which it is being operated is abnormal.

Submitter Information Verification

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Submission Date: Mon Dec 14 11:34:35 EST 2020

Committee: EEW-AAA



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

(C) Additional Protective Measures.

If additional protective measures are required they shall be selected and implemented according to the hierarchy of risk control identified in 110.5(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

<u>Task</u>	<u>Equipment Condition^a</u>	<u>Likelihood of Occurrence^b</u>
Reading a panel meter while operating a meter switch.	Any	No
Performing infrared thermography and other non-contact 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).	-	-
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
Voltage testing on individual battery cells or individual multi-cell units.	-	-
Removal or installation of covers for equipment such as wireways, junction boxes, and cable trays that does not expose bare, energized electrical conductors and circuit parts.	-	-
Opening a panelboard hinged door or cover to access dead front overcurrent devices.	-	-
Removal of battery nonconductive intercell connector covers.	-	-
Maintenance and testing on individual battery cells or individual multi-cell units in an open rack	Abnormal	Yes
Insertion or removal of individual cells or multi-cell units of a battery system in an open rack.	-	-
Arc-resistant equipment with the DOORS CLOSED and SECURED, and where the available fault current and fault clearing time does not exceed that of the arc-resistant rating of the equipment in one of the following conditions:	-	-
(1) Insertion or removal of individual starter buckets	-	-
(2) Insertion or removal (racking) of CBs from cubicles	-	-

<u>Task</u>	<u>Equipment Condition^a</u>	<u>Likelihood of Occurrence^b</u>
(3) Insertion or removal (racking) of ground and test device	-	-
(4) Insertion or removal (racking) of voltage transformers on or off the bus	-	-
-	-	-

^aEquipment is considered to be in a “normal operating condition” if all of the conditions in 110.4(D) are satisfied.

^bAs 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: - ~~An~~ 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)- is IEEE C37.20.7, *Guide for Testing Switchgear Rated Up to 52 kV for Internal Arcing Faults*.

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

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

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

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

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

Statement of Problem and Substantiation for Public Input

Revised Informational Note to comply with new 2020 NEC Style Manual.

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

Changed "requirements" to "recommendations" in reference to Annex O in Informational Note 4 since this annex is Informative.

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Submittal Date: Sun May 23 12:36:16 EDT 2021
Committee: EEW-AAA



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

(C) Additional Protective Measures.

If additional protective measures are required they shall be selected and implemented according to the hierarchy of risk control identified in 110.5(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

<u>Task</u>	<u>Equipment Condition^a</u>	<u>Likelihood of Occurrence^b</u>
Reading a panel meter while operating a meter switch.	Any	No
Performing infrared thermography and other non-contact 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).	-	-
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
Voltage testing on individual battery cells or individual multi-cell units.	- Abnormal -	Yes
Removal or installation of covers for equipment such as wireways, junction boxes, and cable trays that does not expose bare, energized electrical conductors and circuit parts.	-	-
Opening a panelboard hinged door or cover to access dead front overcurrent devices.	-	-
Removal of battery nonconductive intercell connector covers.	-	-
Maintenance and testing on individual battery cells or individual multi-cell units in an open rack	Abnormal	Yes
Insertion or removal of individual cells or multi-cell units of a battery system in an open rack.	-	-
Arc-resistant equipment with the DOORS CLOSED and SECURED, and where the available fault current and fault clearing time does not exceed that of the arc-resistant rating of the equipment in one of the following conditions:	-	-
(1) Insertion or removal of individual starter buckets	-	-
(2) Insertion or removal (racking) of CBs from cubicles	-	-

<u>Task</u>	<u>Equipment Condition^a</u>	<u>Likelihood of Occurrence^b</u>
(3) Insertion or removal (racking) of ground and test device	-	-
(4) Insertion or removal (racking) of voltage transformers on or off the bus	-	-
-	-	-

^aEquipment is considered to be in a “normal operating condition” if all of the conditions in 110.4(D) are satisfied.

^bAs 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: An example of a standard that provides information for arc-resistant equipment referred to in Table 130.5(C) is IEEE C37.20.7, *Guide for Testing Switchgear Rated Up to 52 kV for Internal Arcing Faults*.

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

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

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

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

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

Additional Proposed Changes

<u>File Name</u>	<u>Description</u>	<u>Approved</u>
Table-Mod.jpg	Proposed modification to format of Table 130.5(C)	

Statement of Problem and Substantiation for Public Input

Table 130.5(C) as shown in the 2021 edition is confusing for users of the standard. As shown in the 2015 edition of NFPA 70E, the intent of the items in this section is to indicate the when the equipment is in a “Normal” operating condition the likelihood is “No”, while in an “Abnormal” operating condition the likelihood is “Yes”. The error is more obvious in the digital edition than in the hard copy, but the error exists in both.

The NFPA 70E Tables task group report for the 2021 edition does not contain the horizontal line. When the information was transferred to Terra the horizontal line appeared. As it is presently shown, clarity is lost for users of the document because the horizontal line and spacing of these two categories suggests they are associated with those specific task when in fact the qualified user must evaluate the equipment condition as Normal or Abnormal in order to determine the likelihood as No or Yes.

The horizontal line should be removed, the Normal/No and Abnormal/Yes conditions should be located nearer to each other, and the four list items associated with arc resistant equipment should be indented for clarity.

As an alternative, the table notes clearly explain that equipment is in a “normal operating condition” if all the conditions in 110.4(D) are satisfied. The users must infer that if any of those conditions are not satisfied then the equipment is in “abnormal” condition and the likelihood is yes. Perhaps the TC could clarify this note by adding the following to the note: “If any of the conditions in 110.4(D) are not satisfied then the equipment is not in normal condition and the likelihood of occurrence is yes.” . By adding this note we could simply remove the Abnormal / Yes entries, and the horizontal line, in this section of Table 130.5(C).

Submitter Information Verification

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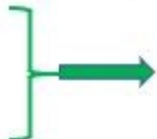
City:

State:

Zip:

Submittal Date: Fri May 28 12:39:38 EDT 2021

Committee: EEW-AAA

Operation of a CB, switch, contactor, or starter.		Normal	No
Voltage testing on individual battery cells or individual multi-cell units.			
Removal or installation of covers for equipment such as wireways, junction boxes, and cable trays that does not expose bare, energized electrical conductors and circuit parts.			
Opening a panelboard hinged door or cover to access dead front overcurrent devices.			
Removal of battery nonconductive intercell connector covers.			
Maintenance and testing on individual battery cells or individual multi-cell units in an open rack		Abnormal	Yes
Insertion or removal of individual cells or multi-cell units of a battery system in an open rack.			
Arc-resistant equipment with the DOORS CLOSED and SECURED, and where the available fault current and fault clearing time does not exceed that of the arc-resistant rating of the equipment in one of the following conditions:			
(1) Insertion or removal of individual starter buckets			
(2) Insertion or removal (racking) of CBs from cubicles			
(3) Insertion or removal (racking) of ground and test device			
(4) Insertion or removal (racking) of voltage transformers on or off the bus			



Public Input No. 371-NFPA 70E-2021 [Section No. 130.5(C)]

(C) Additional Protective Measures.

If additional protective measures are required they shall be selected and implemented according to the hierarchy of risk control identified in 110.5(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

<u>Task</u>	<u>Equipment Condition^a</u>	<u>Likelihood of Occurrence^b</u>
Reading a panel meter while operating a meter switch.	Any	No
Performing infrared thermography and other non-contact 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).	-	-
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
Voltage testing on individual battery cells or individual multi-cell units.	-	-
Removal or installation of covers for equipment such as wireways, junction boxes, and cable trays that does not expose bare, energized electrical conductors and circuit parts.	-	-
Opening a panelboard hinged door or cover to access dead front overcurrent devices.	-	-
Removal of battery nonconductive intercell connector covers.	-	-
Maintenance and testing on individual battery cells or individual multi-cell units in an open rack	Abnormal	Yes
Insertion or removal of individual cells or multi-cell units of a battery system in an open rack.	-	-
Arc-resistant equipment with the DOORS CLOSED and SECURED, and where the available fault current and fault clearing time does not exceed that of the arc-resistant rating of the equipment in one of the following conditions:	-	-
(1) Insertion or removal of individual starter buckets	-	-
(2) Insertion or removal (racking) of CBs from cubicles	-	-

<u>Task</u>	<u>Equipment Condition^a</u>	<u>Likelihood of Occurrence^b</u>
(3) Insertion or removal (racking) of ground and test device	-	-
(4) Insertion or removal (racking) of voltage transformers on or off the bus	-	-
-	-	-

^aEquipment is considered to be in a "normal operating condition" if all of the conditions in 110.4(D) are satisfied.

^bAs 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).

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.

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

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

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

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

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

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

Statement of Problem and Substantiation for Public Input

The table presently only states hearing protection. In some situations, ear canal inserts do not provide sufficient protection. Adding the note to match what is in Table 130.7(C)(15)(c) will provide guidance if the incident energy method is used.

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Committee: EEW-AAA

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

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

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

Statement of Problem and Substantiation for Public Input

Revised Informational Note to comply with new 2020 NEC Style Manual.

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

Submitter Information Verification

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Submittal Date: Sun May 23 12:33:40 EDT 2021

Committee: EEW-AAA



Public Input No. 185-NFPA 70E-2021 [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.

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

~~Informational Note: For Note 1: See Informative Annex D for information on estimating the incident energy, see Informative Annex D.~~

~~Informational Note 2: See Informative Annex H for information on selection of arc-rated clothing and other PPE, see Informative Annex H.~~

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

Incident energy exposures equal to 1.2 cal/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)^e

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

Hard hat

Safety glasses or safety goggles (SR)

Hearing protection

Leather footwear^d

Incident energy exposures greater than 12 cal/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 arc flash suit hood

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

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

Hard hat

Safety glasses or safety goggles (SR)

Hearing protection

Leather footwear^d

SR: Selection of one in group is required.

AN: As needed.

^aArc 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.

^bFace 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.

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

^dFootwear 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.

^eThe 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 Input

Revised Informational Note to comply with new 2020 NEC Style Manual.
Split existing Informational Note into two in order to separately refer to each annex.

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

Submitter Information Verification

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Committee: EEW-AAA



Public Input No. 222-NFPA 70E-2021 [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.

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

Informational Note: For information on estimating the incident energy, see Informative Annex D. For information on selection of arc-rated clothing and other PPE, see Informative Annex H.

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

Incident energy exposures equal to 1.2 cal/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)^e

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

Hard hat

Safety glasses or safety goggles (SR)

Hearing protection

Leather footwear^d

Incident energy exposures greater than 12 cal/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 arc flash suit hood

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

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

Hard hat

Safety glasses or safety goggles (SR)

Hearing protection

Leather footwear^d

SR: Selection of one in group is required.

AN: As needed.

^aArc 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.

^bFace 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.

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

^dFootwear 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.

^eThe 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.

General reference to Article 130 is deleted. It is not required for complete understanding of the statement.

4.1.4 of the new 2020 NEC Style Manual prohibits references to entire articles.

Submitter Information Verification

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Submittal Date: Sun May 23 16:57:36 EDT 2021

Committee: EEW-AAA



Public Input No. 247-NFPA 70E-2021 [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 may affect the results of the electrical distribution system analysis include changes made by utilities or other entities such as transformer sizing, as well as modifications to protective device settings on devices such as circuit breakers or relays.

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

Informational Note: For information on estimating the incident energy, see Informative Annex D. For information on selection of arc-rated clothing and other PPE, see Informative Annex H.

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

Incident energy exposures equal to 1.2 cal/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)^e

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

Hard hat

Safety glasses or safety goggles (SR)

Hearing protection

Leather footwear^d

Incident energy exposures greater than 12 cal/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 arc flash suit hood

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

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

Hard hat

Safety glasses or safety goggles (SR)

Hearing protection

Leather footwear^d

SR: Selection of one in group is required.

AN: As needed.

^aArc 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.

^bFace 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.

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

^dFootwear 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.

^eThe 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 Input

The current language requires the incident energy analysis to be updated when changes occur in the electrical distribution system that could affect the results of the analysis. Some changes are obvious, such as reconfiguration of the system or replacement of equipment. However other changes may not be as easy to identify. The proposed informational note will help users consider changes that may be

made by other entities, such as utilities. The proposed language will also highlight the impact that modifications to settings on protection devices can have, even though the device itself, and associated labeling, may remain in place.

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Submittal Date: Fri May 28 12:34:11 EDT 2021
Committee: EEW-AAA



Public Input No. 26-NFPA 70E-2020 [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.

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

Informational Note: For information on estimating the incident energy, see Informative Annex D. For information on selection of arc-rated clothing and other PPE, see Informative Annex H.

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

Incident energy exposures equal to 1.2 cal/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)^e

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

Hard hat

Safety glasses or safety goggles (SR)

Hearing protection

Leather footwear^d

Incident energy exposures greater than 12 cal/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 arc flash suit hood

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

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

Hard hat

Safety glasses or safety goggles (SR)

Hearing protection

Leather footwear^d

SR: Selection of one in group is required.

AN: As needed.

^aArc 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.

^bFace 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.

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

^dFootwear 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.

^eThe 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 Input

"electric" is added before "shock" to read "electric shock" to correlate with the use of "electric shock" in the definition of "electrical hazard" and Boundary, Restricted Approach as well as to clarify that the type of shock hazard being addressed is a shock hazard rather than others forms of shock such as where one would go into shock due to a severe injury or a reaction associated with fright.

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.

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

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 15-NFPA 70E-2020 [Definition: Shock Hazard.]	Related issue.

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Submittal Date: Tue Dec 22 14:56:37 EST 2020

Committee: EEW-AAA



Public Input No. 374-NFPA 70E-2021 [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 or if methods used to predict incident energy change such that calculation results are different. The incident energy analysis shall also be reviewed for accuracy at intervals not to exceed 5 years.

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

Informational Note: For information on estimating the incident energy, see Informative Annex D. For information on selection of arc-rated clothing and other PPE, see Informative Annex H.

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

Incident energy exposures equal to 1.2 cal/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)^e

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

Hard hat

Safety glasses or safety goggles (SR)

Hearing protection

Leather footwear^d

Incident energy exposures greater than 12 cal/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 arc flash suit hood

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

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

Hard hat

Safety glasses or safety goggles (SR)

Hearing protection

Leather footwear^d

SR: Selection of one in group is required.

AN: As needed.

^aArc 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.

^bFace 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.

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

^dFootwear 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.

^eThe 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.

IEEE 1584 has been revised several times and some of those has resulted in different results. The most recent version should always be used to take advantage of the latest knowledge and technology.

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Submittal Date: Tue Jun 01 16:55:29 EDT 2021

Committee: EEW-AAA



Public Input No. 43-NFPA 70E-2021 [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.

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

Informational Note: For information on estimating the incident energy, see Informative Annex D. For information on selection of arc-rated clothing and other PPE, see Informative Annex H.

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

Incident energy exposures equal to 1.2 cal/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)^e

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

Hard hat

Safety glasses or safety goggles (SR)

Hearing protection

Leather footwear^d

Incident energy exposures greater than 12 cal/cm²

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

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 arc-rated leather protectors (SR)^c

Hard hat

Safety glasses or safety goggles (SR)

Hearing protection

Leather footwear^d

SR: Selection of one in group is required.

AN: As needed.

^aArc 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.

^bFace shields with a wrap-around guarding to protect the face, chin, forehead, ears, and neck area are required by 130.7(C)(10)(c). Where the back of the head is inside the arc flash boundary, a balaclava or an arc flash hood shall be required for full head and neck protection.

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

^dFootwear 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.

^eThe 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 Input

PROBLEM: Current table and text does not provide sufficient arc-flash protection for hands.

SUBSTANTIATION: The qualified person's hands are usually closest to the arc-flash when work is being performed, often much closer than the working distance used to calculate the incident energy. It is important to ensure the employee's hands are well protected. Heavy-duty leather gloves are not defined in 70E and do not appear to be defined by any other standard.

The informational note for 130.7(C)(10)(d)(1) indicates that heavy-duty leather gloves have a minimum of 0.03 inch thickness. Five major manufacturers were contacted and stated that they do not publish nor disclose the thickness of their leather protectors; one responded it is proprietary information. Most leather work gloves do not have thickness indicated on them. The 70E informational note also indicates that the ATPV would be 10 cal/cm² or greater, which is below the 12 cal/cm² rating suggested by Table 130.5(G) – with the situation exacerbated by hands being closer than the incident energy working distance.

The lack of ASTM arc-flash specifications for rubber insulating gloves means they cannot be depended upon to ensure that they will provide consistent or sufficient protection. There is significant variability in glove performance based on class and color from testing performed in the early part of this century, even if it was generally favorable. Since that time there have been market changes with a large proliferation of gloves from a more diverse group of manufacturers. Examination of various manufacturers' gloves has shown large variation in quality. Without clear arc flash performance specifications, the rubber insulating gloves cannot be depended upon for protection.

There are now multiple manufacturers providing leather protectors with ATPV specified that will protect the rubber insulating gloves from the arc flash.

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 42-NFPA 70E-2021 [Section No. 130.7(C)(10)]	
Public Input No. 44-NFPA 70E-2021 [Section No. 130.7(C)(15)]	

Submitter Information Verification

Submitter Full Name: Karl Cunningham

Organization: ES Squared, Inc.

Street Address:

City:

State:

Zip:

Submittal Date: Tue Jan 12 18:30:11 EST 2021

Committee: EEW-AAA



Public Input No. 89-NFPA 70E-2021 [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.

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

Informational Note: For information on estimating the incident energy, see Informative Annex D. For information on selection of arc-rated clothing and other PPE, see Informative Annex H.

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

Incident energy exposures equal to 1.2 cal/cm² up to and including 4 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 or arc flash suit hood (SR)^b

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

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

Hard hat

Safety glasses or safety goggles (SR)

Hearing protection

Leather footwear^d

Incident energy exposures equal to 4.0 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)^e

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

Hard hat

Safety glasses or safety goggles (SR)

Hearing protection

Leather footwear^d

Incident energy exposures greater than 12 cal/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 arc flash suit hood

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

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

Hard hat

Safety glasses or safety goggles (SR)

Hearing protection

Leather footwear^d

SR: Selection of one in group is required.

AN: As needed.

^aArc 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.

^bFace 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.

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

^dFootwear 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.

^eThe 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 Input

The PPE that is required for lower Incident Energy situations would be consistent with the Category Method and not require the balaclava. The panels in our facility are mostly in this lower energy level and would require us to provide balaclava's to all our employees that need to work around exposed energized parts because they do want to share it.

Submitter Information Verification

Submitter Full Name: Rich Weniger

Organization: PAR Systems, LLC

Street Address:

City:

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Submittal Date: Fri Apr 16 16:23:38 EDT 2021

Committee: EEW-AAA

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

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

- (1) Nominal system voltage
- (2) Arc flash boundary
- (3) At least one of the following:
 - (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.

Statement of Problem and Substantiation for Public Input

durability of this label should be included here, even though it is an installation requirement. Many will not reference the NEC where the durability aspects of such a label exists. The last sentence sort of gets the user of 70E to refer to the applicable code or standard, but many users will never do so. Having the information here as a requirement provides the text that addresses inconsistencies that exist.

Submitter Information Verification

Submitter Full Name: Agnieszka Golriz

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City:

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Submittal Date: Thu May 20 14:32:02 EDT 2021

Committee: EEW-AAA

**Public Input No. 361-NFPA 70E-2021 [Section No. 130.5(H)]****(H) Equipment Labeling.**

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

- (1) Nominal system voltage
- (2) Arc flash boundary
- (3) Date the label was created or reviewed
- (4) At least one of the following:
 - (5) 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
 - (6) Minimum arc rating of clothing
 - (7) 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 owner of the electrical equipment shall be responsible for the documentation, installation, and maintenance of the marked label and for ensuring the date is within the last 5 years.

Statement of Problem and Substantiation for Public Input

No change is intended to existing list item (3) by this public input.
Add a new list item (3) and renumber existing list item (3) to (4).
Date the label was created or reviewed

Also add the following phrase to the last paragraph:
"and for ensuring the date is within the last 5 years"

Without a date the accuracy and integrity of the information on the label can be very questionable. It is already a requirement to update the label if the data review identifies that the information is inaccurate at 5-year intervals. I'm aware of a situation where a contractor refused to do any work in the facility because none of the labels had dates. The NEC requires dates on several labels such as in 110.16(B) and 110.24(A).

Submitter Information Verification

Submitter Full Name: Paul Dobrowsky

Organization: Innovative Technology Services

Street Address:

City:

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Submission Date: Tue Jun 01 16:14:31 EDT 2021

Committee: EEW-AAA



Public Input No. 79-NFPA 70E-2021 [Section No. 130.5(H)]

(H) Equipment Labeling.

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

- (1) Nominal system voltage
- (2) Arc flash boundary
- (3) Additional protective measures identified in 110.5(H)(3)
- (4) At least one of the following:
 - (5) 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
 - (6) Minimum arc rating of clothing
 - (7) Site-specific level of PPE
 - (8) Additional protective measures identified in 110.5(H)(3)

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

Statement of Problem and Substantiation for Public Input

Although Terra shows a through d underlined, this recommendation only adds a new (d). This change is recommended since determining "additional protective measures identified in 110.5(H)(3)" is required as part of the arc flash risk assessment per 130.5(C) and must be documented per 130.5(D). In addition, what is presently required by 130.5(H)(3)(a), (b), or (c) would not be necessary if the additional protective measures do not require the use of PPE such as would be the case if any or some combination of the first five of the 6 in the hierarchy of risk control methods were selected.

An additional requirement was added to (H)(3) since the equipment label should also indicate which "additional protective measures identified in 110.5(H)(3)" were selected as a mandatory requirement rather than as only one or more of what is required in the existing 130.5(H)(3).

Submitter Information Verification

Submitter Full Name: Palmer Hickman

Organization: Electrical Training Alliance

Street Address:

City:

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Submittal Date: Mon Apr 05 18:11:24 EDT 2021

Committee: EEW-AAA

**Public Input No. 8-NFPA 70E-2020 [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

(7) Date

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

Statement of Problem and Substantiation for Public Input

The purpose of the 70E Standard is to provide a practical safe working area for employees relative to the hazards arising from the use of electricity. Since the information for the labeling is to be reviewed with changes that are made to the electrical system or at a period not to exceed five years, adding the date to the label would be helpful to those who will work on/with the equipment. The date would give the assurance that the information is up-to-date as of the date on the label.

There is nothing practical about having to find a report and verify the information is the latest and greatest in order to interact with electrical equipment in an emergency situation. Even doing the shock and arc flash risk assessments required by the standard are going to require an assurance that the information is accurate. Why not have that information on the label, with the date, to let the qualified people know the hazards and that the information is up-to-date?

Submitter Information Verification

Submitter Full Name: Roger Zieg

Organization: Zieg Electric

Street Address:

City:

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Zip:

Submittal Date: Sat Dec 12 07:50:26 EST 2020

Committee: EEW-AAA

**Public Input No. 84-NFPA 70E-2021 [Section No. 130.5(H)]****(H) Equipment Labeling.**

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

- (1) Nominal system voltage
- (2) Arc flash boundary
- (3) At least one of the following:
 - (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 the calculation method used or to the 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 owner of the electrical equipment shall be responsible for the documentation, installation, and maintenance of the marked label.

Statement of Problem and Substantiation for Public Input

Although Terra shows more text underlined, this recommendation is only applicable to Exception No. 1. The problem that would be resolved by this proposed change to add the phrase "the calculation method used or to the" is to require labels be replaced where they are rendered inaccurate such as where they are based on calculations of an outdated calculation method such as IEEE 1584-2002, IEEE Guide for Performing Arc Flash Hazard Calculations. Many calculations based on IEEE 1584-2018, IEEE Guide for Performing Arc Flash Hazard Calculations, would yield different results for results such as the arc flash boundary, incident energy, or minimum arc rating of clothing. Existing labels with inaccurate information must be replaced with labels based on current data and testing to fulfill the purpose of this standard. Knowingly allowing existing labels to remain is not a correct action because on concerns that replacing them is inconvenient or would cost more money, or for any other reason.

Submitter Information Verification

Submitter Full Name: Palmer Hickman

Organization: Electrical Training Alliance

Street Address:

City:

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Zip:

Submittal Date: Tue Apr 06 16:38:48 EDT 2021

Committee: EEW-AAA

**Public Input No. 85-NFPA 70E-2021 [Section No. 130.5(H)]****(H) Equipment Labeling.**

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

- (1) Nominal system voltage
- (2) Arc flash boundary
- (3) At least one of the following:
 - (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, or the calculation method used to determine the information on the label changes that renders the label inaccurate, the label shall be updated, replaced, or removed.

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

Statement of Problem and Substantiation for Public Input

Although Terra shows more text underlined, this recommendation is only applicable to the last two paragraphs of 130.5(H). The problem that would be resolved by this proposed change is to require updating, replacement, or removal of labels that are rendered inaccurate such as where they were based calculations of an outdated calculation method such as IEEE 1584-2002, IEEE Guide for Performing Arc Flash Hazard Calculations. Many calculations based on IEEE 1584-2018, IEEE Guide for Performing Arc Flash Hazard Calculations, would yield different results for results such as the arc flash boundary, incident energy, or minimum arc rating of clothing. Existing labels with inaccurate information must be removed or be updated or replaced with labels based on current data and testing to fulfill the purpose of this standard. Knowingly allowing existing labels to remain is not a correct action because on concerns that replacing them is inconvenient or would cost more money, or for any other reason.

Submitter Information Verification

Submitter Full Name: Palmer Hickman

Organization: Electrical Training Alliance

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Submittal Date: Tue Apr 06 17:00:34 EDT 2021

Committee: EEW-AAA

**Public Input No. 86-NFPA 70E-2021 [Section No. 130.5(H)]****(H) Equipment Labeling.**

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

- (1) Nominal system voltage
- (2) Arc flash boundary
- (3) At least one of the following:
 - (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:~~

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

Statement of Problem and Substantiation for Public Input

Although Terra shows much more underlined text, this recommendation is only to delete existing Exception No. 1 and to renumber the remaining exception. Existing Exception No. 1 needs to be deleted as it is an exception allowing existing labels to remain. However, where this exception is located in 130.5(H) is granting an exception to a requirement that does not exist. Alternatively, the NFPA 70E Technical Committee may want to consider relocating this exception to a location after the last paragraph of 130.5(H) where the "maintenance of the marked label" is addressed.

Submitter Information Verification

Submitter Full Name: Palmer Hickman

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Submittal Date: Tue Apr 06 17:13:51 EDT 2021

Committee: EEW-AAA

**Public Input No. 9-NFPA 70E-2020 [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~~

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

Statement of Problem and Substantiation for Public Input

I believe that the exception should be deleted. Only qualified persons are supposed to work on electrical equipment, do the assessments required by the standards, and employ safe work practices. If in fact the purpose of the standard to provide a practical safe working area for employees relative to the hazards arising from the use of electricity, why would the standard allow for less safety for the qualified persons? This exception allows for companies to cut corners on safety because they have deemed that they have qualified people. Having labels on the equipment will aid the qualified persons in their risk assessments as they do their job planning.

Submitter Information Verification

Submitter Full Name: Roger Zieg

Organization: Zieg Electric

Street Address:

City:

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Zip:

Submittal Date: Sat Dec 12 08:19:33 EST 2020

Committee: EEW-AAA

**Public Input No. 92-NFPA 70E-2021 [Section No. 130.5(H)]****(H) Equipment Labeling.**

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

- (1) Nominal system voltage
- (2) Arc flash boundary
- (3) At least one of the following:
 - (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.

If an arc-energy reduction system is utilized, additional labeling indicating the reduced values shall be provided.

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

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

Statement of Problem and Substantiation for Public Input

If the incident energy and arc-flash boundary are reduced by methods such as an energy reducing maintenance switch, the revised values should be posted to inform the worker of the new numbers to ensure proper selection of PPE.

Submitter Information Verification

Submitter Full Name: Ryan Jackson

Organization: Ryan Jackson

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City:

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Zip:

Submittal Date: Tue Apr 27 15:15:34 EDT 2021

Committee: EEW-AAA

**Public Input No. 27-NFPA 70E-2020 [Section No. 130.7]****130.7 Personal and Other Protective Equipment.****(A) General.**

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

Informational Note: The PPE requirements of 130.7 are intended to protect a person from arc flash and electric shock hazards. While some situations could result in burns to the skin, even with the protection selected, 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 130.7 do not address protection against physical trauma other than exposure to the thermal effects of an arc flash.

(B) Care of Equipment.

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

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

(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 noncontact proximity test instrument(s) or measurement of voltage on the secondary side of a low-voltage transformer (VT) mounted in the equipment before using a contact test instrument to test for the absence of voltage below 1000 volts.
- (2) If equipment design allows, observe visible gaps between the equipment conductors and circuit parts and the electrical source(s) of supply.
- (3) Increase the working distance.
- (4) Consider system design options to reduce the incident energy level.

(2) Movement and Visibility.

When arc-rated clothing is worn to protect an employee, it shall cover all ignitable 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 shall wear hearing protection whenever working within the arc flash boundary.

(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) Electric Shock Protection. Employees shall wear rubber insulating gloves with leather protectors where there is a danger of hand injury from electric shock due to contact with exposed energized electrical conductors or circuit parts. Employees shall wear rubber insulating gloves with leather protectors and rubber insulating sleeves where there is a danger of hand and arm injury from electric shock due to contact with exposed energized electrical conductors or circuit parts. Rubber insulating gloves shall be rated for the voltage for which the gloves will be exposed. Rubber insulating gloves shall be permitted to be used without leather protectors, under the following conditions:

- (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

<u>Class Designation of Glove or Sleeve</u>	<u>Maximum ac Use Voltage rms, volts</u>	<u>Maximum dc Use Voltage avg, volts</u>	<u>Distances Between Gauntlet and Cuff, minimum</u>
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

<u>Rubber Insulating Equipment</u>	<u>When to Test</u>
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 footwear meeting ASTM F2413, *Standard Specification for Performance Requirements for Protective (Safety) Toe Cap 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 electric 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.*

(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 electric shock protection, leather protectors shall be worn over the rubber gloves.

Informational Note: The leather protectors worn over rubber insulating gloves provide additional arc flash protection for the hands 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.

(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 polybenzimidazole (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: ASTM F1959/F1959M, *Standard Test Method for Determining the Arc Rating of Materials for Clothing*, and ASTM F1506, *Standard Performance Specification for Flame Resistant and Electric Arc Rated Protective Clothing Worn by Workers Exposed to Flames and Electric Arcs*, contain 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: Additional guidance is provided in ASTM F1506, *Standard Performance Specification for Flame Resistant and Electric Arc Rated Protective Clothing Worn by Workers Exposed to Flames and Electric Arcs*, when trim, name tags, logos, or any combination thereof are affixed to arc-rated clothing.

Informational Note No. 3: Additional guidance is provided in 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*.

(14) Standards for PPE.

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

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

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

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

- (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: Examples of a process for conformity assessment to an appropriate product standard can be found in ANSI/ISEA 125, American National Standard for Conformity Assessment of Safety and Personal Protective Equipment. See H.4

Informational Note No. 2: An example of a process to accredit independent third-party certification organizations is ISO 17065, Conformity assessment — Requirements for bodies certifying products, processes, and services.

- (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 130.7(C)(14) Informational Note: Standards for PPE

<u>Subject</u>	<u>Document Title</u>	<u>Document Number</u>
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: 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

<u>Subject</u>	<u>Document Title</u>	<u>Document Number</u>
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 — Rubber Insulating	Standard Specification for Rubber Insulating Gloves	ASTM D120
Gloves and Sleeves — In-Service Care	Standard Specification for In-Service Care of Insulating Gloves and Sleeves	ASTM F496
Head Protection — Hard Hats	American National Standard for Head Protection	ANSI/ISEA Z89.1
Rainwear — Arc Rated	Standard Specification for Arc and Flame Resistant Rainwear	ASTM F1891
Rubber Protective Products — Visual Inspection	Standard Guide for Visual Inspection of Electrical Protective Rubber Products	ASTM F1236
Sleeves — Insulating	Standard Specification for Rubber Insulating Sleeves	ASTM D1051

(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.

(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

Informational Note No.1: The arc flash PPE category of the protective clothing and equipment is generally based on determination of the estimated exposure level.

Informational Note No.2: In most cases, closed doors do not provide enough protection to eliminate the need for PPE in situations in which the state of the equipment is known to readily change (e.g., doors open or closed, rack in or rack out).

(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 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.)	1	485 mm (19 in.)
Panelboards or other equipment rated greater than 240 volts and up to 600 volts 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.)	2	900 mm (3 ft)
600-volt class motor control centers (MCCs)	2	1.5 m (5 ft)

<u>Equipment</u>	<u>Arc Flash PPE Category</u>	<u>Arc Flash Boundary</u>
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	4	12 m (40 ft)
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.)	-	-
Other equipment 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.)	-	-
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

<u>Equipment</u>	<u>Arc Flash PPE Category</u>	<u>Arc Flash Boundary</u>
Parameters: DOORS CLOSED and SECURED; with an available fault current and a fault clearing time that does not exceed the arc-resistant rating of the equipment*	-	-

N/A: Not applicable

Note:

For equipment rated 600 volts and below and protected by upstream current-limiting fuses or current-limiting molded case circuit breakers sized at 200 amperes or less, the arc flash PPE category can be reduced by one number but not below arc flash PPE category 1.

*For DOORS OPEN refer to the corresponding non-arc-resistant equipment section of this table.

Informational Note No. 1 to Table 130.7(C)(15)(a): The following are typical fault clearing times of overcurrent protective devices:

- (1) 0.5 cycle fault clearing time is typical for current-limiting fuses and current-limiting molded case circuit breakers when the fault current is within the current limiting range.
- (2) 1.5 cycle fault clearing time is typical for molded case circuit breakers rated less than 1000 volts with an instantaneous integral trip.
- (3) 3.0 cycle fault clearing time is typical for insulated case circuit breakers rated less than 1000 volts with an instantaneous integral trip or relay operated trip.
- (4) 5.0 cycle fault clearing time is typical for relay operated circuit breakers rated 1 kV to 35 kV when the relay operates in the instantaneous range (i.e., "no intentional delay").
- (5) 20 cycle fault clearing time is typical for low-voltage power and insulated case circuit breakers with a short time fault clearing delay for motor inrush.
- (6) 30 cycle fault clearing time is typical for low-voltage power and insulated case circuit breakers with a short time fault clearing delay without instantaneous trip.

Informational Note No. 2 to Table 130.7(C)(15)(a): See Table 1 of IEEE 1584, *Guide for Performing Arc Flash Hazard Calculations*, for further information regarding list items (2) through (4) in Informational Note No. 1.

Informational Note No. 3 to Table 130.7(C)(15)(a): An example of a standard that provides information for arc-resistant equipment referred to in Table 130.7(C)(15)(a) is IEEE C37.20.7, *Guide for Testing Switchgear Rated Up to 52 kV for Internal Arcing Faults*.

Informational Note No. 4 to Table 130.7(C)(15)(a): See O.2.4(9) for information on arc-resistant equipment.

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

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

<u>Equipment</u>	<u>Arc Flash PPE Category</u>	<u>Arc Flash Boundary</u>
Parameters: Greater than 250 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: ASTM F1296, *Standard Guide for Evaluating Chemical Protective Clothing*, contains information on evaluating apparel for protection from electrolyte.

(b) Be arc rated

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

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

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

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

Table 130.7(C)(15)(c) Personal Protective Equipment (PPE)

<u>Arc-Flash PPE Category</u>	<u>PPE</u>
1	Arc-Rated Clothing, Minimum Arc Rating of 4 cal/cm² (16.75 J/cm²)^a
-	Arc-rated long-sleeve shirt and pants or arc-rated coverall
-	Arc-rated face shield ^b or arc flash suit hood
-	Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN) ^f
-	Protective Equipment
-	Hard hat
-	Safety glasses or safety goggles (SR)
-	Hearing protection (ear canal inserts) ^c
-	Heavy-duty leather gloves, arc-rated gloves, or rubber insulating gloves with leather protectors (SR) ^d

Arc-Flash PPE Category	PPE
	Leather footwear ^e (AN)
2	Arc-Rated Clothing, Minimum Arc Rating of 8 cal/cm² (33.5 J/cm²)^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-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN) ^f
	Protective Equipment
	Hard hat
	Safety glasses or safety goggles (SR)
	Hearing protection (ear canal inserts) ^c
	Heavy-duty leather gloves, arc-rated gloves, or rubber insulating gloves with leather protectors (SR) ^d
	Leather footwear ^e
3	Arc-Rated Clothing Selected so That the System Arc Rating Meets the Required Minimum Arc Rating of 25 cal/cm² (104.7 J/cm²)^a
	Arc-rated long-sleeve shirt (AR)
	Arc-rated pants (AR) -
	Arc-rated coverall (AR)
	Arc-rated arc flash suit jacket (AR) -
	Arc-rated arc flash suit pants (AR)
	Arc-rated arc flash suit hood
	Arc-rated gloves or rubber insulating gloves with leather protectors (SR) ^d
	Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN) ^f
	Protective Equipment
	Hard hat
	Safety glasses or safety goggles (SR)
	Hearing protection (ear canal inserts) ^c
	Leather footwear ^e
4	Arc-Rated Clothing Selected so That the System Arc Rating Meets the Required Minimum Arc Rating of 40 cal/cm² (167.5 J/cm²)^a
	Arc-rated long-sleeve shirt (AR)
	Arc-rated pants (AR) -
	Arc-rated coverall (AR)
	Arc-rated arc flash suit jacket (AR) -
	Arc-rated arc flash suit pants (AR)
	Arc-rated arc flash suit hood
	Arc-rated gloves or rubber insulating gloves with leather protectors (SR) ^d
	Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN) ^f
	Protective Equipment
	Hard hat
	Safety glasses or safety goggles (SR)
	Hearing protection (ear canal inserts) ^c
	Leather footwear ^e

AN: As needed (optional). AR: As required. SR: Selection required.

^a*Arc rating* is defined in Article 100.

^bFace 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.

^cOther 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.

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

^eFootwear 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.

^fThe 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.

(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), Electric Shock Protection Boundaries.

(a) *Requirements for Insulated Tools.* The following requirements shall apply to insulated tools:

- (2) Insulated tools shall be rated for the voltages on which they are used.
- (3) Insulated tools shall be designed and constructed for the environment to which they are exposed and the manner in which they are used.
- (4) 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).

(e) *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.

(f) *Ropes and Handlines.* Ropes and handlines used within the limited approach boundary shall be nonconductive.

(g) *Fiberglass-Reinforced Plastic Rods.* Fiberglass-reinforced plastic rod and tube used for live-line tools shall meet the requirements of applicable portions of electrical codes and standards dealing with electrical installation requirements.

Informational Note: For further information concerning electrical codes and standards dealing with installation requirements, refer to ASTM F711, *Standard Specification for Fiberglass-Reinforced Plastic (FRP) Rod and Tube Used in Live Line Tools*.

(h) *Portable Ladders.* Portable ladders shall have nonconductive side rails when used within the limited approach boundary or where the employee or ladder could contact exposed energized electrical conductors or circuit parts. Nonconductive ladders shall meet the requirements of applicable state, federal, or local codes and standards.

Informational Note: The standards listed in Table 130.7(G), Informational Note are examples 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: The standards listed in Table 130.7(G), Informational Note are examples of standards that contain information on rubber insulating equipment.

(b) *Voltage-Rated Plastic Guard Equipment.* Plastic guard equipment for protection of employees from unintentional contact with energized conductors or circuit parts, or for protection of employees or energized equipment or material from contact with ground, shall be rated for the voltage and shall meet the requirements of applicable state, federal, or local codes and standards.

Informational Note: The standards listed in Table 130.7(G), Informational Note are 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.

(E) Alerting Techniques.**(1) Safety Signs and Tags.**

Safety signs, safety symbols, or tags shall be used where necessary to warn employees about electrical hazards that might endanger them. Such signs and tags shall meet the requirements of applicable state, federal, or local codes and standards.

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

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

(2) Barricades.

Barricades shall be used in conjunction with safety signs where it is necessary to prevent or limit employee access to work areas containing energized conductors or circuit parts. Conductive barricades shall not be used where it might increase the likelihood of exposure to an electrical hazard. Barricades shall be placed no closer than the limited approach boundary given in Table 130.4(E)(a) and Table 130.4(E)(b). Where the arc flash boundary is greater than the limited approach boundary, barricades shall not be placed closer than the arc flash boundary.

(3) Attendants.

If signs and barricades do not provide sufficient warning and protection from electrical hazards, an attendant shall be stationed to warn and protect employees. The primary duty and responsibility of an attendant providing manual signaling and alerting shall be to keep unqualified employees outside a work area where the unqualified employee might be exposed to electrical hazards. An attendant shall remain in the area as long as there is a potential for employees to be exposed to the electrical hazards.

(F) Look-Alike Equipment.

Where work performed on equipment that is de-energized and placed in an electrically safe condition exists in a work area with other energized equipment that is similar in size, shape, and construction, one of the alerting methods in 130.7(E)(1), (2), or (3) shall be employed to prevent the employee from entering look-alike equipment.

(G) 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: The standards listed in Table 130.7(G), which is part of this Informational Note, are examples of standards that contain information on other protective equipment.

Table 130.7(G) Informational Note: Standards on Other Protective Equipment

<u>Subject</u>	<u>Document</u>	<u>Document Number</u>
Arc Protective Blankets	Standard Test Method for Determining the Protective Performance of an Arc Protective Blanket for Electric Arc Hazards	ASTM F2676
Arc Protective Blankets — Selection, Care, and Use	Standard Guide for Selection, Care, and Use of Arc Protective Blankets	ASTM F3272
Blankets	Standard Specification for Rubber Insulating Blankets	ASTM D1048
Blankets — In-service Care	Standard Specification for In-Service Care of Insulating Blankets	ASTM F479
-	-	-
Covers	Standard Specification for Rubber Insulating Covers	ASTM D1049
Fiberglass Rods — Live Line Tools	Standard Specification for Fiberglass-Reinforced Plastic (FRP) Rod and Tube Used in Live Line Tools	ASTM F711
Insulated Hand Tools	Standard Specification for Insulated and Insulating Hand Tools	ASTM F1505
Ladders	American National Standard for Ladders — Wood — Safety Requirements	ANSI/ ASC A14.1
	-	American National Standard for Ladders — Fixed — Safety Requirements
	-	ANSI /ASC A14.3
-	-	American National Standard Safety Requirements for Job Made Wooden Ladders
-	-	ANSI ASC A14.4
-	-	American National Standard for Ladders — Portable Reinforced Plastic — Safety Requirements
-	-	ANSI ASC A14.5
Line Hose	Standard Specification for Rubber Insulating Line Hoses	ASTM D1050
Line Hose and Covers — In-service Care	Standard Specification for In-Service Care of Insulating Line Hose and Covers	ASTM F478

<u>Subject</u>	<u>Document</u>	<u>Document Number</u>
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 Input

"electric" is added before "shock" to read "electric shock" to correlate with the use of "electric shock" in the definition of "electrical hazard", Boundary, Restricted Approach, as already used in multiple locations within 130.7, as well as to clarify that the type of shock hazard being addressed is a shock hazard rather than others forms of shock such as where one would go into shock due to a severe injury or a reaction associated with fright.

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.

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

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 15-NFPA 70E-2020 [Definition: Shock Hazard.]	Related issue

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Committee: EEW-AAA

**Public Input No. 28-NFPA 70E-2020 [Section No. 130.7]****130.7 Personal and Other Protective Equipment.****(A) General.**

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

Informational Note: The PPE requirements of 130.7 are intended to protect a person from arc flash and electric shock hazards. While some situations could result in burns to the skin, even with the protection selected, 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 130.7 do not address protection against physical trauma other than exposure to the thermal effects of an arc flash.

(B) Care of Equipment.

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

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

(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 noncontact proximity test instrument(s) or measurement of voltage on the secondary side of a low-voltage transformer (VT) mounted in the equipment before using a contact test instrument to test for the absence of voltage below 1000 volts.
- (2) If equipment design allows, observe visible gaps between the equipment conductors and circuit parts and the electrical source(s) of supply.
- (3) Increase the working distance.
- (4) Consider system design options to reduce the incident energy level.

(2) Movement and Visibility.

When arc-rated clothing is worn to protect an employee, it shall cover all ignitable 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 shall wear hearing protection whenever working within the arc flash boundary.

(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) Electric Shock Protection. Employees shall wear rubber insulating gloves with leather protectors where there is a danger of hand injury from electric shock due to contact with exposed energized electrical conductors or circuit parts. Employees shall wear rubber insulating gloves with leather protectors and rubber insulating sleeves where there is a danger of hand and arm injury from electric shock due to contact with exposed energized electrical conductors or circuit parts. Rubber insulating gloves shall be rated for the voltage for which the gloves will be exposed. Rubber insulating gloves shall be permitted to be used without leather protectors, under the following conditions:

- (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

<u>Class Designation of Glove or Sleeve</u>	<u>Maximum ac Use Voltage rms, volts</u>	<u>Maximum dc Use Voltage avg, volts</u>	<u>Distances Between Gauntlet and Cuff, minimum</u>
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

<u>Rubber Insulating Equipment</u>	<u>When to Test</u>
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 footwear meeting ASTM F2413, *Standard Specification for Performance Requirements for Protective (Safety) Toe Cap 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 electric 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.*

(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 electric shock protection, leather protectors shall be worn over the rubber gloves.

Informational Note: The leather protectors worn over rubber insulating gloves provide additional arc flash protection for the hands 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.

(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 polybenzimidazole (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: ASTM F1959/F1959M, *Standard Test Method for Determining the Arc Rating of Materials for Clothing*, and ASTM F1506, *Standard Performance Specification for Flame Resistant and Electric Arc Rated Protective Clothing Worn by Workers Exposed to Flames and Electric Arcs*, contain 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: Additional guidance is provided in ASTM F1506, *Standard Performance Specification for Flame Resistant and Electric Arc Rated Protective Clothing Worn by Workers Exposed to Flames and Electric Arcs*, when trim, name tags, logos, or any combination thereof are affixed to arc-rated clothing.

Informational Note No. 3: Additional guidance is provided in 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*.

(14) Standards for PPE.

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

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

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

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

- (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: Examples of a process for conformity assessment to an appropriate product standard can be found in ANSI/ISEA 125, American National Standard for Conformity Assessment of Safety and Personal Protective Equipment. See H.4

Informational Note No. 2: An example of a process to accredit independent third-party certification organizations is ISO 17065, Conformity assessment — Requirements for bodies certifying products, processes, and services.

- (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 130.7(C)(14) Informational Note: Standards for PPE

<u>Subject</u>	<u>Document Title</u>	<u>Document Number</u>
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: 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

<u>Subject</u>	<u>Document Title</u>	<u>Document Number</u>
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 — Rubber Insulating	Standard Specification for Rubber Insulating Gloves	ASTM D120
Gloves and Sleeves — In-Service Care	Standard Specification for In-Service Care of Insulating Gloves and Sleeves	ASTM F496
Head Protection — Hard Hats	American National Standard for Head Protection	ANSI/ISEA Z89.1
Rainwear — Arc Rated	Standard Specification for Arc and Flame Resistant Rainwear	ASTM F1891
Rubber Protective Products — Visual Inspection	Standard Guide for Visual Inspection of Electrical Protective Rubber Products	ASTM F1236
Sleeves — Insulating	Standard Specification for Rubber Insulating Sleeves	ASTM D1051

(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.

(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

Informational Note No.1: The arc flash PPE category of the protective clothing and equipment is generally based on determination of the estimated exposure level.

Informational Note No.2: In most cases, closed doors do not provide enough protection to eliminate the need for PPE in situations in which the state of the equipment is known to readily change (e.g., doors open or closed, rack in or rack out).

(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 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.)	1	485 mm (19 in.)
Panelboards or other equipment rated greater than 240 volts and up to 600 volts 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.)	2	900 mm (3 ft)
600-volt class motor control centers (MCCs)	2	1.5 m (5 ft)

<u>Equipment</u>	<u>Arc Flash PPE Category</u>	<u>Arc Flash Boundary</u>
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	4	12 m (40 ft)
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.)	-	-
Other equipment 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.)	-	-
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

<u>Equipment</u>	<u>Arc Flash PPE Category</u>	<u>Arc Flash Boundary</u>
Parameters: DOORS CLOSED and SECURED; with an available fault current and a fault clearing time that does not exceed the arc-resistant rating of the equipment*	-	-

N/A: Not applicable

Note:

For equipment rated 600 volts and below and protected by upstream current-limiting fuses or current-limiting molded case circuit breakers sized at 200 amperes or less, the arc flash PPE category can be reduced by one number but not below arc flash PPE category 1.

*For DOORS OPEN refer to the corresponding non-arc-resistant equipment section of this table.

Informational Note No. 1 to Table 130.7(C)(15)(a): The following are typical fault clearing times of overcurrent protective devices:

- (1) 0.5 cycle fault clearing time is typical for current-limiting fuses and current-limiting molded case circuit breakers when the fault current is within the current limiting range.
- (2) 1.5 cycle fault clearing time is typical for molded case circuit breakers rated less than 1000 volts with an instantaneous integral trip.
- (3) 3.0 cycle fault clearing time is typical for insulated case circuit breakers rated less than 1000 volts with an instantaneous integral trip or relay operated trip.
- (4) 5.0 cycle fault clearing time is typical for relay operated circuit breakers rated 1 kV to 35 kV when the relay operates in the instantaneous range (i.e., "no intentional delay").
- (5) 20 cycle fault clearing time is typical for low-voltage power and insulated case circuit breakers with a short time fault clearing delay for motor inrush.
- (6) 30 cycle fault clearing time is typical for low-voltage power and insulated case circuit breakers with a short time fault clearing delay without instantaneous trip.

Informational Note No. 2 to Table 130.7(C)(15)(a): See Table 1 of IEEE 1584, *Guide for Performing Arc Flash Hazard Calculations*, for further information regarding list items (2) through (4) in Informational Note No. 1.

Informational Note No. 3 to Table 130.7(C)(15)(a): An example of a standard that provides information for arc-resistant equipment referred to in Table 130.7(C)(15)(a) is IEEE C37.20.7, *Guide for Testing Switchgear Rated Up to 52 kV for Internal Arcing Faults*.

Informational Note No. 4 to Table 130.7(C)(15)(a): See O.2.4(9) for information on arc-resistant equipment.

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

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

<u>Equipment</u>	<u>Arc Flash PPE Category</u>	<u>Arc Flash Boundary</u>
Parameters: Greater than 250 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: ASTM F1296, *Standard Guide for Evaluating Chemical Protective Clothing*, contains information on evaluating apparel for protection from electrolyte.

(b) Be arc rated

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

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

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

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

Table 130.7(C)(15)(c) Personal Protective Equipment (PPE)

<u>Arc-Flash PPE Category</u>	<u>PPE</u>
1	Arc-Rated Clothing, Minimum Arc Rating of 4 cal/cm² (16.75 J/cm²)^a
-	Arc-rated long-sleeve shirt and pants or arc-rated coverall
-	Arc-rated face shield ^b or arc flash suit hood
-	Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN) ^f
-	Protective Equipment
-	Hard hat
-	Safety glasses or safety goggles (SR)
-	Hearing protection (ear canal inserts) ^c
-	Heavy-duty leather gloves, arc-rated gloves, or rubber insulating gloves with leather protectors (SR) ^d

Arc-Flash PPE Category	PPE
	Leather footwear ^e (AN)
2	Arc-Rated Clothing, Minimum Arc Rating of 8 cal/cm² (33.5 J/cm²)^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-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN) ^f
	Protective Equipment
	Hard hat
	Safety glasses or safety goggles (SR)
	Hearing protection (ear canal inserts) ^c
	Heavy-duty leather gloves, arc-rated gloves, or rubber insulating gloves with leather protectors (SR) ^d
	Leather footwear ^e
3	Arc-Rated Clothing Selected so That the System Arc Rating Meets the Required Minimum Arc Rating of 25 cal/cm² (104.7 J/cm²)^a
	Arc-rated long-sleeve shirt (AR)
	Arc-rated pants (AR) -
	Arc-rated coverall (AR)
	Arc-rated arc flash suit jacket (AR) -
	Arc-rated arc flash suit pants (AR)
	Arc-rated arc flash suit hood
	Arc-rated gloves or rubber insulating gloves with leather protectors (SR) ^d
	Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN) ^f
	Protective Equipment
	Hard hat
	Safety glasses or safety goggles (SR)
	Hearing protection (ear canal inserts) ^c
	Leather footwear ^e
4	Arc-Rated Clothing Selected so That the System Arc Rating Meets the Required Minimum Arc Rating of 40 cal/cm² (167.5 J/cm²)^a
	Arc-rated long-sleeve shirt (AR)
	Arc-rated pants (AR) -
	Arc-rated coverall (AR)
	Arc-rated arc flash suit jacket (AR) -
	Arc-rated arc flash suit pants (AR)
	Arc-rated arc flash suit hood
	Arc-rated gloves or rubber insulating gloves with leather protectors (SR) ^d
	Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN) ^f
	Protective Equipment
	Hard hat
	Safety glasses or safety goggles (SR)
	Hearing protection (ear canal inserts) ^c
	Leather footwear ^e

AN: As needed (optional). AR: As required. SR: Selection required.

^a*Arc rating* is defined in Article 100.

^bFace 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.

^cOther 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.

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

^eFootwear 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.

^fThe 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.

(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), Electric Shock Protection Boundaries.

(a) *Requirements for Insulated Tools.* The following requirements shall apply to insulated tools:

- (2) Insulated tools shall be rated for the voltages on which they are used.
- (3) Insulated tools shall be designed and constructed for the environment to which they are exposed and the manner in which they are used.
- (4) 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).

(e) *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.

(f) *Ropes and Handlines.* Ropes and handlines used within the limited approach boundary shall be nonconductive.

(g) *Fiberglass-Reinforced Plastic Rods.* Fiberglass-reinforced plastic rod and tube used for live-line tools shall meet the requirements of applicable portions of electrical codes and standards dealing with electrical installation requirements.

Informational Note: For further information concerning electrical codes and standards dealing with installation requirements, refer to ASTM F711, *Standard Specification for Fiberglass-Reinforced Plastic (FRP) Rod and Tube Used in Live Line Tools*.

(h) *Portable Ladders.* Portable ladders shall have nonconductive side rails when used within the limited approach boundary or where the employee or ladder could contact exposed energized electrical conductors or circuit parts. Nonconductive ladders shall meet the requirements of applicable state, federal, or local codes and standards.

Informational Note: The standards listed in Table 130.7(G), Informational Note are examples 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: The standards listed in Table 130.7(G), Informational Note are examples of standards that contain information on rubber insulating equipment.

(b) *Voltage-Rated Plastic Guard Equipment.* Plastic guard equipment for protection of employees from unintentional contact with energized conductors or circuit parts, or for protection of employees or energized equipment or material from contact with ground, shall be rated for the voltage and shall meet the requirements of applicable state, federal, or local codes and standards.

Informational Note: The standards listed in Table 130.7(G), Informational Note are 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.

(E) Alerting Techniques.**(1) Safety Signs and Tags.**

Safety signs, safety symbols, or tags shall be used where necessary to warn employees about electrical hazards that might endanger them. Such signs and tags shall meet the requirements of applicable state, federal, or local codes and standards.

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

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

(2) Barricades.

Barricades shall be used in conjunction with safety signs where it is necessary to prevent or limit employee access to work areas containing energized conductors or circuit parts. Conductive barricades shall not be used where it might increase the likelihood of exposure to an electrical hazard. Barricades shall be placed no closer than the limited approach boundary given in Table 130.4(E)(a) and Table 130.4(E)(b). Where the arc flash boundary is greater than the limited approach boundary, barricades shall not be placed closer than the arc flash boundary.

(3) Attendants.

If signs and barricades do not provide sufficient warning and protection from electrical hazards, an attendant shall be stationed to warn and protect employees. The primary duty and responsibility of an attendant providing manual signaling and alerting shall be to keep unqualified employees outside a work area where the unqualified employee might be exposed to electrical hazards. An attendant shall remain in the area as long as there is a potential for employees to be exposed to the electrical hazards.

(F) Look-Alike Equipment.

Where work performed on equipment that is de-energized and placed in an electrically safe condition exists in a work area with other energized equipment that is similar in size, shape, and construction, one of the alerting methods in 130.7(E)(1), (2), or (3) shall be employed to prevent the employee from entering look-alike equipment.

(G) 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: The standards listed in Table 130.7(G), which is part of this Informational Note, are examples of standards that contain information on other protective equipment.

Table 130.7(G) Informational Note: Standards on Other Protective Equipment

<u>Subject</u>	<u>Document</u>	<u>Document Number</u>
Arc Protective Blankets	Standard Test Method for Determining the Protective Performance of an Arc Protective Blanket for Electric Arc Hazards	ASTM F2676
Arc Protective Blankets — Selection, Care, and Use	Standard Guide for Selection, Care, and Use of Arc Protective Blankets	ASTM F3272
Blankets	Standard Specification for Rubber Insulating Blankets	ASTM D1048
Blankets — In-service Care	Standard Specification for In-Service Care of Insulating Blankets	ASTM F479
-	-	-
Covers	Standard Specification for Rubber Insulating Covers	ASTM D1049
Fiberglass Rods — Live Line Tools	Standard Specification for Fiberglass-Reinforced Plastic (FRP) Rod and Tube Used in Live Line Tools	ASTM F711
Insulated Hand Tools	Standard Specification for Insulated and Insulating Hand Tools	ASTM F1505
Ladders	American National Standard for Ladders — Wood — Safety Requirements	ANSI/ ASC A14.1
	-	American National Standard for Ladders — Fixed — Safety Requirements
	-	ANSI /ASC A14.3
-	-	American National Standard Safety Requirements for Job Made Wooden Ladders
-	-	ANSI ASC A14.4
-	-	American National Standard for Ladders — Portable Reinforced Plastic — Safety Requirements
-	-	ANSI ASC A14.5
Line Hose	Standard Specification for Rubber Insulating Line Hoses	ASTM D1050
Line Hose and Covers — In-service Care	Standard Specification for In-Service Care of Insulating Line Hose and Covers	ASTM F478

<u>Subject</u>	<u>Document</u>	<u>Document Number</u>
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 Input

"electric" is added before "shock" to read "electric shock" to correlate with the use of "electric shock" in the definition of "electrical hazard", Boundary, Restricted Approach, in multiple existing locations within 130.7, as well as to clarify that the type of shock hazard being addressed is a shock hazard rather than others forms of shock such as where one would go into shock due to a severe injury or a reaction associated with fright.

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.

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

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 15-NFPA 70E-2020 [Definition: Shock Hazard.]	
Public Input No. 15-NFPA 70E-2020 [Definition: Shock Hazard.]	
Public Input No. 29-NFPA 70E-2020 [Section No. 250.2(B)]	
Public Input No. 30-NFPA 70E-2020 [Chapter 3]	
Public Input No. 31-NFPA 70E-2020 [Section No. C.1.1]	
Public Input No. 32-NFPA 70E-2020 [Section No. E.1]	
Public Input No. 33-NFPA 70E-2020 [Annex F]	
Public Input No. 34-NFPA 70E-2020 [Section No. H.3]	
Public Input No. 35-NFPA 70E-2020 [Section No. J.1]	
Public Input No. 36-NFPA 70E-2020 [Section No. I.1]	
Public Input No. 37-NFPA 70E-2020 [Annex K]	
Public Input No. 38-NFPA 70E-2020 [Annex O]	
Public Input No. 39-NFPA 70E-2020 [Annex R]	

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Committee:	EEW-AAA

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

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

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

Statement of Problem and Substantiation for Public Input

TerraView error. Only change is to relocate reference to front of Informational Note.

Revised Informational Note to comply with new 2020 NEC Style Manual.

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

Submitter Information Verification

Submitter Full Name: Louis Barrios

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Submittal Date: Sun May 23 12:52:52 EDT 2021

Committee: EEW-AAA

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

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

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

- (1) ~~Use noncontact proximity test instrument(s) or measurement of voltage on the secondary side of a low-voltage transformer (VT) mounted in the equipment before using a contact test instrument to test for the absence of voltage below 1000 volts.~~
- (2)
- (3) If equipment design allows, observe visible gaps between the equipment conductors and circuit parts and the electrical source(s) of supply.
- (4) Increase the working distance.
- (5) Consider system design options to reduce the incident energy level.

Statement of Problem and Substantiation for Public Input

Delete clause (1) in the Informational Note. This Informational Note was added in the last revision cycle and provides beneficial guidance on what additional steps can be taken to reduce the risk of incident energy exposure to persons performing absence of voltage testing where the predicted energy exceeds the ratings of commercially available protective clothing. However, clause 1 in the Informational Note is not clear. Is the VT permanently installed or temporarily installed for the purpose of voltage detection? Is this a VT that would be installed on 600V or 480V systems and the voltage being measured first is 120V on the secondary of the VT? If an enclosure is being opened to first verify the absence indirectly on the secondary of the VT, would the individual still be exposed to the high energy levels on the VT primary if exposed? Clause 1 should be deleted or revised to improve clarity.

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Submittal Date: Mon May 31 10:59:11 EDT 2021

Committee: EEW-AAA

**Public Input No. 337-NFPA 70E-2021 [Section No. 130.7(C)(1)]****(1) General.**

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

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

- (1) Use noncontact proximity test instrument(s) or measurement of voltage on the secondary side of a low-voltage transformer (VT) mounted in the equipment before using a contact test instrument to test for the absence of voltage below 1000 volts.
- (2) If equipment design allows, observe visible gaps between the equipment conductors and circuit parts and the electrical source(s) of supply.
- (3) Increase the working distance.
- (4) Consider system design options to reduce the incident energy level.

Exception: An arc rated balaclava or arc rated flash suite hood shall not be required when the head is inside the arc flash boundary when the incident energy is 4 cal/cm2 or less.

Statement of Problem and Substantiation for Public Input

This revision will align with the requirements in the NFPA 70E tables for category 1.

Submitter Information Verification

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Submittal Date: Tue Jun 01 14:47:44 EDT 2021

Committee: EEW-AAA

**Public Input No. 40-NFPA 70E-2020 [Section No. 130.7(C)(4)]****(4) Eye Protection.**

Employees shall wear non-conductive protective equipment for the eyes whenever there is danger of injury from electric arcs, flashes, or from flying objects resulting from electrical explosion.

Statement of Problem and Substantiation for Public Input

NFPA 70E 130.8(D) mentions that metal frame glasses should not be worn within the arc flash and shock boundaries. I propose we re-emphasize the danger of metallic safety glasses, even if they are ANSI rated. My proposed change to 130.7(C)(4) would do that. I would hope a result of the change would be for companies to better understand that electrical workers need safety glasses, and the eye protection should be ANSI rated and non-conductive.

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Submittal Date: Mon Dec 28 14:01:31 EST 2020

Committee: EEW-AAA

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

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

Statement of Problem and Substantiation for Public Input

Many have different opinions of what working is. Some believe it when you are getting paid, others only when something is actually being done, other than napping. The term "working" is not defined in this standard and removing does not lessen the requirement.

Submitter Information Verification

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Submittal Date: Tue Jun 01 17:27:34 EDT 2021

Committee: EEW-AAA

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

Employees shall wear hearing protection whenever ~~working~~ the worker's torso is within the arc flash boundary.

Statement of Problem and Substantiation for Public Input

This section could be construed as the actual work taking place. For example, a zero voltage check. The arc flash boundary could be 1 inch, but the probes are within this boundary. Perhaps another way of saying this is: "hearing protection is required whenever arc rated PPE is required to be worn." Or, delete this section all together. Let the hearing protection be specified by the PPE requirements.

Submitter Information Verification

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Committee: EEW-AAA



Public Input No. 330-NFPA 70E-2021 [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 leather protectors where there is a danger of hand injury from electric shock due to contact with exposed energized electrical conductors or circuit parts. Employees shall wear rubber insulating gloves with leather protectors and rubber insulating sleeves where there is a danger of hand and arm injury from electric shock due to contact with exposed energized electrical conductors or circuit parts.

Rubber insulating gloves shall be rated for the voltage for which the gloves will be exposed.

Where rubber insulating rubber gloves are used for shock protection, leather protectors shall be worn over the rubber insulating gloves.

Rubber insulating gloves shall be permitted to be used without leather 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

<u>Class Designation of Glove or Sleeve</u>	<u>Maximum ac Use Voltage rms, volts</u>	<u>Maximum dc Use Voltage avg, volts</u>	<u>Distances Between Gauntlet and Cuff, minimum</u>
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

<u>Rubber Insulating Equipment</u>	<u>When to Test</u>
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.

Statement of Problem and Substantiation for Public Input

Previously requirements for using leather protectors over rubber insulating gloves and when rubber insulating gloves can be used without leather protectors were in two different sections. This text will consolidate both requirements at one place

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 329-NFPA 70E-2021 [Section No. 130.7(C)(10)]	

Submitter Information Verification

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Submittal Date: Tue Jun 01 13:54:49 EDT 2021
Committee: EEW-AAA


Public Input No. 53-NFPA 70E-2021 [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 leather protectors where there is a danger of hand injury from electric shock due to contact with exposed energized electrical conductors or circuit parts. Employees shall wear rubber insulating gloves with leather protectors and rubber insulating sleeves where there is a danger of hand and arm injury from electric shock due to contact with exposed energized electrical conductors or circuit parts. Rubber insulating gloves shall be rated for the voltage for which the gloves will be exposed. Rubber insulating gloves shall be permitted to be used without leather protectors, under the following conditions:

- (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

<u>Class Designation of Glove or Sleeve</u>	<u>Maximum ac Use Voltage rms, volts</u>	<u>Maximum dc Use Voltage avg, volts</u>	<u>Distances Between Gauntlet and Leather Protector Cuff and Rubber Insulating Glove Cuff, minimum</u>
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

<u>Rubber Insulating Equipment</u>	<u>When to Test</u>
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.

Statement of Problem and Substantiation for Public Input

Terra has shown more underlined text than this recommendation is proposing.

The use of the term "gauntlet" in the table heading is not clear in the context presented. Both the rubber insulating glove and the leather protector have a gauntlet or gauntlet area. Editorial changes are recommended to make the table heading clear. I offer the following

information that I found in an online search for an illustration of what a gauntlet is. This image which included Section 8.7.2 from ASTM F-496 appeared in the image search: "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 4." This text is the basis for this revision.

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Submittal Date: Tue Feb 23 15:46:18 EST 2021

Committee: EEW-AAA

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

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

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

Statement of Problem and Substantiation for Public Input

Revised Informational Note to comply with new 2020 NEC Style Manual.

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

Submitter Information Verification

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Submittal Date: Sun May 23 13:10:56 EDT 2021

Committee: EEW-AAA



Public Input No. 329-NFPA 70E-2021 [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 No. 1: 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 (41.0 J/cm^2).~~

~~Where insulating rubber gloves are used for shock protection, leather protectors shall be worn over the rubber gloves.~~

(1)

~~Informational Note No. 2: The leather protectors worn over rubber insulating gloves provide additional arc flash protection for the hands for arc flash protection exposure.~~

(h) *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 Input

130.7 (C) 10) is titled Arc Flash protective equipment This deleted text is for shock protection and belongs in 130.7 (C) (7) and is proposed to be relocated to 130.7 (C) (7)

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 330-NFPA 70E-2021 [Section No. 130.7(C)(7)]	

Submitter Information Verification

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Submittal Date: Tue Jun 01 13:49:25 EDT 2021

Committee: EEW-AAA



Public Input No. 42-NFPA 70E-2021 [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.*

Heavy-duty leather gloves or arc-

(1) 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, arc-rated leather protectors shall be worn over the rubber gloves.

Informational Note: The leather protectors worn over rubber insulating gloves provide additional arc flash protection for the hands for arc flash protection exposure.

(g) *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 Input

PROBLEM: The current text does not provide sufficient protection for hands.

SUBSTANTIATION: The qualified person's hands are usually closest to the arc-flash when work is being performed, often much closer than the working distance used to calculate the incident energy. It is important to ensure the employee's hands are well protected. Heavy-duty leather gloves are not defined in 70E and do not appear to be defined by any other standard.

The informational note for 130.7(C)(10)(d)(1) indicates that heavy-duty leather gloves have a minimum of 0.03 inch thickness. Five major manufacturers were contacted and stated that they do not publish nor disclose the thickness of their leather protectors; one responded it is proprietary information. Most leather work gloves do not have thickness indicated on them. The 70E informational note also indicates that the ATPV would be 10 cal/cm^2 or greater, which is below the 12 cal/cm^2 rating suggested by Table 130.5(G) – with the situation exacerbated by hands being closer than the incident energy working distance.

The lack of ASTM arc-flash specifications for rubber insulating gloves means they cannot be depended upon to ensure that they will provide consistent or sufficient protection. There is significant variability in glove performance based on class and color from testing performed in the early part of this century, even if it was generally favorable. Since that time there have been market changes with a large proliferation of gloves from a more diverse group of manufacturers. Examination of various manufacturers' gloves has shown large variation in quality. Without clear arc flash performance specifications, the rubber insulating gloves cannot be depended upon for protection.

There are now multiple manufacturers providing leather protectors with ATPV specified that will protect the rubber insulating gloves from the arc flash.

Related Public Inputs for This Document

Related Input

[Public Input No. 43-NFPA 70E-2021 \[Section No. 130.5\(G\)\]](#)

[Public Input No. 44-NFPA 70E-2021 \[Section No. 130.7\(C\)\(15\)\]](#)

Relationship

Submitter Information Verification

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Submittal Date: Tue Jan 12 18:25:16 EST 2021

Committee: EEW-AAA

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

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

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

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

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

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

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

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

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

Statement of Problem and Substantiation for Public Input

Revised Informational Note to comply with new 2020 NEC Style Manual and to align format with other Informational Notes.

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

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Committee: EEW-AAA

**Public Input No. 189-NFPA 70E-2021 [Section No. 130.7(C)(13)]****(13) Care and Maintenance of Arc-Rated Clothing and Arc-Rated Arc Flash Suits.**

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

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

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

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

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

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

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

Statement of Problem and Substantiation for Public Input

Revised Informational Note to comply with new 2020 NEC Style Manual.

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

Submitter Information Verification

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Public Input No. 190-NFPA 70E-2021 [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: ~~The standards listed in See Table 130.7(C)(14), which is a part of this Informational Note, are examples for a list of standards that contain information on the care, inspection, testing, and manufacturing of PPE.~~

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

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

- (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:

~~Examples of a process for conformity assessment to an appropriate product standard can be found in~~

- (1)

See H.4 in Informative Annex H and ANSI/ISEA 125, American National Standard for Conformity Assessment of Safety and Personal Protective

~~Equipment. See — H.4~~

- (1)

Equipment for e examples of a process for conformity assessment to an appropriate product standard.

Informational Note No. 2:

~~An example of a process to accredit independent third-party certification organizations is~~

- (1)

See ISO 17065, Conformity assessment — Requirements for bodies certifying products, processes, and services as 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 130.7(C)(14) Informational Note: Standards for PPE

<u>Subject</u>	<u>Document Title</u>	<u>Document Number</u>
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: Requirements	IEC 61482–2

<u>Subject</u>	<u>Document Title</u>	<u>Document Number</u>
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 — Rubber Insulating	Standard Specification for Rubber Insulating Gloves	ASTM D120
Gloves and Sleeves — In-Service Care	Standard Specification for In-Service Care of Insulating Gloves and Sleeves	ASTM F496
Head Protection — Hard Hats	American National Standard for Head Protection	ANSI/ISEA Z89.1
Rainwear — Arc Rated	Standard Specification for Arc and Flame Resistant Rainwear	ASTM F1891
Rubber Protective Products — Visual Inspection	Standard Guide for Visual Inspection of Electrical Protective Rubber Products	ASTM F1236
Sleeves — Insulating	Standard Specification for Rubber Insulating Sleeves	ASTM D1051

Statement of Problem and Substantiation for Public Input

TerraView error. Only change is to relocate reference to front of Informational Notes and to clean up existing language of the Informational Notes.

Revised Informational Note to comply with new 2020 NEC Style Manual.

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

Submitter Information Verification

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Committee: EEW-AAA



Public Input No. 317-NFPA 70E-2021 [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: The standards listed in Table 130.7(C)(14), which is part of this Informational Note, are examples of standards that contain information on the care, inspection, testing, and manufacturing of PPE.

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

(b) **Conformity Assessment.** ~~All suppliers or manufacturers of PPE shall demonstrate.~~ An employer shall ensure that the PPE provided in accordance with the requirements of Chapter 1 demonstrates 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: Examples of a process for conformity assessment to an appropriate product standard can be found in ANSI/ISEA 125, American National Standard for Conformity Assessment of Safety and Personal Protective Equipment. See H.4

Informational Note No. 2: An example of a process to accredit independent third-party certification organizations is ISO 17065, Conformity assessment — Requirements for bodies certifying products, processes, and services.

(f) **Marking.** ~~All suppliers or manufacturers of PPE shall provide the~~ An employer shall ensure that the PPE provided in accordance with the requirements of Chapter 1 contains 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 130.7(C)(14) Informational Note: Standards for PPE

Subject	Document Title	Document Number
Clothing — Arc Rated	Standard Performance Specification for Flame Resistant and Electric Arc Rated Protective Clothing Worn by Workers Exposed to Flames and Electric Arc	ASTM F1506
	Standard Guide for Industrial Laundering of Flame, Thermal, and Arc Resistant Clothing	ASTM F1449
	Standard Guide for Home Laundering Care and Maintenance of Flame, Thermal and Arc Resistant Clothing	ASTM F2757
	Live working — Protective clothing against the thermal hazards of an electric arc — Part 1-1: Test methods — Method 1: Determination of the arc rating (ELIM, ATPV, and/or EBT) of clothing materials and of protective clothing using an open arc	IEC 61482–1–1
	Live working — Protective clothing against the thermal hazards of an electric arc — Part 2: Requirements	IEC 61482–2
Aprons — Insulating	Standard Specification for Electrically Insulating Aprons	ASTM F2677
Eye and Face Protection — General	American National Standard for Occupational and Educational Professional Eye and Face Protection	ANSI/ISEA Z87.1
Face — Arc Rated	Standard Test Method for Determining the Arc Rating and Standard Specification for Personal Eye or Face Protective Products	ASTM F2178
Fall Protection	Standard Specification for Personal Climbing Equipment	ASTM F887

<u>Subject</u>	<u>Document Title</u>	<u>Document Number</u>
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 — Rubber Insulating	Standard Specification for Rubber Insulating Gloves	ASTM D120
Gloves and Sleeves — In-Service Care	Standard Specification for In-Service Care of Insulating Gloves and Sleeves	ASTM F496
Head Protection — Hard Hats	American National Standard for Head Protection	ANSI/ISEA Z89.1
Rainwear — Arc Rated	Standard Specification for Arc and Flame Resistant Rainwear	ASTM F1891
Rubber Protective Products — Visual Inspection	Standard Guide for Visual Inspection of Electrical Protective Rubber Products	ASTM F1236
Sleeves — Insulating	Standard Specification for Rubber Insulating Sleeves	ASTM D1051

Statement of Problem and Substantiation for Public Input

Note: Terra view appears to have made a bit of mess of the public input. The only proposed revisions are to the sentences in (b) and (c). No revisions are proposed to the list items below (b) and (c).

Rationale: The requirements of 130.7(C)(14),(b) and (c), while well intentioned, are beyond the scope of Chapter 1. As set forth in Article 105, the employer has the responsibility to establish, document, and implement the safety-related work practices and procedures required by 70E. No where in Article 105 is a supplier or manufacturer mentioned, nor requirements imposed on these entities anywhere else in the standard.

The proposed revision does not change the protection afforded by 130.7(C)(14), it simply shifts the responsibility to the employer.

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Public Input No. 11-NFPA 70E-2020 [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.

(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

Informational Note No.1: The arc flash PPE category of the protective clothing and equipment is generally based on determination of the estimated exposure level.

Informational Note No.2: In most cases, closed doors do not provide enough protection to eliminate the need for PPE in situations in which the state of the equipment is known to readily change (e.g., doors open or closed, rack in or rack out).

(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>
<u>Enclosed</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 455 mm (18 in.)	-	-
<u>Enclosed</u> 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.)	-	-

<u>Equipment</u>	<u>Arc Flash PPE Category</u>	<u>Arc Flash Boundary</u>
600-volt class motor control centers (MCCs) 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.)	2	1.5 m (5 ft)
	-	-
600-volt class motor control centers (MCCs) 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.)	4	4.3 m (14 ft)
	-	-
600-volt class switchgear (with power circuit breakers or fused switches) and 600-volt class switchboards 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.)	4	6 m (20 ft)
	-	-
Other 600-volt class (277 volts through 600 volts, nominal) equipment 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.)	2	1.5 m (5 ft)
	-	-
NEMA E2 (fused contactor) motor starters, 2.3 kV through 7.2 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)
	-	-
Metal-clad switchgear, 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)
	-	-
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

<u>Equipment</u>	<u>Arc Flash PPE Category</u>	<u>Arc Flash Boundary</u>
Arc-resistant equipment 1 kV through 15 kV	N/A	N/A
Parameters: DOORS CLOSED and SECURED; with an available fault current and a fault clearing time that does not exceed the arc-resistant rating of the equipment*	-	-

N/A: Not applicable

Note:

For equipment rated 600 volts and below and protected by upstream current-limiting fuses or current-limiting molded case circuit breakers sized at 200 amperes or less, the arc flash PPE category can be reduced by one number but not below arc flash PPE category 1.

*For DOORS OPEN refer to the corresponding non-arc-resistant equipment section of this table.

Informational Note No. 1 to Table 130.7(C)(15)(a): The following are typical fault clearing times of overcurrent protective devices:

(1) 0.5 cycle fault clearing time is typical for current-limiting fuses and current-limiting molded case circuit breakers when the fault current is within the current limiting range.

(2) 1.5 cycle fault clearing time is typical for molded case circuit breakers rated less than 1000 volts with an instantaneous integral trip.

(3) 3.0 cycle fault clearing time is typical for insulated case circuit breakers rated less than 1000 volts with an instantaneous integral trip or relay operated trip.

(4) 5.0 cycle fault clearing time is typical for relay operated circuit breakers rated 1 kV to 35 kV when the relay operates in the instantaneous range (i.e., "no intentional delay").

(5) 20 cycle fault clearing time is typical for low-voltage power and insulated case circuit breakers with a short time fault clearing delay for motor inrush.

(6) 30 cycle fault clearing time is typical for low-voltage power and insulated case circuit breakers with a short time fault clearing delay without instantaneous trip.

Informational Note No. 2 to Table 130.7(C)(15)(a): See Table 1 of IEEE 1584, *Guide for Performing Arc Flash Hazard Calculations*, for further information regarding list items (2) through (4) in Informational Note No. 1.

Informational Note No. 3 to Table 130.7(C)(15)(a): An example of a standard that provides information for arc-resistant equipment referred to in Table 130.7(C)(15)(a) is IEEE C37.20.7, *Guide for Testing Switchgear Rated Up to 52 kV for Internal Arcing Faults*.

Informational Note No. 4 to Table 130.7(C)(15)(a): See O.2.4(9) for information on arc-resistant equipment.

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

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

<u>Equipment</u>	<u>Arc Flash PPE Category</u>	<u>Arc Flash Boundary</u>
Parameters: Greater than 250 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: ASTM F1296, *Standard Guide for Evaluating Chemical Protective Clothing*, contains information on evaluating apparel for protection from electrolyte.

(b) Be arc rated

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

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

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

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

Table 130.7(C)(15)(c) Personal Protective Equipment (PPE)

<u>Arc-Flash PPE Category</u>	<u>PPE</u>
1	Arc-Rated Clothing, Minimum Arc Rating of 4 cal/cm² (16.75 J/cm²)^a
-	Arc-rated long-sleeve shirt and pants or arc-rated coverall
-	Arc-rated face shield ^b or arc flash suit hood
-	Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN) ^f
-	Protective Equipment
-	Hard hat
-	Safety glasses or safety goggles (SR)
-	Hearing protection (ear canal inserts) ^c
-	Heavy-duty leather gloves, arc-rated gloves, or rubber insulating gloves with leather protectors (SR) ^d

Arc-Flash PPE Category	PPE
	Leather footwear ^e (AN)
2	Arc-Rated Clothing, Minimum Arc Rating of 8 cal/cm² (33.5 J/cm²)^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-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN) ^f
	Protective Equipment
	Hard hat
	Safety glasses or safety goggles (SR)
	Hearing protection (ear canal inserts) ^c
	Heavy-duty leather gloves, arc-rated gloves, or rubber insulating gloves with leather protectors (SR) ^d
	Leather footwear ^e
3	Arc-Rated Clothing Selected so That the System Arc Rating Meets the Required Minimum Arc Rating of 25 cal/cm² (104.7 J/cm²)^a
	Arc-rated long-sleeve shirt (AR)
	Arc-rated pants (AR) -
	Arc-rated coverall (AR)
	Arc-rated arc flash suit jacket (AR) -
	Arc-rated arc flash suit pants (AR)
	Arc-rated arc flash suit hood
	Arc-rated gloves or rubber insulating gloves with leather protectors (SR) ^d
	Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN) ^f
	Protective Equipment
	Hard hat
	Safety glasses or safety goggles (SR)
	Hearing protection (ear canal inserts) ^c
	Leather footwear ^e
4	Arc-Rated Clothing Selected so That the System Arc Rating Meets the Required Minimum Arc Rating of 40 cal/cm² (167.5 J/cm²)^a
	Arc-rated long-sleeve shirt (AR)
	Arc-rated pants (AR) -
	Arc-rated coverall (AR)
	Arc-rated arc flash suit jacket (AR) -
	Arc-rated arc flash suit pants (AR)
	Arc-rated arc flash suit hood
	Arc-rated gloves or rubber insulating gloves with leather protectors (SR) ^d
	Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN) ^f
	Protective Equipment
	Hard hat
	Safety glasses or safety goggles (SR)
	Hearing protection (ear canal inserts) ^c
	Leather footwear ^e

AN: As needed (optional). AR: As required. SR: Selection required.

^aArc rating is defined in Article 100.

^bFace 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.

^cOther 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.

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

^eFootwear 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.

^fThe 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 Input

"Enclosed" is added ahead of "Panelboard" to read "Enclosed Panelboard." Panelboard is a defined term and is often misused to describe what is being proposed in this recommendation. For example, in the "Equipment" column in Table 130.7(C)(15)(a), the phrase "Panelboards or other equipment..." is actually referring to a panelboard installed inside the defined term "Cabinet" with a cover installed or a panelboard installed within an enclosure (also a defined term). This recommendation is based on the definition of "Enclosed Panelboard" from UL 67 and is intended to more accurately define what a panelboard installed inside an enclosure which is the intent of its meaning in Table 130.7(C)(15)(a), for example. A companion Public Input was submitted to add a definition of "Panelboard, Enclosed" in Article 100.

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 10-NFPA 70E-2020 [New Definition after Definition: Panelboard.]	Related issue.
Public Input No. 12-NFPA 70E-2020 [Section No. 130.5(C)]	Related issue.
Public Input No. 10-NFPA 70E-2020 [New Definition after Definition: Panelboard.]	
Public Input No. 12-NFPA 70E-2020 [Section No. 130.5(C)]	

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Public Input No. 191-NFPA 70E-2021 [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.

(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

Informational Note No.1: The arc flash PPE category of the protective clothing and equipment is generally based on determination of the estimated exposure level.

Informational Note No.2: In most cases, closed doors do not provide enough protection to eliminate the need for PPE in situations in which the state of the equipment is known to readily change (e.g., doors open or closed, rack in or rack out).

(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 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)

<u>Equipment</u>	<u>Arc Flash PPE Category</u>	<u>Arc Flash Boundary</u>
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	4	12 m (40 ft)
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.)	-	-
Other equipment 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.)	-	-
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

<u>Equipment</u>	<u>Arc Flash PPE Category</u>	<u>Arc Flash Boundary</u>
Parameters: DOORS CLOSED and SECURED; with an available fault current and a fault clearing time that does not exceed the arc-resistant rating of the equipment*	-	-

N/A: Not applicable

Note:

For equipment rated 600 volts and below and protected by upstream current-limiting fuses or current-limiting molded case circuit breakers sized at 200 amperes or less, the arc flash PPE category can be reduced by one number but not below arc flash PPE category 1.

*For DOORS OPEN refer to the corresponding non-arc-resistant equipment section of this table.

Informational Note No. 1 to Table 130.7(C)(15)(a): The following are typical fault clearing times of overcurrent protective devices:

- (1) 0.5 cycle fault clearing time is typical for current-limiting fuses and current-limiting molded case circuit breakers when the fault current is within the current limiting range.
- (2) 1.5 cycle fault clearing time is typical for molded case circuit breakers rated less than 1000 volts with an instantaneous integral trip.
- (3) 3.0 cycle fault clearing time is typical for insulated case circuit breakers rated less than 1000 volts with an instantaneous integral trip or relay operated trip.
- (4) 5.0 cycle fault clearing time is typical for relay operated circuit breakers rated 1 kV to 35 kV when the relay operates in the instantaneous range (i.e., "no intentional delay").
- (5) 20 cycle fault clearing time is typical for low-voltage power and insulated case circuit breakers with a short time fault clearing delay for motor inrush.
- (6) 30 cycle fault clearing time is typical for low-voltage power and insulated case circuit breakers with a short time fault clearing delay without instantaneous trip.

Informational Note No. 2 to Table 130.7(C)(15)(a): See Table 1 of IEEE 1584, *Guide for Performing Arc Flash Hazard Calculations*, for further information regarding list items (2) through (4) in Informational Note No. 1.

Informational Note No. 3 to Table 130.7(C)(15)(a): - ~~An~~ See IEEE C37.20.7, *Guide for Testing Switchgear Rated Up to 52 kV for Internal Arcing Faults* for an example of a standard that provides information for arc-resistant equipment referred to in Table 130.7(C)(15)(a) - ~~is IEEE C37.20.7, Guide for Testing Switchgear Rated Up to 52 kV for Internal Arcing Faults~~.

Informational Note No. 4 to Table 130.7(C)(15)(a): See O.2.4(9) for information on arc-resistant equipment.

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

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

<u>Equipment</u>	<u>Arc Flash PPE Category</u>	<u>Arc Flash Boundary</u>
Parameters: Greater than 250 volts and less than or equal to 600 volts	-	-
Maximum arc duration and minimum working distance: 2 sec @ 455 mm (18 in.)	-	-
Available fault current less than 1.5 kA	2	900 mm
		- (3 ft)
Available fault current greater than or equal to 1.5 kA and less than 3 kA	2	1.2 m
		- (4 ft)
Available fault current greater than or equal to 3 kA and less than 7 kA	3	1.8 m
		- (6 ft.)
Available fault current greater than or equal to 7 kA and less than 10 kA	4	2.5 m
		- (8 ft)

Notes:

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

(a) Be evaluated for electrolyte protection

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

(b) Be arc rated

Informational Note: - See ASTM F1891, *Standard Specification for Arc and Flame Resistant Rainwear*, contains information 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: ~~When See D.5 for the basis for table values and alternative methods to determine dc incident energy. When~~ determining available fault current, the effects of cables and any other impedances in the circuit should be included. Power system modeling is the best method to determine the available short-circuit current at the point of the arc. Battery cell short-circuit current can be obtained from the battery manufacturer. ~~See D.5 for the basis for table values and alternative methods to determine dc incident energy.~~ Methods should be used with good engineering judgment.

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

Table 130.7(C)(15)(c) Personal Protective Equipment (PPE)

<u>Arc-Flash PPE Category</u>	<u>PPE</u>
1	Arc-Rated Clothing, Minimum Arc Rating of 4 cal/cm² (16.75 J/cm²)^a
-	Arc-rated long-sleeve shirt and pants or arc-rated coverall
-	Arc-rated face shield ^b or arc flash suit hood
-	Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN) ^f
-	Protective Equipment
-	Hard hat
-	Safety glasses or safety goggles (SR)
-	Hearing protection (ear canal inserts) ^c
-	Heavy-duty leather gloves, arc-rated gloves, or rubber insulating gloves with leather protectors (SR) ^d

Arc-Flash PPE Category	PPE
	Leather footwear ^e (AN)
2	Arc-Rated Clothing, Minimum Arc Rating of 8 cal/cm² (33.5 J/cm²)^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-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN) ^f
	Protective Equipment
	Hard hat
	Safety glasses or safety goggles (SR)
	Hearing protection (ear canal inserts) ^c
	Heavy-duty leather gloves, arc-rated gloves, or rubber insulating gloves with leather protectors (SR) ^d
	Leather footwear ^e
3	Arc-Rated Clothing Selected so That the System Arc Rating Meets the Required Minimum Arc Rating of 25 cal/cm² (104.7 J/cm²)^a
	Arc-rated long-sleeve shirt (AR)
	Arc-rated pants (AR) -
	Arc-rated coverall (AR)
	Arc-rated arc flash suit jacket (AR) -
	Arc-rated arc flash suit pants (AR)
	Arc-rated arc flash suit hood
	Arc-rated gloves or rubber insulating gloves with leather protectors (SR) ^d
	Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN) ^f
	Protective Equipment
	Hard hat
	Safety glasses or safety goggles (SR)
	Hearing protection (ear canal inserts) ^c
	Leather footwear ^e
4	Arc-Rated Clothing Selected so That the System Arc Rating Meets the Required Minimum Arc Rating of 40 cal/cm² (167.5 J/cm²)^a
	Arc-rated long-sleeve shirt (AR)
	Arc-rated pants (AR) -
	Arc-rated coverall (AR)
	Arc-rated arc flash suit jacket (AR) -
	Arc-rated arc flash suit pants (AR)
	Arc-rated arc flash suit hood
	Arc-rated gloves or rubber insulating gloves with leather protectors (SR) ^d
	Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN) ^f
	Protective Equipment
	Hard hat
	Safety glasses or safety goggles (SR)
	Hearing protection (ear canal inserts) ^c
	Leather footwear ^e

AN: As needed (optional). AR: As required. SR: Selection required.

^a*Arc rating* is defined in Article 100.

^bFace 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.

^cOther 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.

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

^eFootwear 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.

^fThe 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 Input

TerraView error. Only change is to relocate reference to front of Informational Notes as shown.

Revised Informational Note to comply with new 2020 NEC Style Manual.

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

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Public Input No. 295-NFPA 70E-2021 [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.

(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

Informational Note: Maximum fault-clearing times for upstream overcurrent protective devices can be estimated based upon the typical fault clearing time for the applicable device and operating condition of the equipment.

(a) *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:

- (2) Power systems with greater than the estimated maximum available fault current
- (3) Power systems with longer than the maximum arc duration
- (4) Less than the minimum working distance

Informational Note No.1: The arc flash PPE category of the protective clothing and equipment is generally based on determination of the estimated exposure level.

Informational Note No.2: In most cases, closed doors do not provide enough protection to eliminate the need for PPE in situations in which the state of the equipment is known to readily change (e.g., doors open or closed, rack in or rack out).

(e) *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 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.)	1	485 mm (19 in.)
Panelboards or other equipment rated greater than 240 volts and up to 600 volts 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.)	2	900 mm (3 ft)

<u>Equipment</u>	<u>Arc Flash PPE Category</u>	<u>Arc Flash Boundary</u>
600-volt class motor control centers (MCCs) 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.)	2	1.5 m (5 ft)
600-volt class motor control centers (MCCs) 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.)	4	4.3 m (14 ft)
600-volt class switchgear (with power circuit breakers or fused switches) and 600-volt class switchboards 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.)	4	6 m (20 ft)
Other 600-volt class (277 volts through 600 volts, nominal) equipment 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.)	2	1.5 m (5 ft)
NEMA E2 (fused contactor) motor starters, 2.3 kV through 7.2 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)
Metal-clad switchgear, 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)
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

<u>Equipment</u>	<u>Arc Flash PPE Category</u>	<u>Arc Flash Boundary</u>
Arc-resistant equipment 1 kV through 15 kV	N/A	N/A
Parameters: DOORS CLOSED and SECURED; with an available fault current and a fault clearing time that does not exceed the arc-resistant rating of the equipment*	-	-

N/A: Not applicable

Note:

For equipment rated 600 volts and below and protected by upstream current-limiting fuses or current-limiting molded case circuit breakers sized at 200 amperes or less, the arc flash PPE category can be reduced by one number but not below arc flash PPE category 1.

*For DOORS OPEN refer to the corresponding non-arc-resistant equipment section of this table.

Informational Note No. 1 to Table 130.7(C)(15)(a): The following are typical fault clearing times of overcurrent protective devices:

- (1) 0.5 cycle fault clearing time is typical for current-limiting fuses and current-limiting molded case circuit breakers when the fault current is within the current limiting range.
- (2) 1.5 cycle fault clearing time is typical for molded case circuit breakers rated less than 1000 volts with an instantaneous integral trip.
- (3) 3.0 cycle fault clearing time is typical for insulated case circuit breakers rated less than 1000 volts with an instantaneous integral trip or relay operated trip.
- (4) 5.0 cycle fault clearing time is typical for relay operated circuit breakers rated 1 kV to 35 kV when the relay operates in the instantaneous range (i.e., "no intentional delay").
- (5) 20 cycle fault clearing time is typical for low-voltage power and insulated case circuit breakers with a short time fault clearing delay for motor inrush.
- (6) 30 cycle fault clearing time is typical for low-voltage power and insulated case circuit breakers with a short time fault clearing delay without instantaneous trip.

Informational Note No. 2 to Table 130.7(C)(15)(a): See Table 1 of IEEE 1584, *Guide for Performing Arc Flash Hazard Calculations*, for further information regarding list items (2) through (4) in Informational Note No. 1.

Informational Note No. 3 to Table 130.7(C)(15)(a): An example of a standard that provides information for arc-resistant equipment referred to in Table 130.7(C)(15)(a) is IEEE C37.20.7, *Guide for Testing Switchgear Rated Up to 52 kV for Internal Arcing Faults*.

Informational Note No. 4 to Table 130.7(C)(15)(a): See O.2.4(9) for information on arc-resistant equipment.

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

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

<u>Equipment</u>	<u>Arc Flash PPE Category</u>	<u>Arc Flash Boundary</u>
Parameters: Greater than 250 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: ASTM F1296, *Standard Guide for Evaluating Chemical Protective Clothing*, contains information on evaluating apparel for protection from electrolyte.

(b) Be arc rated

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

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

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

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

Table 130.7(C)(15)(c) Personal Protective Equipment (PPE)

<u>Arc-Flash PPE Category</u>	<u>PPE</u>
1	Arc-Rated Clothing, Minimum Arc Rating of 4 cal/cm² (16.75 J/cm²)^a
-	Arc-rated long-sleeve shirt and pants or arc-rated coverall
-	Arc-rated face shield ^b or arc flash suit hood
-	Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN) ^f
-	Protective Equipment
-	Hard hat
-	Safety glasses or safety goggles (SR)
-	Hearing protection (ear canal inserts) ^c
-	Heavy-duty leather gloves, arc-rated gloves, or rubber insulating gloves with leather protectors (SR) ^d

Arc-Flash PPE Category	PPE
	Leather footwear ^e (AN)
2	Arc-Rated Clothing, Minimum Arc Rating of 8 cal/cm² (33.5 J/cm²)^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-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN) ^f
	Protective Equipment
	Hard hat
	Safety glasses or safety goggles (SR)
	Hearing protection (ear canal inserts) ^c
	Heavy-duty leather gloves, arc-rated gloves, or rubber insulating gloves with leather protectors (SR) ^d
	Leather footwear ^e
3	Arc-Rated Clothing Selected so That the System Arc Rating Meets the Required Minimum Arc Rating of 25 cal/cm² (104.7 J/cm²)^a
	Arc-rated long-sleeve shirt (AR)
	Arc-rated pants (AR) -
	Arc-rated coverall (AR)
	Arc-rated arc flash suit jacket (AR) -
	Arc-rated arc flash suit pants (AR)
	Arc-rated arc flash suit hood
	Arc-rated gloves or rubber insulating gloves with leather protectors (SR) ^d
	Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN) ^f
	Protective Equipment
	Hard hat
	Safety glasses or safety goggles (SR)
	Hearing protection (ear canal inserts) ^c
	Leather footwear ^e
4	Arc-Rated Clothing Selected so That the System Arc Rating Meets the Required Minimum Arc Rating of 40 cal/cm² (167.5 J/cm²)^a
	Arc-rated long-sleeve shirt (AR)
	Arc-rated pants (AR) -
	Arc-rated coverall (AR)
	Arc-rated arc flash suit jacket (AR) -
	Arc-rated arc flash suit pants (AR)
	Arc-rated arc flash suit hood
	Arc-rated gloves or rubber insulating gloves with leather protectors (SR) ^d
	Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN) ^f
	Protective Equipment
	Hard hat
	Safety glasses or safety goggles (SR)
	Hearing protection (ear canal inserts) ^c
	Leather footwear ^e

AN: As needed (optional). AR: As required. SR: Selection required.

^aArc rating is defined in Article 100.

^bFace 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.

^cOther 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.

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

^eFootwear 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.

^fThe 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 Input

This public input seeks to add an informational note to 130.7(C)(15)(a) to give guidance to employees using the PPE category method in how to determine fault-clearing time when applying this method. Many have understood this maximum fault-clearing time to be the fault-clearing time of the OCPD at the estimated available fault current value. The estimated available fault current is the estimated amount of current delivered to a point in the system under bolted fault conditions. This table is about selecting PPE for arcing fault current conditions and is meant for the worker that is performing work on a system where there has not been an incident energy analysis performed. Fault clearing times at bolted fault current levels are the shortest time in any given situation that an OCPD will clear a fault. Arcing faults are always somewhere less than this bolted fault value. Having workers try to estimate how fast the OCPD will open in an arcing fault or trying to interpret OCPD time-current curves sort of defeats the purpose of having reference tables for selection of PPE. However, a qualified person can make a determination on whether or not an OCPD has been properly installed and maintained and if the circuit in question is the proper application and not a case where the available fault current exceeds the AIC rating. If all of this has been met the worker can reasonably assume that the OCPD would clear an arcing fault within the typical fault clearing times listed in the informational note to Table 130.7(C)(15)(a). Therefore, the worker only needs to understand what type of upstream device is in play, what condition it is in, and how fast a properly operating OCPD of that type will clear a fault. Providing guidance on how workers can determine fault clearing times within this table can help clear up confusion among some on how this is done. As if often the case at the worker level, when something is confusing it leads to a higher chance of safe work practices being ignored. Often when there is no incident energy analysis performed and the worker doesn't understand the application of the PPE category method, they end up not wearing any PPE at all or wearing more than required which also hurts the safety culture in a company when they start to feel so much PPE is unnecessary. Guidance on how to determine fault clearing times of the OCPD in question will help improve the application of this method for employees exposed to arc flash hazards.

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Public Input No. 307-NFPA 70E-2021 [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.

(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

Informational Note No.1: The arc flash PPE category of the protective clothing and equipment is generally based on determination of the estimated exposure level.

Informational Note No.2: In most cases, closed doors do not provide enough protection to eliminate the need for PPE in situations in which the state of the equipment is known to readily change (e.g., doors open or closed, rack in or rack out).

(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 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)

<u>Equipment</u>	<u>Arc Flash PPE Category</u>	<u>Arc Flash Boundary</u>
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	4	12 m (40 ft)
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.)	-	-
Other equipment 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.)	-	-
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

<u>Equipment</u>	<u>Arc Flash PPE Category</u>	<u>Arc Flash Boundary</u>
Parameters: DOORS CLOSED and SECURED; with an available fault current and a fault clearing time that does not exceed the arc-resistant rating of the equipment*	-	-

N/A: Not applicable

Note:

For equipment rated 600 volts and below and protected by upstream current-limiting fuses or current-limiting molded case circuit breakers sized at 200 amperes or less, the arc flash PPE category can be reduced by one number but not below arc flash PPE category 1.

*For DOORS OPEN refer to the corresponding non-arc-resistant equipment section of this table.

Informational Note No. 1 to Table 130.7(C)(15)(a): The following are typical fault clearing times of overcurrent protective devices:

- (1) 0.5 cycle fault clearing time is typical for current-limiting fuses and current-limiting molded case circuit breakers when the fault current is within the current limiting range.
- (2) 1.5 cycle fault clearing time is typical for molded case circuit breakers rated less than 1000 volts with an instantaneous integral trip.
- (3) 3.0 cycle fault clearing time is typical for insulated case circuit breakers rated less than 1000 volts with an instantaneous integral trip or relay operated trip.
- (4) 5.0 cycle fault clearing time is typical for relay operated circuit breakers rated 1 kV to 35 kV when the relay operates in the instantaneous range (i.e., "no intentional delay").
- (5) 20 cycle fault clearing time is typical for low-voltage power and insulated case circuit breakers with a short time fault clearing delay for motor inrush.
- (6) 30 cycle fault clearing time is typical for low-voltage power and insulated case circuit breakers with a short time fault clearing delay without instantaneous trip.

Informational Note No. 2 to Table 130.7(C)(15)(a): See Table 1 of IEEE 1584, *Guide for Performing Arc Flash Hazard Calculations*, for further information regarding list items (2) through (4) in Informational Note No. 1.

Informational Note No. 3 to Table 130.7(C)(15)(a): An example of a standard that provides information for arc-resistant equipment referred to in Table 130.7(C)(15)(a) is IEEE C37.20.7, *Guide for Testing Switchgear Rated Up to 52 kV for Internal Arcing Faults*.

Informational Note No. 4 to Table 130.7(C)(15)(a): See O.2.4(9) for information on arc-resistant equipment.

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

Maximum arc duration and minimum

<u>Equipment</u>	<u>Arc Flash PPE Category</u>	<u>Arc Flash Boundary</u>
Storage batteries, dc switchboards, and other dc supply sources	-	-
Parameters: Greater than or equal to 100 volts and less than or equal to 250 volts 150 volts	-	-
Minimum working distance: 2 sec @ 455 mm (18 in.)	-	-
Available fault current less than 4-17 kA	2 none	900 mm
-	-	(3 ft)
Available fault current greater than or equal to 4 kA and less than 7 kA	2	1.2 m
-	-	(4 ft)
Available fault current greater than or equal to 7 kA and less than 15 kA	3	1.8 m
-	-	(6 ft)
none		

<u>Equipment</u>	<u>Arc Flash PPE Category</u>	<u>Arc Flash Boundary</u>
Storage batteries, dc switchboards, and other dc supply sources	-	-
Parameters: Greater than 250 volts- 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: ASTM F1296, *Standard Guide for Evaluating Chemical Protective Clothing*, contains information on evaluating apparel for protection from electrolyte.

(b) Be arc rated

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

(2) ~~At two~~ For voltages above 150 volts nominal, 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. For voltages below 150 volts nominal, the table is based on test data and worst case arcing.

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

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

Informational Note No. 3: For voltages below 150 volts nominal, the recommendation is based on 'US Department of Energy - Bonneville Power Administration Engineering and Technical Services Report BPA F 5450.05 DC Arc Flash: 125V, 1300 amp-hour battery dated May 11, 2017' and '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.'

Informational Note No. 4: For voltages below 100 volts there is no arc flash hazard. There is, however, a significant arcing concern for any battery that does not have internal overcurrent protection which can lead to personnel hazards (at any voltage) including but not limited to severe burns and injury due to flying pieces of molten metal. This is different from an arc flash phenomena but still requires prevention and appropriate PPE.

Table 130.7(C)(15)(c) Personal Protective Equipment (PPE)

<u>Arc-Flash PPE Category</u>	<u>PPE</u>
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

<u>Arc-Flash PPE Category</u>	<u>PPE</u>
	Arc-rated face shield ^b or arc flash suit hood
	Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN) ^f
	Protective Equipment
	Hard hat
	Safety glasses or safety goggles (SR)
	Hearing protection (ear canal inserts) ^c
	Heavy-duty leather gloves, arc-rated gloves, or rubber insulating gloves with leather protectors (SR) ^d
	Leather footwear ^e (AN)
2	Arc-Rated Clothing, Minimum Arc Rating of 8 cal/cm² (33.5 J/cm²)^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-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN) ^f
	Protective Equipment
	Hard hat
	Safety glasses or safety goggles (SR)
	Hearing protection (ear canal inserts) ^c
	Heavy-duty leather gloves, arc-rated gloves, or rubber insulating gloves with leather protectors (SR) ^d
	Leather footwear ^e
3	Arc-Rated Clothing Selected so That the System Arc Rating Meets the Required Minimum Arc Rating of 25 cal/cm² (104.7 J/cm²)^a
	Arc-rated long-sleeve shirt (AR)
	Arc-rated pants (AR) -
	Arc-rated coverall (AR)
	Arc-rated arc flash suit jacket (AR) -
	Arc-rated arc flash suit pants (AR)
	Arc-rated arc flash suit hood
	Arc-rated gloves or rubber insulating gloves with leather protectors (SR) ^d
	Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN) ^f
	Protective Equipment
	Hard hat
	Safety glasses or safety goggles (SR)
	Hearing protection (ear canal inserts) ^c
	Leather footwear ^e
4	Arc-Rated Clothing Selected so That the System Arc Rating Meets the Required Minimum Arc Rating of 40 cal/cm² (167.5 J/cm²)^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-Flash PPE Category	PPE
	Arc-rated gloves or rubber insulating gloves with leather protectors (SR) ^d
	Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN) ^f
	Protective Equipment
	Hard hat
	Safety glasses or safety goggles (SR)
	Hearing protection (ear canal inserts) ^c
	Leather footwear ^e

AN: As needed (optional). AR: As required. SR: Selection required.

^aArc rating is defined in Article 100.

^bFace 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.

^cOther 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.

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

^eFootwear 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.

^fThe 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 Input

New test data, referenced below, is clear and consistent that the arc flash hazard for 120-volt nominal systems is minimal for short circuit currents less than 17,000 amps which covers most utility/switchgear applications. The data also show that there is no arc flash hazard for systems below 100 volts. Millions of dollars are wasted every year for over-protection of personnel for arc flash hazards for 120 volt (and below) battery systems. This over-protection can lead to other safety issues and more importantly, cause personnel to overlook/ignore other more prevalent hazards with battery systems. The data is clear. Two separate reports reach the same conclusion. Of the 750,000 estimated stationary battery installations in the US, the vast majority of these systems are at or below 120-volts nominal. This change will improve safety and also be consistent with the data.

My recommendation for this table may not be the best landing spot to state this information and if the committee wants to place it in another table or in another article, such as 320, I am completely fine with that as well.

I've been in the stationary battery business for over 30 years and have been a part of the IEEE Energy Storage and Stationary Battery committee for 30 years. As a committee, we have researched over the years to find one documented (or otherwise) case of a dc arc flash for any system under 150 volts. We also searched the OSHA database. We asked for examples at many large battery conferences. There were many cases that someone claimed they were involved in a dc arc flash but in every case, it turned out to be an arcing issue that someone received thermal burns or was injured by molten metal. This can happen on a two-volt cell but it is not arc flash.

References:

1. US Department of Energy - Bonneville Power Administration Engineering and Technical Services Report BPA F 5450.05 DC Arc Flash: 125V, 1300 amp-hour battery dated May 11, 2017
2. 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.

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Public Input No. 315-NFPA 70E-2021 [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.

(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

Informational Note No.1: The arc flash PPE category of the protective clothing and equipment is generally based on determination of the estimated exposure level.

Informational Note No.2: In most cases, closed doors do not provide enough protection to eliminate the need for PPE in situations in which the state of the equipment is known to readily change (e.g., doors open or closed, rack in or rack out).

(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 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)

<u>Equipment</u>	<u>Arc Flash PPE Category</u>	<u>Arc Flash Boundary</u>
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	4	12 m (40 ft)
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.)	-	-
Other equipment 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.)	-	-
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

<u>Equipment</u>	<u>Arc Flash PPE Category</u>	<u>Arc Flash Boundary</u>
Parameters: DOORS CLOSED and SECURED; with an available fault current and a fault clearing time that does not exceed the arc-resistant rating of the equipment*	-	-

N/A: Not applicable

Note:

For equipment rated 600 volts and below and protected by upstream current-limiting fuses or current-limiting molded case circuit breakers sized at 200 amperes or less, the arc flash PPE category can be reduced by one number but not below arc flash PPE category 1.

*For DOORS OPEN refer to the corresponding non-arc-resistant equipment section of this table.

Informational Note No. 1 to Table 130.7(C)(15)(a): The following are typical fault clearing times of overcurrent protective devices:

- (1) 0.5 cycle fault clearing time is typical for current-limiting fuses and current-limiting molded case circuit breakers when the fault current is within the current limiting range.
- (2) 1.5 cycle fault clearing time is typical for molded case circuit breakers rated less than 1000 volts with an instantaneous integral trip.
- (3) 3.0 cycle fault clearing time is typical for insulated case circuit breakers rated less than 1000 volts with an instantaneous integral trip or relay operated trip.
- (4) 5.0 cycle fault clearing time is typical for relay operated circuit breakers rated 1 kV to 35 kV when the relay operates in the instantaneous range (i.e., "no intentional delay").
- (5) 20 cycle fault clearing time is typical for low-voltage power and insulated case circuit breakers with a short time fault clearing delay for motor inrush.
- (6) 30 cycle fault clearing time is typical for low-voltage power and insulated case circuit breakers with a short time fault clearing delay without instantaneous trip.

Informational Note No. 2 to Table 130.7(C)(15)(a): See Table 1 of IEEE 1584, *Guide for Performing Arc Flash Hazard Calculations*, for further information regarding list items (2) through (4) in Informational Note No. 1.

Informational Note No. 3 to Table 130.7(C)(15)(a): An example of a standard that provides information for arc-resistant equipment referred to in Table 130.7(C)(15)(a) is IEEE C37.20.7, *Guide for Testing Switchgear Rated Up to 52 kV for Internal Arcing Faults*.

Informational Note No. 4 to Table 130.7(C)(15)(a): See O.2.4(9) for information on arc-resistant equipment.

Informational Note No. 4 to Table 130.7(C)(15)(a): Where there is horizontal bus in 600-V class switchgear and 600 V class switchboard equipment the incident energy could exceed the minimum arc rating of PPE category 4. For more information regarding horizontal bus configuration see IEEE 1584-2018.

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

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

<u>Equipment</u>	<u>Arc Flash PPE Category</u>	<u>Arc Flash Boundary</u>
Storage batteries, dc switchboards, and other dc supply sources	-	-
Parameters: Greater than 250 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: ASTM F1296, *Standard Guide for Evaluating Chemical Protective Clothing*, contains information on evaluating apparel for protection from electrolyte.

(b) Be arc rated

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

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

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

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

Table 130.7(C)(15)(c) Personal Protective Equipment (PPE)

<u>Arc-Flash PPE Category</u>	<u>PPE</u>
1	Arc-Rated Clothing, Minimum Arc Rating of 4 cal/cm² (16.75 J/cm²)^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

<u>Arc-Flash PPE Category</u>	<u>PPE</u>
	Heavy-duty leather gloves, arc-rated gloves, or rubber insulating gloves with leather protectors (SR) ^d
	Leather footwear ^e (AN)
2	Arc-Rated Clothing, Minimum Arc Rating of 8 cal/cm² (33.5 J/cm²)^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-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN) ^f
	Protective Equipment
	Hard hat
	Safety glasses or safety goggles (SR)
	Hearing protection (ear canal inserts) ^c
	Heavy-duty leather gloves, arc-rated gloves, or rubber insulating gloves with leather protectors (SR) ^d
	Leather footwear ^e
3	Arc-Rated Clothing Selected so That the System Arc Rating Meets the Required Minimum Arc Rating of 25 cal/cm² (104.7 J/cm²)^a
	Arc-rated long-sleeve shirt (AR)
	Arc-rated pants (AR) -
	Arc-rated coverall (AR)
	Arc-rated arc flash suit jacket (AR) -
	Arc-rated arc flash suit pants (AR)
	Arc-rated arc flash suit hood
	Arc-rated gloves or rubber insulating gloves with leather protectors (SR) ^d
	Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN) ^f
	Protective Equipment
	Hard hat
	Safety glasses or safety goggles (SR)
	Hearing protection (ear canal inserts) ^c
	Leather footwear ^e
4	Arc-Rated Clothing Selected so That the System Arc Rating Meets the Required Minimum Arc Rating of 40 cal/cm² (167.5 J/cm²)^a
	Arc-rated long-sleeve shirt (AR)
	Arc-rated pants (AR) -
	Arc-rated coverall (AR)
	Arc-rated arc flash suit jacket (AR) -
	Arc-rated arc flash suit pants (AR)
	Arc-rated arc flash suit hood
	Arc-rated gloves or rubber insulating gloves with leather protectors (SR) ^d
	Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN) ^f
	Protective Equipment
	Hard hat
	Safety glasses or safety goggles (SR)
	Hearing protection (ear canal inserts) ^c

Arc-Flash PPE Category	PPE
	Leather footwear ^e

AN: As needed (optional). AR: As required. SR: Selection required.

^aArc rating is defined in Article 100.

^bFace 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.

^cOther 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.

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

^eFootwear 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.

^fThe 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 Input

Note: Terra view appears to have made a bit of a mess of this input. The only revision that is proposed is a new informational note 5 to Table 130.7(C)(15)(a).

Rationale: As our knowledge of arc flash phenomenon evolves, we should re-examine long held beliefs, not on the basis of whether they are good enough, rather, can they be improved.

Example: For over a decade Table 130.7(C)(15)(a) included a reduction in the PPE category based on task. In 2015 when 70E shifted to the risk assessment model and risk terminology it became clear that this reduction was inappropriate and was eliminated.

Studies undertaken to revise IEEE 1584 have provided an increased understanding regarding the effect of conductor configuration (i.e., bus configuration) on incident energy. Is this understanding complete? No. Will further research provide additional insights? Undoubtedly. However, that is the future. Decisions regarding the content of NFPA 70E must be made with information now available, not what might be.

The claim that Table 130.7(C)(15)(a) was based on experience and was not built with the benefit of some type of incident energy estimation is irrelevant. The table must still provide similar or more conservative protection than that afforded by such an estimate using whatever current peer reviewed method is available.

When the maximum available fault current and fault clearing time and the minimum working distance parameters in each section of Table 130.7(C)(15)(a) are used to estimate incident energy using the IEEE 1584:18 models and the various bus configurations, in most situations Table 130.7(C)(15)(a) is still conservative. The lone exception is 600V class switchgear. Assuming a 35 kA available fault current, a 0.5 s (30 cycles) fault clearing time, and an 18 inch working distance, incident energy could exceed 70 calories/cm² at a working distance of 18 inches for horizontal bus (HCB).

It would therefore be prudent to add an informational Note to Table 130.7(C)(15)(a) alerting users of the possible effect of this type of bus configuration on the 600 V class switchgear section of the table.

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Public Input No. 332-NFPA 70E-2021 [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.

(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) or Table B.1 shall be used to determine the arc flash PPE category. The parameters of 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 Table 130.7(C)(15)(a) shall not be used for equipment types and classifications that are not listed or where the listed parameters are exceeded. Table B.1 parameters and instructions for use for various ac equipment types or classifications are listed in Table B.1 and the associated notes. Table B.1 shall not be used for equipment types and classifications that are not listed or where the listed parameters are exceeded. Where neither Table 130.7(C)(15)(a) nor B.1 are permitted to be used, 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
Less than the minimum working distance

Informational Note: Table B.1 is located in Normative Annex B. The Table is based on the constant energy line method. The purpose of this method is to simplify the information gathering required to use the Table.

(4) *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:

- (5) Power systems with greater than the estimated maximum available fault current
- (6) Power systems with longer than the maximum arc duration
- (7) Less than the minimum working distance

Informational Note No. 1: The arc flash PPE category of the protective clothing and equipment is generally based on determination of the estimated exposure level.

Informational Note No. 2: In most cases, closed doors do not provide enough protection to eliminate the need for PPE in situations in which the state of the equipment is known to readily change (e.g., doors open or closed, rack in or rack out).

(8) *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 455 mm (18 in.)	-	-
Panelboards or other equipment rated greater than 240 volts and up to 600 volts	2	900 mm (3 ft)

<u>Equipment</u>	<u>Arc Flash PPE Category</u>	<u>Arc Flash Boundary</u>
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	4	12 m (40 ft)
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.)	-	-
Other equipment 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.)	-	-
Arc-resistant equipment up to 600-volt class	N/A	N/A

<u>Equipment</u>	<u>Arc Flash PPE Category</u>	<u>Arc Flash Boundary</u>
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*		
Arc-resistant equipment 1 kV through 15 kV	N/A	N/A
Parameters: DOORS CLOSED and SECURED; with an available fault current and a fault clearing time that does not exceed the arc-resistant rating of the equipment*		

N/A: Not applicable

Note:

For equipment rated 600 volts and below and protected by upstream current-limiting fuses or current-limiting molded case circuit breakers sized at 200 amperes or less, the arc flash PPE category can be reduced by one number but not below arc flash PPE category 1.

*For DOORS OPEN refer to the corresponding non-arc-resistant equipment section of this table.

Informational Note No. 1 to Table 130.7(C)(15)(a): The following are typical fault clearing times of overcurrent protective devices:

- (1) 0.5 cycle fault clearing time is typical for current-limiting fuses and current-limiting molded case circuit breakers when the fault current is within the current limiting range.
- (2) 1.5 cycle fault clearing time is typical for molded case circuit breakers rated less than 1000 volts with an instantaneous integral trip.
- (3) 3.0 cycle fault clearing time is typical for insulated case circuit breakers rated less than 1000 volts with an instantaneous integral trip or relay operated trip.
- (4) 5.0 cycle fault clearing time is typical for relay operated circuit breakers rated 1 kV to 35 kV when the relay operates in the instantaneous range (i.e., "no intentional delay").
- (5) 20 cycle fault clearing time is typical for low-voltage power and insulated case circuit breakers with a short time fault clearing delay for motor inrush.
- (6) 30 cycle fault clearing time is typical for low-voltage power and insulated case circuit breakers with a short time fault clearing delay without instantaneous trip.

Informational Note No. 2 to Table 130.7(C)(15)(a): See Table 1 of IEEE 1584, *Guide for Performing Arc Flash Hazard Calculations*, for further information regarding list items (2) through (4) in Informational Note No. 1.

Informational Note No. 3 to Table 130.7(C)(15)(a): An example of a standard that provides information for arc-resistant equipment referred to in Table 130.7(C)(15)(a) is IEEE C37.20.7, *Guide for Testing Switchgear Rated Up to 52 kV for Internal Arcing Faults*.

Informational Note No. 4 to Table 130.7(C)(15)(a): See O.2.4(9) for information on arc-resistant equipment.

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

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

<u>Equipment</u>	<u>Arc Flash PPE Category</u>	<u>Arc Flash Boundary</u>
Available fault current greater than or equal to 7 kA and less than 15 kA	3	1.8 m
		(6 ft)
Storage batteries, dc switchboards, and other dc supply sources	-	-
Parameters: Greater than 250 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: ASTM F1296, *Standard Guide for Evaluating Chemical Protective Clothing*, contains information on evaluating apparel for protection from electrolyte.

(b) Be arc rated

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

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

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

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

Table 130.7(C)(15)(c) Personal Protective Equipment (PPE)

<u>Arc-Flash PPE Category</u>	<u>PPE</u>
1	Arc-Rated Clothing, Minimum Arc Rating of 4 cal/cm² (16.75 J/cm²)^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

<u>Arc-Flash PPE Category</u>	<u>PPE</u>
	Hard hat
	Safety glasses or safety goggles (SR)
	Hearing protection (ear canal inserts) ^c
	Heavy-duty leather gloves, arc-rated gloves, or rubber insulating gloves with leather protectors (SR) ^d
	Leather footwear ^e (AN)
2	Arc-Rated Clothing, Minimum Arc Rating of 8 cal/cm² (33.5 J/cm²)^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-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN) ^f
	Protective Equipment
	Hard hat
	Safety glasses or safety goggles (SR)
	Hearing protection (ear canal inserts) ^c
	Heavy-duty leather gloves, arc-rated gloves, or rubber insulating gloves with leather protectors (SR) ^d
	Leather footwear ^e
3	Arc-Rated Clothing Selected so That the System Arc Rating Meets the Required Minimum Arc Rating of 25 cal/cm² (104.7 J/cm²)^a
	Arc-rated long-sleeve shirt (AR)
	Arc-rated pants (AR) -
	Arc-rated coverall (AR)
	Arc-rated arc flash suit jacket (AR) -
	Arc-rated arc flash suit pants (AR)
	Arc-rated arc flash suit hood
	Arc-rated gloves or rubber insulating gloves with leather protectors (SR) ^d
	Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN) ^f
	Protective Equipment
	Hard hat
	Safety glasses or safety goggles (SR)
	Hearing protection (ear canal inserts) ^c
	Leather footwear ^e
4	Arc-Rated Clothing Selected so That the System Arc Rating Meets the Required Minimum Arc Rating of 40 cal/cm² (167.5 J/cm²)^a
	Arc-rated long-sleeve shirt (AR)
	Arc-rated pants (AR) -
	Arc-rated coverall (AR)
	Arc-rated arc flash suit jacket (AR) -
	Arc-rated arc flash suit pants (AR)
	Arc-rated arc flash suit hood
	Arc-rated gloves or rubber insulating gloves with leather protectors (SR) ^d
	Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN) ^f
	Protective Equipment

<u>Arc-Flash PPE Category</u>	<u>PPE</u>
	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.

^aArc rating is defined in Article 100.

^bFace 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.

^cOther 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.

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

^eFootwear 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.

^fThe 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 Input

Note: It appears that Terra View has renumbered existing paragraphs (b) and (c) as (d) and (e) respectively. This is not the intent of the proposed revision.

Rationale: This is one of two parallel proposals to add an alternate PPE category table for ac equipment. This Table and the proposed revisions to 130.7(C)(15) are published in CSA Z462-2021.

One of the challenges faced by users of Table 130.7(C)(15)(a) are verifying the parameters of available fault current and fault clearing time are not exceeded for the equipment at the work location. The proposed alternate Table is based on the constant energy line method. Papers, for which IEEE holds copyright, discussing this method are:

"Application of Incident Energy Reference Boundary Area Plots in TCCs Considering IEEE 1584-2018 Input Parameter Variability", published in IEEE Transactions on Industry Applications, vol. 56, no. 5, pp. 4640-4651, Sept.-Oct. 2020, doi: 10.1109/TIA.2020.3004769, by A. Marroquin and A. Parsons

"Arc-Flash Ppe – A Simplified Constant Energy Line Table Method", Presented at the IEEE 2021 ESW by R. Hallé, K. Gray, D. Roberts, and M. Valdes

The purpose of this alternate method is to simplify the information gathering to require only one of two possibilities:

Supply transformer rating

Overcurrent protective device rating (e.g., fuse) or setting (e.g., relay operated circuit breaker)

A flow chart is included that explains how to use the method.

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 340-NFPA 70E-2021 [Annex B]	
Public Input No. 340-NFPA 70E-2021 [Annex B]	

Submitter Information Verification

Submitter Full Name: Daniel Roberts
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Public Input No. 350-NFPA 70E-2021 [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.

(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

Informational Note No.1:- The arc flash PPE category of the protective clothing and equipment is generally based on determination of the estimated exposure level.

Informational Note No.2:- In most cases, closed doors do not provide enough protection to eliminate the need for PPE in situations in which the state of the equipment is known to readily change (e.g., doors open or closed, rack in or rack out).

(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 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.)	1	485 mm (19 in.)
Panelboards or other equipment rated greater than 240 volts and up to 600 volts 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.)	2	900 mm (3 ft)
600-volt class motor control centers (MCCs)	2	1.5 m (5 ft)

<u>Equipment</u>	<u>Arc Flash PPE Category</u>	<u>Arc Flash Boundary</u>
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	4	12 m (40 ft)
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.)	-	-
Other equipment 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.)	-	-
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

<u>Equipment</u>	<u>Arc Flash PPE Category</u>	<u>Arc Flash Boundary</u>
Parameters: DOORS CLOSED and SECURED; with an available fault current and a fault clearing time that does not exceed the arc-resistant rating of the equipment*	-	-

N/A: Not applicable

Note:

For equipment rated 600 volts and below and protected by upstream current-limiting fuses or current-limiting molded case circuit breakers sized at 200 amperes or less, the arc flash PPE category can be reduced by one number but not below arc flash PPE category 1.

*For DOORS OPEN refer to the corresponding non-arc-resistant equipment section of this table.

Informational Note No. 1 to Table 130.7(C)(15)(a): The following are typical fault clearing times of overcurrent protective devices:

(1) 0.5 cycle fault clearing time is typical for current-limiting fuses and current-limiting molded case circuit breakers when the fault current is within the current limiting range.

(2) 1.5 cycle fault clearing time is typical for molded case circuit breakers rated less than 1000 volts with an instantaneous integral trip.

(3) 3.0 cycle fault clearing time is typical for insulated case circuit breakers rated less than 1000 volts with an instantaneous integral trip or relay operated trip.

(4) 5.0 cycle fault clearing time is typical for relay operated circuit breakers rated 1 kV to 35 kV when the relay operates in the instantaneous range (i.e., "no intentional delay").

(5) 20 cycle fault clearing time is typical for low-voltage power and insulated case circuit breakers with a short time fault clearing delay for motor inrush.

(6) 30 cycle fault clearing time is typical for low-voltage power and insulated case circuit breakers with a short time fault clearing delay without instantaneous trip.

Informational Note No. 2 to Table 130.7(C)(15)(a): See Table 1 of IEEE 1584, *Guide for Performing Arc Flash Hazard Calculations*, for further information regarding list items (2) through (4) in Informational Note No. 1.

Informational Note No. 3 to Table 130.7(C)(15)(a): An example of a standard that provides information for arc-resistant equipment referred to in Table 130.7(C)(15)(a) is IEEE C37.20.7, *Guide for Testing Switchgear Rated Up to 52 kV for Internal Arcing Faults*.

Informational Note No. 4 to Table 130.7(C)(15)(a): See O.2.4(9) for information on arc-resistant equipment.

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

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

<u>Equipment</u>	<u>Arc Flash PPE Category</u>	<u>Arc Flash Boundary</u>
Parameters: Greater than 250 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: ASTM F1296, *Standard Guide for Evaluating Chemical Protective Clothing*, contains information on evaluating apparel for protection from electrolyte.

(b) Be arc rated

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

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

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

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

Table 130.7(C)(15)(c) Personal Protective Equipment (PPE)

<u>Arc-Flash PPE Category</u>	<u>PPE</u>
1	Arc-Rated Clothing, Minimum Arc Rating of 4 cal/cm² (16.75 J/cm²)^a
-	Arc-rated long-sleeve shirt and pants or arc-rated coverall
-	Arc-rated face shield ^b or arc flash suit hood
-	Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN) ^f
-	Protective Equipment
-	Hard hat
-	Safety glasses or safety goggles (SR)
-	Hearing protection (ear canal inserts) ^c
-	Heavy-duty leather gloves, arc-rated gloves, or rubber insulating gloves with leather protectors (SR) ^d

Arc-Flash PPE Category	PPE
	Leather footwear ^e (AN)
2	Arc-Rated Clothing, Minimum Arc Rating of 8 cal/cm² (33.5 J/cm²)^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-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN) ^f
	Protective Equipment
	Hard hat
	Safety glasses or safety goggles (SR)
	Hearing protection (ear canal inserts) ^c
	Heavy-duty leather gloves, arc-rated gloves, or rubber insulating gloves with leather protectors (SR) ^d
	Leather footwear ^e
3	Arc-Rated Clothing Selected so That the System Arc Rating Meets the Required Minimum Arc Rating of 25 cal/cm² (104.7 J/cm²)^a
	Arc-rated long-sleeve shirt (AR)
	Arc-rated pants (AR) -
	Arc-rated coverall (AR)
	Arc-rated arc flash suit jacket (AR) -
	Arc-rated arc flash suit pants (AR)
	Arc-rated arc flash suit hood
	Arc-rated gloves or rubber insulating gloves with leather protectors (SR) ^d
	Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN) ^f
	Protective Equipment
	Hard hat
	Safety glasses or safety goggles (SR)
	Hearing protection (ear canal inserts) ^c
	Leather footwear ^e
4	Arc-Rated Clothing Selected so That the System Arc Rating Meets the Required Minimum Arc Rating of 40 cal/cm² (167.5 J/cm²)^a
	Arc-rated long-sleeve shirt (AR)
	Arc-rated pants (AR) -
	Arc-rated coverall (AR)
	Arc-rated arc flash suit jacket (AR) -
	Arc-rated arc flash suit pants (AR)
	Arc-rated arc flash suit hood
	Arc-rated gloves or rubber insulating gloves with leather protectors (SR) ^d
	Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN) ^f
	Protective Equipment
	Hard hat
	Safety glasses or safety goggles (SR)
	Hearing protection (ear canal inserts) ^c
	Leather footwear ^e

AN: As needed (optional). AR: As required. SR: Selection required.

^a*Arc rating* is defined in Article 100.

^bFace 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.

^cOther 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.

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

^eFootwear 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.

^fThe 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 Input

The two Informational notes are applicable in general and not limited to Direct Current equipment only.
Informational Note No. 1 is applicable to both ac and dc and has been relocated under 130.7 (C) (15).
Informational Note No. 2 is better suited under 130.5 (B)

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 352-NFPA 70E-2021 [Section No. 130.5(A)]	
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Public Input No. 355-NFPA 70E-2021 [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: The arc flash PPE category of the protective clothing and equipment is generally based on determination of the estimated exposure level based on task being performed.

(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

Informational Note No.1: The arc flash PPE category of the protective clothing and equipment is generally based on determination of the estimated exposure level.

Informational Note No.2: In most cases, closed doors do not provide enough protection to eliminate the need for PPE in situations in which the state of the equipment is known to readily change (e.g., doors open or closed, rack in or rack out).

(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 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.)	1	485 mm (19 in.)
Panelboards or other equipment rated greater than 240 volts and up to 600 volts 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.)	2	900 mm (3 ft)

<u>Equipment</u>	<u>Arc Flash PPE Category</u>	<u>Arc Flash Boundary</u>
600-volt class motor control centers (MCCs) 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.)	2	1.5 m (5 ft)
600-volt class motor control centers (MCCs) 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.)	4	4.3 m (14 ft)
600-volt class switchgear (with power circuit breakers or fused switches) and 600-volt class switchboards 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.)	4	6 m (20 ft)
Other 600-volt class (277 volts through 600 volts, nominal) equipment 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.)	2	1.5 m (5 ft)
NEMA E2 (fused contactor) motor starters, 2.3 kV through 7.2 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)
Metal-clad switchgear, 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)
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

<u>Equipment</u>	<u>Arc Flash PPE Category</u>	<u>Arc Flash Boundary</u>
Arc-resistant equipment 1 kV through 15 kV	N/A	N/A
Parameters: DOORS CLOSED and SECURED; with an available fault current and a fault clearing time that does not exceed the arc-resistant rating of the equipment*	-	-

N/A: Not applicable

Note:

For equipment rated 600 volts and below and protected by upstream current-limiting fuses or current-limiting molded case circuit breakers sized at 200 amperes or less, the arc flash PPE category can be reduced by one number but not below arc flash PPE category 1.

*For DOORS OPEN refer to the corresponding non-arc-resistant equipment section of this table.

Informational Note No. 1 to Table 130.7(C)(15)(a): The following are typical fault clearing times of overcurrent protective devices:

- (1) 0.5 cycle fault clearing time is typical for current-limiting fuses and current-limiting molded case circuit breakers when the fault current is within the current limiting range.
- (2) 1.5 cycle fault clearing time is typical for molded case circuit breakers rated less than 1000 volts with an instantaneous integral trip.
- (3) 3.0 cycle fault clearing time is typical for insulated case circuit breakers rated less than 1000 volts with an instantaneous integral trip or relay operated trip.
- (4) 5.0 cycle fault clearing time is typical for relay operated circuit breakers rated 1 kV to 35 kV when the relay operates in the instantaneous range (i.e., "no intentional delay").
- (5) 20 cycle fault clearing time is typical for low-voltage power and insulated case circuit breakers with a short time fault clearing delay for motor inrush.
- (6) 30 cycle fault clearing time is typical for low-voltage power and insulated case circuit breakers with a short time fault clearing delay without instantaneous trip.

Informational Note No. 2 to Table 130.7(C)(15)(a): See Table 1 of IEEE 1584, *Guide for Performing Arc Flash Hazard Calculations*, for further information regarding list items (2) through (4) in Informational Note No. 1.

Informational Note No. 3 to Table 130.7(C)(15)(a): An example of a standard that provides information for arc-resistant equipment referred to in Table 130.7(C)(15)(a) is IEEE C37.20.7, *Guide for Testing Switchgear Rated Up to 52 kV for Internal Arcing Faults*.

Informational Note No. 4 to Table 130.7(C)(15)(a): See O.2.4(9) for information on arc-resistant equipment.

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

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

<u>Equipment</u>	<u>Arc Flash PPE Category</u>	<u>Arc Flash Boundary</u>
Parameters: Greater than 250 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: ASTM F1296, *Standard Guide for Evaluating Chemical Protective Clothing*, contains information on evaluating apparel for protection from electrolyte.

(b) Be arc rated

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

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

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

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

Table 130.7(C)(15)(c) Personal Protective Equipment (PPE)

<u>Arc-Flash PPE Category</u>	<u>PPE</u>
1	Arc-Rated Clothing, Minimum Arc Rating of 4 cal/cm² (16.75 J/cm²)^a
-	Arc-rated long-sleeve shirt and pants or arc-rated coverall
-	Arc-rated face shield ^b or arc flash suit hood
-	Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN) ^f
-	Protective Equipment
-	Hard hat
-	Safety glasses or safety goggles (SR)
-	Hearing protection (ear canal inserts) ^c
-	Heavy-duty leather gloves, arc-rated gloves, or rubber insulating gloves with leather protectors (SR) ^d

Arc-Flash PPE Category	PPE
	Leather footwear ^e (AN)
2	Arc-Rated Clothing, Minimum Arc Rating of 8 cal/cm² (33.5 J/cm²)^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-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN) ^f
	Protective Equipment
	Hard hat
	Safety glasses or safety goggles (SR)
	Hearing protection (ear canal inserts) ^c
	Heavy-duty leather gloves, arc-rated gloves, or rubber insulating gloves with leather protectors (SR) ^d
	Leather footwear ^e
3	Arc-Rated Clothing Selected so That the System Arc Rating Meets the Required Minimum Arc Rating of 25 cal/cm² (104.7 J/cm²)^a
	Arc-rated long-sleeve shirt (AR)
	Arc-rated pants (AR) -
	Arc-rated coverall (AR)
	Arc-rated arc flash suit jacket (AR) -
	Arc-rated arc flash suit pants (AR)
	Arc-rated arc flash suit hood
	Arc-rated gloves or rubber insulating gloves with leather protectors (SR) ^d
	Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN) ^f
	Protective Equipment
	Hard hat
	Safety glasses or safety goggles (SR)
	Hearing protection (ear canal inserts) ^c
	Leather footwear ^e
4	Arc-Rated Clothing Selected so That the System Arc Rating Meets the Required Minimum Arc Rating of 40 cal/cm² (167.5 J/cm²)^a
	Arc-rated long-sleeve shirt (AR)
	Arc-rated pants (AR) -
	Arc-rated coverall (AR)
	Arc-rated arc flash suit jacket (AR) -
	Arc-rated arc flash suit pants (AR)
	Arc-rated arc flash suit hood
	Arc-rated gloves or rubber insulating gloves with leather protectors (SR) ^d
	Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN) ^f
	Protective Equipment
	Hard hat
	Safety glasses or safety goggles (SR)
	Hearing protection (ear canal inserts) ^c
	Leather footwear ^e

AN: As needed (optional). AR: As required. SR: Selection required.

^a*Arc rating* is defined in Article 100.

^bFace 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.

^cOther 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.

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

^eFootwear 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.

^fThe 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 Input

This relocated Informational note is applicable to both Alternating Current (ac) Equipment and Direct Current (dc) Equipment

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 350-NFPA 70E-2021 [Section No. 130.7(C)(15)]	Relocated Informational Note 1 from 130.7 (C)(15)(b)
Public Input No. 352-NFPA 70E-2021 [Section No. 130.5(A)]	Relocated Informational Note no. 2 from 130.7 (15)(b)

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Public Input No. 44-NFPA 70E-2021 [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.

(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

Informational Note No.1: The arc flash PPE category of the protective clothing and equipment is generally based on determination of the estimated exposure level.

Informational Note No.2: In most cases, closed doors do not provide enough protection to eliminate the need for PPE in situations in which the state of the equipment is known to readily change (e.g., doors open or closed, rack in or rack out).

(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 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)

<u>Equipment</u>	<u>Arc Flash PPE Category</u>	<u>Arc Flash Boundary</u>
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	4	12 m (40 ft)
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.)	-	-
Other equipment 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.)	-	-
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

<u>Equipment</u>	<u>Arc Flash PPE Category</u>	<u>Arc Flash Boundary</u>
Parameters: DOORS CLOSED and SECURED; with an available fault current and a fault clearing time that does not exceed the arc-resistant rating of the equipment*	-	-

N/A: Not applicable

Note:

For equipment rated 600 volts and below and protected by upstream current-limiting fuses or current-limiting molded case circuit breakers sized at 200 amperes or less, the arc flash PPE category can be reduced by one number but not below arc flash PPE category 1.

*For DOORS OPEN refer to the corresponding non-arc-resistant equipment section of this table.

Informational Note No. 1 to Table 130.7(C)(15)(a): The following are typical fault clearing times of overcurrent protective devices:

- (1) 0.5 cycle fault clearing time is typical for current-limiting fuses and current-limiting molded case circuit breakers when the fault current is within the current limiting range.
- (2) 1.5 cycle fault clearing time is typical for molded case circuit breakers rated less than 1000 volts with an instantaneous integral trip.
- (3) 3.0 cycle fault clearing time is typical for insulated case circuit breakers rated less than 1000 volts with an instantaneous integral trip or relay operated trip.
- (4) 5.0 cycle fault clearing time is typical for relay operated circuit breakers rated 1 kV to 35 kV when the relay operates in the instantaneous range (i.e., "no intentional delay").
- (5) 20 cycle fault clearing time is typical for low-voltage power and insulated case circuit breakers with a short time fault clearing delay for motor inrush.
- (6) 30 cycle fault clearing time is typical for low-voltage power and insulated case circuit breakers with a short time fault clearing delay without instantaneous trip.

Informational Note No. 2 to Table 130.7(C)(15)(a): See Table 1 of IEEE 1584, *Guide for Performing Arc Flash Hazard Calculations*, for further information regarding list items (2) through (4) in Informational Note No. 1.

Informational Note No. 3 to Table 130.7(C)(15)(a): An example of a standard that provides information for arc-resistant equipment referred to in Table 130.7(C)(15)(a) is IEEE C37.20.7, *Guide for Testing Switchgear Rated Up to 52 kV for Internal Arcing Faults*.

Informational Note No. 4 to Table 130.7(C)(15)(a): See O.2.4(9) for information on arc-resistant equipment.

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

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

<u>Equipment</u>	<u>Arc Flash PPE Category</u>	<u>Arc Flash Boundary</u>
Parameters: Greater than 250 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: ASTM F1296, *Standard Guide for Evaluating Chemical Protective Clothing*, contains information on evaluating apparel for protection from electrolyte.

(b) Be arc rated

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

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

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

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

Table 130.7(C)(15)(c) Personal Protective Equipment (PPE)

<u>Arc-Flash PPE Category</u>	<u>PPE</u>
1	Arc-Rated Clothing, Minimum Arc Rating of 4 cal/cm² (16.75 J/cm²)^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- Arc- rated gloves, or rubber insulating gloves with <u>arc-rated</u> leather protectors (SR) ^d

Arc-Flash PPE Category	PPE
	Leather footwear ^e (AN)
2	Arc-Rated Clothing, Minimum Arc Rating of 8 cal/cm² (33.5 J/cm²)^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-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 arc-rated leather protectors (SR) ^d
	Leather footwear ^e
3	Arc-Rated Clothing Selected so That the System Arc Rating Meets the Required Minimum Arc Rating of 25 cal/cm² (104.7 J/cm²)^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 arc-rated leather protectors (SR) ^d
	Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN) ^f
	Protective Equipment
	Hard hat
	Safety glasses or safety goggles (SR)
	Hearing protection (ear canal inserts) ^c
	Leather footwear ^e
4	Arc-Rated Clothing Selected so That the System Arc Rating Meets the Required Minimum Arc Rating of 40 cal/cm² (167.5 J/cm²)^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 arc-rated leather protectors (SR) ^d
	Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN) ^f
	Protective Equipment
	Hard hat
	Safety glasses or safety goggles (SR)
	Hearing protection (ear canal inserts) ^c
	Leather footwear ^e

AN: As needed (optional). AR: As required. SR: Selection required.

^aArc rating is defined in Article 100.

^bFace 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.

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

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

^eFootwear 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.

^fThe 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 Input

PROBLEM: Current table and text does not provide sufficient arc-flash protection for hands.

SUBSTANTIATION: The qualified person's hands are usually closest to the arc-flash when work is being performed, often much closer than the working distance used to calculate the incident energy. It is important to ensure the employee's hands are well protected. Heavy-duty leather gloves are not defined in 70E and do not appear to be defined by any other standard.

The informational note for 130.7(C)(10)(d)(1) indicates that heavy-duty leather gloves have a minimum of 0.03 inch thickness. Five major manufacturers were contacted and stated that they do not publish nor disclose the thickness of their leather protectors; one responded it is proprietary information. Most leather work gloves do not have thickness indicated on them. The 70E informational note also indicates that the ATPV would be 10 cal/cm² or greater, which is below the 12 cal/cm² rating suggested by Table 130.5(G) – with the situation exacerbated by hands being closer than the incident energy working distance.

The lack of ASTM arc-flash specifications for rubber insulating gloves means they cannot be depended upon to ensure that they will provide consistent or sufficient protection. There is significant variability in glove performance based on class and color from testing performed in the early part of this century, even if it was generally favorable. Since that time there have been market changes with a large proliferation of gloves from a more diverse group of manufacturers. Examination of various manufacturers' gloves has shown large variation in quality. Without clear arc flash performance specifications, the rubber insulating gloves cannot be depended upon for protection.

There are now multiple manufacturers providing leather protectors with ATPV specified that will protect the rubber insulating gloves from the arc flash.

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 42-NFPA 70E-2021 [Section No. 130.7(C)(10)]	Same problem and substantiation
Public Input No. 43-NFPA 70E-2021 [Section No. 130.5(G)]	Same problem and substantiation

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Public Input No. 45-NFPA 70E-2021 [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.

(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

Informational Note No.1: The arc flash PPE category of the protective clothing and equipment is generally based on determination of the estimated exposure level.

Informational Note No.2: In most cases, closed doors do not provide enough protection to eliminate the need for PPE in situations in which the state of the equipment is known to readily change (e.g., doors open or closed, rack in or rack out).

(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 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)

<u>Equipment</u>	<u>Arc Flash PPE Category</u>	<u>Arc Flash Boundary</u>
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	4	12 m (40 ft)
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.)	-	-
Other equipment 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.)	-	-
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

<u>Equipment</u>	<u>Arc Flash PPE Category</u>	<u>Arc Flash Boundary</u>
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 fuse operates in 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 when the circuit breaker operates in the instantaneous range .

(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 when the circuit breaker operates in the instantaneous range .

(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 when the circuit breaker operates in the short time delay range .

(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 when the circuit breaker operates in the short time delay range ..

Informational Note No. 2 to Table 130.7(C)(15)(a): See Table 1 of IEEE 1584, *Guide for Performing Arc Flash Hazard Calculations*, for further information regarding list items (2) through (4) in Informational Note No. 1.

Informational Note No. 3 to Table 130.7(C)(15)(a): An example of a standard that provides information for arc-resistant equipment referred to in Table 130.7(C)(15)(a) is IEEE C37.20.7, *Guide for Testing Switchgear Rated Up to 52 kV for Internal Arcing Faults*.

Informational Note No. 4 to Table 130.7(C)(15)(a): See O.2.4(9) for information on arc-resistant equipment.

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

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

<u>Equipment</u>	<u>Arc Flash PPE Category</u>	<u>Arc Flash Boundary</u>
Parameters: Greater than 250 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: ASTM F1296, *Standard Guide for Evaluating Chemical Protective Clothing*, contains information on evaluating apparel for protection from electrolyte.

(b) Be arc rated

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

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

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

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

Table 130.7(C)(15)(c) Personal Protective Equipment (PPE)

<u>Arc-Flash PPE Category</u>	<u>PPE</u>
1	Arc-Rated Clothing, Minimum Arc Rating of 4 cal/cm² (16.75 J/cm²)^a
-	Arc-rated long-sleeve shirt and pants or arc-rated coverall
-	Arc-rated face shield ^b or arc flash suit hood
-	Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN) ^f
-	Protective Equipment
-	Hard hat
-	Safety glasses or safety goggles (SR)
-	Hearing protection (ear canal inserts) ^c
-	Heavy-duty leather gloves, arc-rated gloves, or rubber insulating gloves with leather protectors (SR) ^d

Arc-Flash PPE Category	PPE
	Leather footwear ^e (AN)
2	Arc-Rated Clothing, Minimum Arc Rating of 8 cal/cm² (33.5 J/cm²)^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-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN) ^f
	Protective Equipment
	Hard hat
	Safety glasses or safety goggles (SR)
	Hearing protection (ear canal inserts) ^c
	Heavy-duty leather gloves, arc-rated gloves, or rubber insulating gloves with leather protectors (SR) ^d
	Leather footwear ^e
3	Arc-Rated Clothing Selected so That the System Arc Rating Meets the Required Minimum Arc Rating of 25 cal/cm² (104.7 J/cm²)^a
	Arc-rated long-sleeve shirt (AR)
	Arc-rated pants (AR) -
	Arc-rated coverall (AR)
	Arc-rated arc flash suit jacket (AR) -
	Arc-rated arc flash suit pants (AR)
	Arc-rated arc flash suit hood
	Arc-rated gloves or rubber insulating gloves with leather protectors (SR) ^d
	Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN) ^f
	Protective Equipment
	Hard hat
	Safety glasses or safety goggles (SR)
	Hearing protection (ear canal inserts) ^c
	Leather footwear ^e
4	Arc-Rated Clothing Selected so That the System Arc Rating Meets the Required Minimum Arc Rating of 40 cal/cm² (167.5 J/cm²)^a
	Arc-rated long-sleeve shirt (AR)
	Arc-rated pants (AR) -
	Arc-rated coverall (AR)
	Arc-rated arc flash suit jacket (AR) -
	Arc-rated arc flash suit pants (AR)
	Arc-rated arc flash suit hood
	Arc-rated gloves or rubber insulating gloves with leather protectors (SR) ^d
	Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN) ^f
	Protective Equipment
	Hard hat
	Safety glasses or safety goggles (SR)
	Hearing protection (ear canal inserts) ^c
	Leather footwear ^e

AN: As needed (optional). AR: As required. SR: Selection required.

^aArc rating is defined in Article 100.

^bFace 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.

^cOther 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.

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

^eFootwear 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.

^fThe 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 Input

The only changes in this public input are those included for informational note No. 1 to table 130.7(C)(15)(a) items (1), (2), (3), (5), and (6).

The general changes made follow the lead of the existing item (4) of this table which correctly points out the typical clearing is valid for “when the relay operates in the instantaneous range.” The other clearing times too are only applicable when the devices operate in a specific range based on the amount of current that flows through them.

Item (1) is modified to align with and be consistent with other language. The existing language specifies when the fault current is within the current limiting range but fails to be specific as to what fault current. To be more technically accurate it is reworded to stat “when the fuse operates in the current limiting range” and this aligns with existing (4) as well as the other modifications being suggested as part of this public input.

Item (2) is modified to identify that a 1.5 clearing time is typical for MCCBs rated less than 1000V with an instantaneous integral trip unit “when the circuit breaker operates in the instantaneous range.” If the currents are low enough the clearing times will be longer. This language presents a level of technical accuracy and aligns with existing (4) as well as the other modifications being suggested as part of this public input.

Item (3) is modified to identify that a 3.0 cycle fault clearing time is typical for ICCBs rated less than 1kV with an instantaneous integral trip or relay operated trip “when the circuit breaker operates in the instantaneous range.” This language presents a level of technical accuracy and aligns with existing (4) as well as the other modifications being suggested as part of this public input.

Item (5) is modified to identify that a 20 cycle fault clearing time is typical for LVPCBs and ICCBs with a short-time fault clearing delay for motor inrush “when the circuit breaker operates in the short time delay range.” This language presents a level of technical accuracy and aligns with existing (4) as well as the other modifications being suggested as part of this public input.

Item (6) is modified to identify that a 30 cycle fault clearing time is typical for LVPCBs and ICCBs with a short time fault clearing delay without an instantaneous trip “when the circuit breaker operates in the short time delay range.” This language presents a level of technical accuracy and aligns with existing (4) as well as the other modifications being suggested as part of this public input.

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Public Input No. 46-NFPA 70E-2021 [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.

(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

Informational Note No.1: The arc flash PPE category of the protective clothing and equipment is generally based on determination of the estimated exposure level.

Informational Note No.2: In most cases, closed doors do not provide enough protection to eliminate the need for PPE in situations in which the state of the equipment is known to readily change (e.g., doors open or closed, rack in or rack out).

(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 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.)	1	485 mm (19 in.)
Panelboards or other equipment rated greater than 240 volts and up to 600 volts 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.)	2	900 mm (3 ft)
600-volt class motor control centers (MCCs)	2	1.5 m (5 ft)

<u>Equipment</u>	<u>Arc Flash PPE Category</u>	<u>Arc Flash Boundary</u>
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	4	12 m (40 ft)
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.)	-	-
Other equipment 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.)	-	-
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

<u>Equipment</u>	<u>Arc Flash PPE Category</u>	<u>Arc Flash Boundary</u>
Parameters: DOORS CLOSED and SECURED; with an available fault current and a fault clearing time that does not exceed the arc-resistant rating of the equipment*	-	-

N/A: Not applicable

Note:

For equipment rated 600 volts and below and protected by upstream current-limiting fuses or current-limiting molded case circuit breakers sized at 200 amperes or less, the arc flash PPE category can be reduced by one number but not below arc flash PPE category 1.

*For DOORS OPEN refer to the corresponding non-arc-resistant equipment section of this table.

Informational Note No. 1 to Table 130.7(C)(15)(a): The following are typical fault clearing times of overcurrent protective devices:

(1) 0.5 cycle fault clearing time is typical for current-limiting fuses and current-limiting molded case circuit breakers when the fault current is within the current limiting range.

(2) 1.5 cycle fault clearing time is typical for molded case circuit breakers rated less than 1000 volts with an instantaneous integral trip.

(3) 3.0 cycle fault clearing time is typical for insulated case circuit breakers rated less than 1000 volts with an instantaneous integral trip or relay operated trip.

(4) 5.0 cycle fault clearing time is typical for relay operated circuit breakers rated 1 kV to 35 kV when the relay operates in the instantaneous range (i.e., "no intentional delay").

(5) 20 cycle fault clearing time is typical for low-voltage power and insulated case circuit breakers with a short time fault clearing delay for motor inrush.

(6) 30 cycle fault clearing time is typical for low-voltage power and insulated case circuit breakers with a short time fault clearing delay without instantaneous trip.

Informational Note No. 2 to Table 130.7(C)(15)(a): See Table 1 of IEEE 1584, *Guide for Performing Arc Flash Hazard Calculations*, for further information regarding list items (2) through (4) in Informational Note No. 1.

Informational Note No. 3 to Table 130.7(C)(15)(a): An example of a standard that provides information for arc-resistant equipment referred to in Table 130.7(C)(15)(a) is IEEE C37.20.7, *Guide for Testing Switchgear Rated Up to 52 kV for Internal Arcing Faults*.

Informational Note No. 4 to Table 130.7(C)(15)(a): See O.2.4(9) for information on arc-resistant equipment.

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

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

<u>Equipment</u>	<u>Arc Flash PPE Category</u>	<u>Arc Flash Boundary</u>
Parameters: Greater than 250 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: ASTM F1296, *Standard Guide for Evaluating Chemical Protective Clothing*, contains information on evaluating apparel for protection from electrolyte.

(b) Be arc rated

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

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

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

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

Table 130.7(C)(15)(c) Personal Protective Equipment (PPE)

<u>Arc-Flash PPE Category</u>	<u>PPE</u>
1	Arc-Rated Clothing, Minimum Arc Rating of 4 cal/cm² (16.75 J/cm²)^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 leather protectors (SR) ^d

Arc-Flash PPE Category	PPE
	Leather footwear ^e (AN)
2	Arc-Rated Clothing, Minimum Arc Rating of 8 cal/cm² (33.5 J/cm²)^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-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN) ^f
	Protective Equipment
	Hard hat
	Safety glasses or safety goggles (SR)
	Hearing protection (ear canal inserts) ^c
	Heavy-duty leather gloves, arc-rated gloves, or rubber insulating gloves with leather protectors (SR) ^d
	Leather footwear ^e
3	Arc-Rated Clothing Selected so That the System Arc Rating Meets the Required Minimum Arc Rating of 25 cal/cm² (104.7 J/cm²)^a
	Arc-rated long-sleeve shirt (AR)
	Arc-rated pants (AR) -
	Arc-rated coverall (AR)
	Arc-rated arc flash suit jacket (AR) -
	Arc-rated arc flash suit pants (AR)
	Arc-rated arc flash suit hood
	Arc-rated gloves or rubber insulating gloves with leather protectors (SR) ^d
	Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN) ^f
	Protective Equipment
	Hard hat
	Safety glasses or safety goggles (SR)
	Hearing protection (ear canal inserts) ^c
	Leather footwear ^e
4	Arc-Rated Clothing Selected so That the System Arc Rating Meets the Required Minimum Arc Rating of 40 cal/cm² (167.5 J/cm²)^a
	Arc-rated long-sleeve shirt (AR)
	Arc-rated pants (AR) -
	Arc-rated coverall (AR)
	Arc-rated arc flash suit jacket (AR) -
	Arc-rated arc flash suit pants (AR)
	Arc-rated arc flash suit hood
	Arc-rated gloves or rubber insulating gloves with leather protectors (SR) ^d
	Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN) ^f
	Protective Equipment
	Hard hat
	Safety glasses or safety goggles (SR)
	Hearing protection (ear canal inserts) ^c
	Leather footwear ^e

AN: As needed (optional). AR: As required. SR: Selection required.

^a*Arc rating* is defined in Article 100.

^bFace 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.

^cOther 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.

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

^eFootwear 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.

^fThe 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 Input

The arc rated balaclava is called out in Table 130.5(G) for 1.2 calories to 12 calories. Footnote b to that table states that "...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. 130.7(C)(3) also calls out protection for the face, neck and chin whenever there is a danger of injury from ...arc flashes. An arc rated balaclava is called out with the use of Category II PPE.

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Public Input No. 87-NFPA 70E-2021 [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.

(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

Informational Note No.1: The arc flash PPE category of the protective clothing and equipment is generally based on determination of the estimated exposure level.

Informational Note No.2: In most cases, closed doors do not provide enough protection to eliminate the need for PPE in situations in which the state of the equipment is known to readily change (e.g., doors open or closed, rack in or rack out).

(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 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)

<u>Equipment</u>	<u>Arc Flash PPE Category</u>	<u>Arc Flash Boundary</u>
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	4	12 m (40 ft)
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.)	-	-
Other equipment 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.)	-	-
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

<u>Equipment</u>	<u>Arc Flash PPE Category</u>	<u>Arc Flash Boundary</u>
Parameters: DOORS CLOSED and SECURED; with an available fault current and a fault clearing time that does not exceed the arc-resistant rating of the equipment*	-	-

N/A: Not applicable

Note:

For equipment rated 600 volts and below and protected by upstream current-limiting fuses or current-limiting molded case circuit breakers sized at 200 amperes or less, the arc flash PPE category can be reduced by one number but not below arc flash PPE category 1.

*For DOORS OPEN refer to the corresponding non-arc-resistant equipment section of this table.

Informational Note No. 1 to Table 130.7(C)(15)(a): The following are typical fault clearing times of overcurrent protective devices:

(1) 0.5 cycle fault clearing time is typical for current-limiting fuses and current-limiting molded case circuit breakers- ~~when the fault current is within the current limiting range~~.

(2) 1.5 cycle fault clearing time is typical for molded case circuit breakers rated less than 1000 volts with an instantaneous integral trip.

(3) 3.0 cycle fault clearing time is typical for insulated case circuit breakers rated less than 1000 volts with an instantaneous integral trip or relay operated trip.

(4) 5.0 cycle fault clearing time is typical for relay operated circuit breakers rated 1 kV to 35 kV when the relay operates in the instantaneous range (i.e., "no intentional delay").

(5) 20 cycle fault clearing time is typical for low-voltage power and insulated case circuit breakers with a short time fault clearing delay for motor inrush.

(6) 30 cycle fault clearing time is typical for low-voltage power and insulated case circuit breakers with a short time fault clearing delay without instantaneous trip.

Informational Note No. 2 to Table 130.7(C)(15)(a): See Table 1 of IEEE 1584, *Guide for Performing Arc Flash Hazard Calculations*, for further information regarding list items (2) through (4) in Informational Note No. 1.

Informational Note No. 3 to Table 130.7(C)(15)(a): An example of a standard that provides information for arc-resistant equipment referred to in Table 130.7(C)(15)(a) is IEEE C37.20.7, *Guide for Testing Switchgear Rated Up to 52 kV for Internal Arcing Faults*.

Informational Note No. 4 to Table 130.7(C)(15)(a): See O.2.4(9) for information on arc-resistant equipment.

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

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

<u>Equipment</u>	<u>Arc Flash PPE Category</u>	<u>Arc Flash Boundary</u>
Parameters: Greater than 250 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: ASTM F1296, *Standard Guide for Evaluating Chemical Protective Clothing*, contains information on evaluating apparel for protection from electrolyte.

(b) Be arc rated

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

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

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

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

Table 130.7(C)(15)(c) Personal Protective Equipment (PPE)

<u>Arc-Flash PPE Category</u>	<u>PPE</u>
1	Arc-Rated Clothing, Minimum Arc Rating of 4 cal/cm² (16.75 J/cm²)^a
-	Arc-rated long-sleeve shirt and pants or arc-rated coverall
-	Arc-rated face shield ^b or arc flash suit hood
-	Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN) ^f
-	Protective Equipment
-	Hard hat
-	Safety glasses or safety goggles (SR)
-	Hearing protection (ear canal inserts) ^c
-	Heavy-duty leather gloves, arc-rated gloves, or rubber insulating gloves with leather protectors (SR) ^d

Arc-Flash PPE Category	PPE
	Leather footwear ^e (AN)
2	Arc-Rated Clothing, Minimum Arc Rating of 8 cal/cm² (33.5 J/cm²)^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-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN) ^f
	Protective Equipment
	Hard hat
	Safety glasses or safety goggles (SR)
	Hearing protection (ear canal inserts) ^c
	Heavy-duty leather gloves, arc-rated gloves, or rubber insulating gloves with leather protectors (SR) ^d
	Leather footwear ^e
3	Arc-Rated Clothing Selected so That the System Arc Rating Meets the Required Minimum Arc Rating of 25 cal/cm² (104.7 J/cm²)^a
	Arc-rated long-sleeve shirt (AR)
	Arc-rated pants (AR) -
	Arc-rated coverall (AR)
	Arc-rated arc flash suit jacket (AR) -
	Arc-rated arc flash suit pants (AR)
	Arc-rated arc flash suit hood
	Arc-rated gloves or rubber insulating gloves with leather protectors (SR) ^d
	Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN) ^f
	Protective Equipment
	Hard hat
	Safety glasses or safety goggles (SR)
	Hearing protection (ear canal inserts) ^c
	Leather footwear ^e
4	Arc-Rated Clothing Selected so That the System Arc Rating Meets the Required Minimum Arc Rating of 40 cal/cm² (167.5 J/cm²)^a
	Arc-rated long-sleeve shirt (AR)
	Arc-rated pants (AR) -
	Arc-rated coverall (AR)
	Arc-rated arc flash suit jacket (AR) -
	Arc-rated arc flash suit pants (AR)
	Arc-rated arc flash suit hood
	Arc-rated gloves or rubber insulating gloves with leather protectors (SR) ^d
	Arc-rated jacket, parka, high-visibility apparel, rainwear, or hard hat liner (AN) ^f
	Protective Equipment
	Hard hat
	Safety glasses or safety goggles (SR)
	Hearing protection (ear canal inserts) ^c
	Leather footwear ^e

AN: As needed (optional). AR: As required. SR: Selection required.

^a*Arc rating* is defined in Article 100.

^bFace 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.

^cOther 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.

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

^eFootwear 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.

^fThe 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 Input

The reference to comparing fault current with the current limiting region is out of the scope of this table. A similar comparison is not noted for molded case circuit breakers with an instantaneous and so it would not make sense to include this reference in the current limiting OCPD. A comparison made with available fault current would be inaccurate.

In fact, this entire table should only have one reference to fault current and that is the maximum noted. Clearing times of any reference are not appropriate as no comparison is made and if a comparison of available fault current is made it would be technically inaccurate. This table was not created based upon a relation between fault current and OCPD trip curves. It was built on industry practice and practical experience.

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Public Input No. 18-NFPA 70E-2020 [Section No. 130.7(D)(1)]

(1) Insulated Tools and Equipment.

Tools and handling equipment used within the restricted approach boundary shall be insulated. Insulated tools shall be protected from damage to the insulating material.

Informational Note: See 130.4(E), Electric Shock Protection Boundaries.

(a) *Requirements for Insulated Tools.* The following requirements shall apply to insulated tools:

- (2) Insulated tools shall be rated for the voltages on which they are used.
- (3) Insulated tools shall be designed and constructed for the environment to which they are exposed and the manner in which they are used.
- (4) 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).

(e) *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.

(f) *Ropes and Handlines.* Ropes and handlines used within the limited approach boundary shall be nonconductive.

(g) *Fiberglass-Reinforced Plastic Rods.* Fiberglass-reinforced plastic rod and tube used for live-line tools shall meet the requirements of applicable portions of electrical codes and standards dealing with electrical installation requirements.

Informational Note: For further information concerning electrical codes and standards dealing with installation requirements, refer to ASTM F711, *Standard Specification for Fiberglass-Reinforced Plastic (FRP) Rod and Tube Used in Live Line Tools*.

(h) *Portable Ladders.* Portable ladders shall have nonconductive side rails when used within the limited approach boundary or where the employee or ladder could contact exposed energized electrical conductors or circuit parts. Nonconductive ladders shall meet the requirements of applicable state, federal, or local codes and standards.

Informational Note: The standards listed in Table 130.7(G), Informational Note are examples of standards that contain information on portable ladders.

Statement of Problem and Substantiation for Public Input

"electric" is added before "shock" to read "electric shock" to correlate with the use of "electric shock" in the definition of "electrical hazard" and Boundary, Restricted Approach as well as to clarify that the type of shock hazard being addressed is a shock hazard rather than others forms of shock such as where one would go into shock due to a severe injury or a reaction associated with fright.

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.

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

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
<u>Public Input No. 15-NFPA 70E-2020 [Definition: Shock Hazard.]</u>	Related issue.

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Public Input No. 192-NFPA 70E-2021 [Section No. 130.7(D)(1)]

(1) Insulated Tools and Equipment.

Tools and handling equipment used within the restricted approach boundary shall be insulated. Insulated tools shall be protected from damage to the insulating material.

Informational Note: See 130.4(E), Shock Protection Boundaries.

(a) *Requirements for Insulated Tools.* The following requirements shall apply to insulated tools:

- (2) Insulated tools shall be rated for the voltages on which they are used.
- (3) Insulated tools shall be designed and constructed for the environment to which they are exposed and the manner in which they are used.
- (4) 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).

(e) *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.

(f) *Ropes and Handlines.* Ropes and handlines used within the limited approach boundary shall be nonconductive.

(g) *Fiberglass-Reinforced Plastic Rods.* Fiberglass-reinforced plastic rod and tube used for live-line tools shall meet the requirements of applicable portions of electrical codes and standards dealing with electrical installation requirements.

Informational Note: ~~For further information concerning electrical codes and standards dealing with installation requirements, refer to~~ See ASTM F711, Standard Specification for Fiberglass-Reinforced Plastic (FRP) Rod and Tube Used in Live Line Tools ~~Tools for further information concerning electrical codes and standards dealing with installation requirements.~~

(h) *Portable Ladders.* Portable ladders shall have nonconductive side rails when used within the limited approach boundary or where the employee or ladder could contact exposed energized electrical conductors or circuit parts. Nonconductive ladders shall meet the requirements of applicable state, federal, or local codes and standards.

Informational Note: ~~The standards listed in~~ See Table 130.7(G), Informational Note ~~are examples of standards for a list of example standards~~ that contain information on portable ladders.

Statement of Problem and Substantiation for Public Input

TerraView error. Only change is to relocate reference to front of Informational Notes as shown.

Revised Informational Note to comply with new 2020 NEC Style Manual.

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

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**Public Input No. 193-NFPA 70E-2021 [Section No. 130.7(D)(2)]****(2) Barriers.**

Exposed energized electrical conductors or circuit parts operating at 50 volts or more shall be guarded by a barrier in accordance with 130.7(D)(2)(a) through 130.7(D)(2)(c) to prevent unintentional contact while an employee is working within the restricted approach boundary of those conductors or circuit parts. Barriers shall be supported to remain in place and shall prevent unintentional contact by a person, tool, or equipment.

(a) *Rubber Insulating Equipment.* Rubber insulating equipment used for protection from unintentional contact with energized conductors or circuit parts shall be rated for the voltage and shall meet the requirements of applicable state, federal, or local codes and standards.

Informational Note: ~~The standards listed in See Table 130.7(G), Informational Note are examples for a list of~~ example standards that contain information on rubber insulating equipment.

(b) *Voltage-Rated Plastic Guard Equipment.* Plastic guard equipment for protection of employees from unintentional contact with energized conductors or circuit parts, or for protection of employees or energized equipment or material from contact with ground, shall be rated for the voltage and shall meet the requirements of applicable state, federal, or local codes and standards.

Informational Note: ~~The standards listed in See Table 130.7(G), Informational Note are examples of standards for a~~ list of example 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.

Statement of Problem and Substantiation for Public Input

Revised Informational Note to comply with new 2020 NEC Style Manual.

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

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**Public Input No. 82-NFPA 70E-2021 [Section No. 130.7(E)]**

~~(E)– Alerting Techniques.~~

~~(1)– Safety Signs and Tags.~~

~~Safety signs, safety symbols, or tags shall be used where necessary to warn employees about electrical hazards that might endanger them. Such signs and tags shall meet the requirements of applicable state, federal, or local codes and standards.~~

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

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

~~(2)– Barricades.~~

~~Barricades shall be used in conjunction with safety signs where it is necessary to prevent or limit employee access to work areas containing energized conductors or circuit parts. Conductive barricades shall not be used where it might increase the likelihood of exposure to an electrical hazard. Barricades shall be placed no closer than the limited approach boundary given in Table 130.4(E)(a) and Table 130.4(E)(b). Where the arc flash boundary is greater than the limited approach boundary, barricades shall not be placed closer than the arc flash boundary.~~

~~(3)– Attendants.~~

~~If signs and barricades do not provide sufficient warning and protection from electrical hazards, an attendant shall be stationed to warn and protect employees. The primary duty and responsibility of an attendant providing manual signaling and alerting shall be to keep unqualified employees outside a work area where the unqualified employee might be exposed to electrical hazards. An attendant shall remain in the area as long as there is a potential for employees to be exposed to the electrical hazards.~~

Statement of Problem and Substantiation for Public Input

This subdivision should be removed from 130.7 as these requirements are not personal or other protective equipment (the title of 130.7). It is recommended that these requirements be relocated to 130.8, Other Precautions for Personnel Activities, as these requirements fit what the title of 130.8 covers.

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 83-NFPA 70E-2021 [New Section after 130.8]	Relocation correlation
Public Input No. 83-NFPA 70E-2021 [New Section after 130.8]	

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**Public Input No. 194-NFPA 70E-2021 [Section No. 130.7(E)(1)]****(1) Safety Signs and Tags.**

Safety signs, safety symbols, or tags shall be used where necessary to warn employees about electrical hazards that might endanger them. Such signs and tags shall meet the requirements of applicable state, federal, or local codes and standards.

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

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

Statement of Problem and Substantiation for Public Input

Revised Informational Note to comply with new 2020 NEC Style Manual.

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

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**Public Input No. 377-NFPA 70E-2021 [Section No. 130.7(E)(3)]****(3) Attendants.**

~~If signs and barricades do not provide sufficient warning and protection from electrical hazards, an attendant. A Risk Assessment shall be performed to determine the need for an attendant before the work begins. If it is determined that an attendant is needed, that person shall be stationed to warn and protect employees from the electrical hazards . The primary duty and responsibility of an attendant providing manual signaling and alerting shall be to keep unqualified employees outside a work area where the unqualified employee might be exposed to electrical hazards. An attendant shall remain in the area as long as there is a potential for employees to be exposed to the electrical hazards.~~

Statement of Problem and Substantiation for Public Input

If we wait till "it is determined that an attendant is needed", that means it is too late and the initial protective measures were not enough. This must be determined before work begins, not find out later that the measures did not work.

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**Public Input No. 81-NFPA 70E-2021 [Section No. 130.7(F)]**

~~(F) Look-Alike Equipment.~~

~~Where work performed on equipment that is de-energized and placed in an electrically safe condition exists in a work area with other energized equipment that is similar in size, shape, and construction, one of the alerting methods in 130.7(E)(1) , (2), or (3) shall be employed to prevent the employee from entering look-alike equipment.~~

Statement of Problem and Substantiation for Public Input

This subdivision should be removed from 130.7 as these requirements are not personal or other protective equipment (the title of 130.7). It is recommended that these requirements be relocated to 130.8, Other Precautions for Personnel Activities, as these requirements fit what the title of 130.8 covers.

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 83-NFPA 70E-2021 [New Section after 130.8]	Relocation correlation
Public Input No. 83-NFPA 70E-2021 [New Section after 130.8]	

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Public Input No. 195-NFPA 70E-2021 [Section No. 130.7(G)]

(G) 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: ~~The standards listed in See Table 130.7(G), which is part of this Informational Note, are examples of standards.~~ Informational Note for a list of example standards that contain information on other protective equipment.

Table 130.7(G) Informational Note: Standards on Other Protective Equipment

<u>Subject</u>	<u>Document</u>	<u>Document Number</u>	
Arc Protective Blankets	Standard Test Method for Determining the Protective Performance of an Arc Protective Blanket for Electric Arc Hazards	ASTM F2676	
Arc Protective Blankets — Selection, Care, and Use	Standard Guide for Selection, Care, and Use of Arc Protective Blankets	ASTM F3272	
Blankets	Standard Specification for Rubber Insulating Blankets	ASTM D1048	
Blankets — In-service Care	Standard Specification for In-Service Care of Insulating Blankets	ASTM F479	
-	-	-	
Covers	Standard Specification for Rubber Insulating Covers	ASTM D1049	
Fiberglass Rods — Live Line Tools	Standard Specification for Fiberglass-Reinforced Plastic (FRP) Rod and Tube Used in Live Line Tools	ASTM F711	
Insulated Hand Tools	Standard Specification for Insulated and Insulating Hand Tools	ASTM F1505	
Ladders	American National Standard for Ladders — Wood — Safety Requirements	ANSI/ ASC A14.1	
	-	American National Standard for Ladders — Fixed — Safety Requirements	ANSI /ASC A14.3
	-	American National Standard Safety Requirements for Job Made Wooden Ladders	ANSI ASC A14.4
-	-	American National Standard for Ladders — Portable Reinforced Plastic — Safety Requirements	ANSI ASC A14.5
Line Hose	Standard Specification for Rubber Insulating Line Hoses	ASTM D1050	
Line Hose and Covers — In-service Care	Standard Specification for In-Service Care of Insulating Line Hose and Covers	ASTM F478	

<u>Subject</u>	<u>Document</u>	<u>Document Number</u>
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 Input

Revised Informational Note to comply with new 2020 NEC Style Manual and to align language with other references to Table 130.7(G).

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

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Public Input No. 83-NFPA 70E-2021 [New Section after 130.8]

130.8

(O) Relocate the requirements of 130.7(F), [Look-Alike Equipment, here](#),

(P) Relocate the requirements of 130.7(E), [Alerting Techniques, here](#).

Statement of Problem and Substantiation for Public Input

Relocate 130.7(F) to 130.8(O)

Look-Alike Equipment.

Where work performed on equipment that is de-energized and placed in an electrically safe condition exists in a work area with other energized equipment that is similar in size, shape, and construction, one of the alerting methods in 130.7(E)(1), (2), or (3) shall be employed to prevent the employee from entering look-alike equipment.

Relocate 130.7(E) to 130.8(P)

Alerting Techniques.

130.8(P)(1) Safety Signs and Tags.

Safety signs, safety symbols, or tags shall be used where necessary to warn employees about electrical hazards that might endanger them. Such signs and tags shall meet the requirements of applicable state, federal, or local codes and standards.

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

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

130.8(P)(2) Barricades.

Barricades shall be used in conjunction with safety signs where it is necessary to prevent or limit employee access to work areas containing energized conductors or circuit parts. Conductive barricades shall not be used where it might increase the likelihood of exposure to an electrical hazard. Barricades shall be placed no closer than the limited approach boundary given in Table 130.4(E)(a) and Table 130.4(E)(b). Where the arc flash boundary is greater than the limited approach boundary, barricades shall not be placed closer than the arc flash boundary.

130.8(P)(3) Attendants.

If signs and barricades do not provide sufficient warning and protection from electrical hazards, an attendant shall be stationed to warn and protect employees. The primary duty and responsibility of an attendant providing manual signaling and alerting shall be to keep unqualified employees outside a work area where the unqualified employee might be exposed to electrical hazards. An attendant shall remain in the area as long as there is a potential for employees to be exposed to the electrical hazards.

These requirements are not personal or other protective equipment and therefore should not be located in 130.7 which, by its title, addresses personal and other protective equipment. The topics addressed by these requirements are a logical fit to what is covered by 130.8 - Other Precautions for Personnel Activities.

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 82-NFPA 70E-2021 [Section No. 130.7(E)]	Relocation correlation
Public Input No. 81-NFPA 70E-2021 [Section No. 130.7(F)]	Relocation correlation
Public Input No. 81-NFPA 70E-2021 [Section No. 130.7(F)]	
Public Input No. 82-NFPA 70E-2021 [Section No. 130.7(E)]	

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Submittal Date: Tue Apr 06 14:16:36 EDT 2021

Committee: EEW-AAA

**Public Input No. 196-NFPA 70E-2021 [Section No. 130.8(J)]****(J) Occasional Use of Flammable Materials.**

Where flammable materials are present only occasionally, electric equipment capable of igniting them shall not be permitted to be used, unless measures are taken to prevent hazardous conditions from developing. Such materials shall include, but are not limited to, flammable gases, vapors, or liquids, combustible dust, and ignitable fibers or flyings.

Informational Note: - ~~Electrical- See NFPA 70 - National Electrical Code for electrical~~ installation requirements for locations where flammable materials are present on a regular basis- ~~are contained in NFPA 70 - National Electrical Code~~ .

Statement of Problem and Substantiation for Public Input

Revised Informational Note to comply with new 2020 NEC Style Manual.

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

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Committee: EEW-AAA

**Public Input No. 362-NFPA 70E-2021 [Section No. 130.8(M)]****(M) Reclosing Circuits After Protective Device Operation.**

After a circuit is de-energized by the automatic operation of a circuit protective device, the circuit shall not be manually re-energized until it has been determined that the equipment and circuit can be safely energized. ~~The repetitive manual reclosing of circuit breakers or re-energizing circuits through replaced fuses shall be prohibited.~~ When it is determined from the design of the circuit and the overcurrent devices involved that the automatic operation of a device was caused by an overload rather than a fault condition, examination of the circuit or connected equipment shall not be required before the circuit is re-energized.

Statement of Problem and Substantiation for Public Input

Delete the second sentence. As presently written, it infers that replacing a fuse or closing a circuit breaker is acceptable once. The first and third sentences are sufficient.

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Committee: EEW-AAA

**Public Input No. 375-NFPA 70E-2021 [Section No. 130.11]****130.11** Cutting or Drilling.

Before cutting or drilling into equipment, floors, walls, or structural elements where a likelihood of contacting energized electrical lines or parts exists, the employer shall perform a risk assessment to:

- (1) Identify and mark the location of conductors, cables, raceways, or equipment
- (2) ~~Create~~ Establish and verify an electrically safe work condition
- (3) Identify safe work practices, risk control methods, additional protective measures, and ~~PPE to be used~~ any required shock or arc flash PPE

Statement of Problem and Substantiation for Public Input

This revision is intended to editorially revise 130.11 to reflect the terminology used in Article 120, specifically 120.5 where an electrically safe work condition must be achieved and verified, as well as the requirements of 110.5(H)(3) and 130.4 and 130.5.

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**Public Input No. 379-NFPA 70E-2021 [Section No. 130.12]****130.12** Cutting, Removing, or Rerouting of Electrical Conductors and Circuit Parts .

Where conductors and circuit parts are de-energized in order to cut, remove, ~~reroute,~~ or ~~reroute~~ otherwise work on them and the conductor terminations or circuit parts are not within sight from the point of work, such as where the electrical conductors or circuit parts are remote from the source of supply in a junction or pull box, additional steps to verify absence of voltage or identify the electrical conductors and circuit parts shall be taken prior to cutting, removing, ~~rerouting,~~ or ~~rerouting~~ otherwise work on the conductors and circuit parts .

Informational Note No. 1 : Additional steps to be taken where conductors are de-energized in order to cut, remove, or reroute them include, but are not limited to, remotely spiking the conductors, pulling conductors to visually verify movement, remotely cutting the conductors, or other approved methods. Nonshielded conductors could be additionally verified with a noncontact test instrument, and shielded conductors could be verified with devices that identify the conductors.

Informational Note No. 2: Note that de-energizing is only one of several steps in lockout/tagout procedures and in establishing an electrically safe work condition.

Statement of Problem and Substantiation for Public Input

This revision revises the requirement to parallel the text of other 70E requirements such as in 110.2. and 110.3 where the phrase "electrical conductors and circuit parts" is used. The requirement is also revised to include any work that occurs where an electrically safe work condition has not not been established, not only cutting, removing, or rerouting conductors. In addition, an additional informational note is added to provide the critical distinction that de-energizing as used in 110.12 is clearly not the same as electrical conductors and circuit parts being under lockout/tagout or an electrically safe work condition being established. See 120.4(B)(1) as an example of de-energizing being one step in lockout/tagout procedures. Also see 1910.333(b)(1) from OSHA 29 CFR Part 1910 where 1910.333(b)(1) it states, in part that "conductors and parts of electric equipment that have been deenergized but have not been locked out or tagged in accordance with paragraph (b) of this section shall be treated as energized parts, and paragraph (c) of this section applies to work on or near them." This essentially means that deenergized electrical conductors and circuit parts must be treated as energized electrical conductors and circuit parts if they are merely deenergized and not locked out or tagged out..

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Committee: EEW-AAA

**Public Input No. 197-NFPA 70E-2021 [Section No. 200.1]****200.1** Scope.

Chapter 2 addresses the requirements that follow.

- (1) Chapter 2 covers practical safety-related maintenance requirements for electrical equipment and installations in workplaces as included in 90.2. These requirements identify only that maintenance directly associated with employee safety.
- (2) Chapter 2 does not prescribe specific maintenance methods or testing procedures. It is left to the employer to choose from the various maintenance methods available to satisfy the requirements of Chapter 2.
- (3) For the purpose of Chapter 2, maintenance shall be defined as preserving or restoring the condition of electrical equipment and installations, or parts of either, for the safety of employees who work where exposed to electrical hazards. Repair or replacement of individual portions or parts of equipment shall be permitted without requiring modification or replacement of other portions or parts that are in a safe condition.

Informational Note: ~~Refer to NFPA 70B~~ See NFPA 70B , *Recommended Practice for Electrical Equipment Maintenance*; ANSI/NETA MTS, *Standard for Maintenance Testing Specifications for Electrical Power Distribution Equipment and Systems*; and IEEE 3007.2, *Recommended Practice for the Maintenance of Industrial and Commercial Power Systems*, for guidance on maintenance frequency, methods, and tests.

Statement of Problem and Substantiation for Public Input

Revised Informational Note to align language with other Informational Notes and to comply with new 2020 NEC Style Manual.

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

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**Public Input No. 230-NFPA 70E-2021 [Article 205]****Article 205** General Maintenance Requirements

205.1–1 Scope. This article covers general maintenance requirements and testing that are performed by qualified persons.

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.

205.2–3 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.

205.3–4 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.

205.4–5 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.

205.5–6 Spaces About Electrical Equipment.

All working space and clearances required by electrical codes and standards shall be maintained.

Informational Note: For further information concerning spaces about electrical equipment, see Article 110, Parts II and III, of *NFPA 70, National Electrical Code*.

205.6–7 Grounding and Bonding.

Equipment, raceway, cable tray, and enclosure bonding and grounding shall be maintained to ensure electrical continuity.

205.7–8 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.

205.8–9 Safety Equipment.

Locks, interlocks, and other safety equipment shall be maintained in proper working condition to accomplish the control purpose.

205.9–10 Clear Spaces.

Access to working space and escape passages shall be kept clear and unobstructed.

205.10–11 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.

205.11–12 Warning Signs.

Warning signs, where required, shall be visible, securely attached, and maintained in legible condition.

205.12–13 Identification of Circuits.

Circuit or voltage identification shall be securely affixed and maintained in updated and legible condition.

205.13–14 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.

205.14–15 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.

205.15– 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.

Statement of Problem and Substantiation for Public Input

In accordance with Section 2.2.1 of the 2020 NEC Style Manual, the first section of an article is required to be the scope.

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

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

Statement of Problem and Substantiation for Public Input

Add new section 205.1 Scope. Renumber subsequent sections.

2.2.1 of the new 2020 NEC Style Manual requires each article to have a scope, which shall be the first section of the article.

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**Public Input No. 198-NFPA 70E-2021 [Section No. 205.5]****205.5 Spaces About Electrical Equipment.**

All working space and clearances required by electrical codes and standards shall be maintained.

Informational Note: ~~For further information concerning spaces about electrical equipment, see See Article 110, Parts II and III, of NFPA 70, National Electrical Code.~~ for further information concerning spaces about electrical equipment,

Statement of Problem and Substantiation for Public Input

Revised Informational Note to comply with new 2020 NEC Style Manual.

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

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

Article 210 Substations, Switchgear Assemblies, Switchboards, Panelboards, Motor Control Centers, and Disconnect Switches

210.4– 1 Scope. This article covers general maintenance requirements for substations, switchgear assemblies, switchboards, panelboards, motor control centers, and disconnect switches.

210.2 Enclosures.

Enclosures shall be kept free of material that would expose employees to an electrical hazard.

210.2– 3 Area Enclosures.

Fences, physical protection, enclosures, or other protective means, where required to guard against unauthorized access or unintentional contact with exposed energized conductors and circuit parts, shall be maintained.

210.3– 4 Conductors.

Current-carrying conductors (buses, switches, disconnects, joints, and terminations) and bracing shall be maintained to perform as follows:

- (1) Conduct rated current without overheating
- (2) Withstand available fault current

210.4– 5 Insulation Integrity.

Insulation integrity shall be maintained to support the voltage impressed.

210.5– 6 Protective Devices.

Protective devices shall be maintained to adequately withstand or interrupt available fault current.

Informational Note: Improper or inadequate maintenance can result in increased opening time of the overcurrent protective device, thus increasing the incident energy.

Statement of Problem and Substantiation for Public Input

In accordance with Section 2.2.1 of the 2020 NEC Style Manual, the first section of an article is required to be the scope.

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Submittal Date: Wed May 26 08:39:15 EDT 2021

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

210.1 Scope

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

Statement of Problem and Substantiation for Public Input

Add new section 210.1 Scope. Renumber subsequent sections.

2.2.1 of the new 2020 NEC Style Manual requires each article to have a scope, which shall be the first section of the article.

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Committee: EEW-AAA

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

215.4— 1. Scope.

This article covers general maintenance requirements 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.

215.2— 3 Open Wiring Protection.

Open wiring protection, such as location or barriers, shall be maintained to prevent unintentional contact.

215.3— 4 Raceways and Cable Trays.

Raceways and cable trays shall be maintained to provide physical protection and support for conductors.

Statement of Problem and Substantiation for Public Input

In accordance with Section 2.2.1 of the 2020 NEC Style Manual, the first section of an article is required to be the scope.

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

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

Statement of Problem and Substantiation for Public Input

Add new section 215.1 Scope. Renumber subsequent sections.

2.2.1 of the new 2020 NEC Style Manual requires each article to have a scope, which shall be the first section of the article.

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Committee: EEW-AAA

**Public Input No. 135-NFPA 70E-2021 [Section No. 220.1]****220.1** Scope.

This article ~~shall apply to~~ contains specific safety-related maintenance practices for controllers, ~~including~~ which includes electrical equipment that governs the starting, stopping, direction of motion, acceleration, speed, and protection of rotating equipment and other power utilization apparatus in the workplace.

Statement of Problem and Substantiation for Public Input

Modified existing scope statement to be consistent with the other proposed scope statements in Chapter 2 and to remove requirement.

2.2.1 of the new 2020 NEC Style Manual requires each article to have a scope, which shall be the first section of the article.

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

225.1 Scope

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

Statement of Problem and Substantiation for Public Input

Add new section 225.1 Scope. Renumber subsequent sections

2.2.1 of the new 2020 NEC Style Manual requires each article to have a scope, which shall be the first section of the article.

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

230.4-1 Scope.

This article covers general maintenance requirements for fuses and circuit breakers.

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.

230.2-3 Guards, Barriers, and Access Plates.

Guards, barriers, and access plates shall be maintained to prevent employees from contacting moving or energized parts.

Statement of Problem and Substantiation for Public Input

In accordance with Section 2.2.1 of the 2020 NEC Style Manual, the first section of an article is required to be the scope.

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

230.1 Scope

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

Statement of Problem and Substantiation for Public Input

Add new section 230.1 Scope. Renumber subsequent sections.

2.2.1 of the new 2020 NEC Style Manual requires each article to have a scope, which shall be the first section of the article.

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**Public Input No. 138-NFPA 70E-2021 [Section No. 235.1]****235.1 Scope.**

This article ~~covers maintenance requirements in~~ contains 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.

Statement of Problem and Substantiation for Public Input

Revised existing 235.1 Scope to align with other proposed scope statements in Chapter 2.

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Submittal Date: Sat May 22 22:15:12 EDT 2021

Committee: EEW-AAA

**Public Input No. 157-NFPA 70E-2021 [Section No. 235.2]****235.2 Maintenance Requirements for Hazardous (Classified) Locations.**

Equipment and installations in these locations shall be maintained such that the following criteria are met:

- (1) No energized parts are exposed.

Exception to (1): Intrinsically safe and nonincendive circuits shall be permitted to be exposed .

- (2) There are no breaks in conduit systems, fittings, or enclosures from damage, corrosion, or other causes.
- (3) All bonding jumpers are securely fastened and intact.
- (4) All fittings, boxes, and enclosures with bolted covers have all bolts installed and bolted tight.
- (5) All threaded conduit are wrenchtight and enclosure covers are tightened in accordance with the manufacturer's instructions.
- (6) There are no open entries into fittings, boxes, or enclosures that would compromise the protection characteristics.
- (7) All close-up plugs, breathers, seals, and drains are securely in place.
- (8) Marking of luminaires (lighting fixtures) for maximum lamp wattage and temperature rating is legible and not exceeded.
- (9) Required markings are secure and legible.

Statement of Problem and Substantiation for Public Input

Added "...shall be permitted to be exposed."

3.1.4.1 of the new 2020 NEC Style Manual requires Exceptions to be written in complete sentences.

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**Public Input No. 234-NFPA 70E-2021 [Article 240]****Article 240** Batteries and Battery Rooms240.1— 1 Scope.

This article covers general maintenance requirements 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.

240.2— 3 Eye and Body Wash Apparatus.

Eye and body wash apparatus shall be maintained in operable condition.

Statement of Problem and Substantiation for Public Input

In accordance with Section 2.2.1 of the 2020 NEC Style Manual, the first section of an article is required to be the scope.

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

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

Statement of Problem and Substantiation for Public Input

Add new section 240.1 Scope. Renumber subsequent sections.

2.2.1 of the new 2020 NEC Style Manual requires each article to have a scope, which shall be the first section of the article.

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**Public Input No. 235-NFPA 70E-2021 [Article 245]****Article 245** Portable Electric Tools and Equipment245.1 Scope.

This article covers general maintenance requirements for portable electric 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.

Statement of Problem and Substantiation for Public Input

In accordance with Section 2.2.1 of the 2020 NEC Style Manual, the first section of an article is required to be the scope.

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

245.1 Scope

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

Statement of Problem and Substantiation for Public Input

Add new section 245.1 Scope. Renumber subsequent sections.

2.2.1 of the new 2020 NEC Style Manual requires each article to have a scope, which shall be the first section of the article.

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**Public Input No. 236-NFPA 70E-2021 [Article 250]****Article 250** Personal Safety and Protective Equipment250.1– 1 Scope.

This article covers general maintenance requirements 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 leather 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

250.2– 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 250.1(1) through 250.1(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.

250.3– 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: Guidance for inspecting and testing safety grounds is provided in ASTM F2249, *Standard Specification for In-Service Test Methods for Temporary Grounding Jumper Assemblies Used on De-energized Electric Power Lines and Equipment*.

(C) Grounding and Testing Devices.

Grounding and testing devices shall be stored in a clean and dry area. Grounding and testing devices shall be properly inspected and tested before each use.

Informational Note: Guidance for testing of grounding and testing devices is provided in Section 9.5 of IEEE C37.20.6, *Standard for 4.76 kV to 38 kV Rated Ground and Test Devices Used in Enclosures*.

250.4– 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 110.8(E).

Statement of Problem and Substantiation for Public Input

In accordance with Section 2.2.1 of the 2020 NEC Style Manual, the first section of an article is required to be the scope.

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Submittal Date: Wed May 26 09:19:54 EDT 2021

Committee: EEW-AAA

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

This article contains specific inspection, testing and maintenance practices for personal safety and protective equipment.

Statement of Problem and Substantiation for Public Input

Add new section 250.1 Scope. Renumber subsequent sections.

2.2.1 of the new 2020 NEC Style Manual requires each article to have a scope, which shall be the first section of the article.

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Committee: EEW-AAA

**Public Input No. 29-NFPA 70E-2020 [Section No. 250.2(B)]****(B) Testing.**

The insulation of protective equipment and protective tools, such as items specified in 250.1(1) through 250.1(14), that is used as primary protection from electric 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.

Statement of Problem and Substantiation for Public Input

"electric" is added before "shock" to read "electric shock" to correlate with the use of "electric shock" in the definition of "electrical hazard", Boundary, Restricted Approach, numerous existing locations in 130.7, as well as to clarify that the type of shock hazard being addressed is a shock hazard rather than others forms of shock such as where one would go into shock due to a severe injury or a reaction associated with fright.

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.

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

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 15-NFPA 70E-2020 [Definition: Shock Hazard.]	Related issue.
Public Input No. 28-NFPA 70E-2020 [Section No. 130.7]	Related issue.
Public Input No. 30-NFPA 70E-2020 [Chapter 3]	

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**Public Input No. 199-NFPA 70E-2021 [Section No. 250.3(B)]****(B) Testing.**

Prior to being returned to service, temporary protective grounding equipment that has been repaired or modified shall be tested. Temporary protective grounding equipment shall be tested as service conditions require.

Informational Note: ~~Guidance for inspecting and testing safety grounds is provided in.~~ See ASTM F2249, *Standard Specification for In-Service Test Methods for Temporary Grounding Jumper Assemblies Used on De-energized Electric Power Lines and Equipment*. for guidance on inspecting and testing safety grounds is provided in

Statement of Problem and Substantiation for Public Input

Revised Informational Note to comply with new 2020 NEC Style Manual.

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

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Committee: EEW-AAA

**Public Input No. 200-NFPA 70E-2021 [Section No. 250.3(C)]****(C) Grounding and Testing Devices.**

Grounding and testing devices shall be stored in a clean and dry area. Grounding and testing devices shall be properly inspected and tested before each use.

Informational Note: ~~Guidance for testing of grounding and testing devices is provided in~~ See Section 9.5 of IEEE C37.20.6, *Standard for 4.76 kV to 38 kV Rated Ground and Test Devices Used in Enclosures*: for guidance on testing of grounding and testing devices is provided in

Statement of Problem and Substantiation for Public Input

Revised Informational Note to comply with new 2020 NEC Style Manual.

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

Submitter Information Verification

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Committee: EEW-AAA

**Public Input No. 30-NFPA 70E-2020 [Chapter 3]****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. 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 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.

Article 310 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.

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- an electric 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.**(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.

(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.**(A)** Qualified Persons.**(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- an electric 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

(2) Qualified Persons.

Qualified persons shall be permitted to work within the cell line working zone.

(B) Unqualified Persons.

(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.

(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.**(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-~~ Electric shock hazards are related to current through the body, producing possible injury or damage to health. ~~Shock-~~ Electric 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.

(B) Signs.

Permanent signs shall clearly designate electrolytic cell areas.

(C) Arc Flash Risk Assessment.

The requirements of 130.5, Arc Flash Risk Assessment, shall not be required for electrolytic cell line working zones.

(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

(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.

(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.

(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.

(D) Safeguards.

Safeguards shall include one or a combination of the following means.

(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.

(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.

(3) Barriers.

Barriers shall be devices that prevent contact with energized or grounded surfaces that could present an electrical hazard.

(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.

(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.

(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~~ electric 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.

(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.

(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.

(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.

(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

(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.

(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

(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.

(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.

(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.

(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 320 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 50 volts, nominal.

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.

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.**(A) General Safety Hazards.****(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.

(2) Battery Risk Assessment.

Prior to any work on a battery system, a risk assessment shall be performed to identify the chemical, ~~electrical~~ electric 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.

(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 electric 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: 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*.

(6) Warning Signs.

The following warning signs or labels shall be posted in appropriate locations:

- (1) Electrical hazard warnings indicating the electric 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(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:

- (3) Potential presence of explosive gas (when applicable to the battery type)
- (4) Prohibition of open flame and smoking
- (5) Danger of chemical burns from the electrolyte (when applicable to the battery type)

- (6) Notice for personnel to use and wear protective equipment and apparel appropriate to the hazard for the battery
- (7) 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: 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*.

(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 handles listed as insulated for the maximum working voltage.

(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 110.5(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.

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.

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.**(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.

(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.**(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 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.**(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 120.1, 120.2, and 110.3.

(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 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:
 - (6) Motor drives
 - (7) Uninterruptible power supply systems
 - (8) 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~~ electric 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:
 - (6) Radar equipment
 - (7) Radio communication equipment, including broadcast transmitters
 - (8) Satellite-earth-transmitters
 - (9) Industrial scientific and medical equipment
 - (10) RF induction heaters and dielectric heaters
 - (11) Industrial microwave heaters and diathermy radiators

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.

350.2 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.

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 110.5(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.

(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: Refer to 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 Energy Thresholds.

Energy exposure levels shall not exceed those identified in the following list unless appropriate controls are implemented as approved by the ESA:

- (1) AC: 50 volts and 5 milliamperes
- (2) DC: 100 volts and 40 milliamperes

Informational Note No. 1: This information is extracted from the 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.

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: 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.**(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 110.5(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 than 100 joules.
- (3) ~~Shock~~ Electric shock hazard. The appropriate electric 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).

(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 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.

(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 Input

"electric" is added before "shock" to read "electric shock" to distinguish electric shock from the type of shock used in Article 360 including within the definition of Arc Blast Hazard (A source of possible injury or damage to health from the energy deposited into acoustical shock-wave and high-velocity shrapnel.), and to correlate with the use of "electric shock" in the definition of "electrical hazard", Boundary, Restricted Approach, numerous existing locations in 130.7. In addition, several occurrences of "electrical" were revised to "electric" for consistency and correlation.

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 15-NFPA 70E-2020 [Definition: Shock Hazard.]	Related issue.
Public Input No. 29-NFPA 70E-2020 [Section No. 250.2(B)]	Related issue.
Public Input No. 28-NFPA 70E-2020 [Section No. 130.7]	Related issue.
Public Input No. 15-NFPA 70E-2020 [Definition: Shock Hazard.]	
Public Input No. 31-NFPA 70E-2020 [Section No. C.1.1]	
Public Input No. 32-NFPA 70E-2020 [Section No. E.1]	
Public Input No. 33-NFPA 70E-2020 [Annex F]	
Public Input No. 34-NFPA 70E-2020 [Section No. H.3]	
Public Input No. 35-NFPA 70E-2020 [Section No. J.1]	
Public Input No. 36-NFPA 70E-2020 [Section No. I.1]	
Public Input No. 38-NFPA 70E-2020 [Annex O]	
Public Input No. 39-NFPA 70E-2020 [Annex R]	

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Public Input No. 279-NFPA 70E-2021 [New Section after 300.3]

DC Approach Boundaries

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Table 300. Shock Protection Approach Boundaries to Exposed Energized Electrical Conductors or Circuit Parts for Direct-Current Voltage Systems

(1)	(2)	(3)	(4)
<u>Nominal Potential Difference</u>	<u>Limited Approach Boundary</u>		<u>Restricted Approach Boundary; Includes Inadvertent Movement Adder</u>
	<u>Exposed Movable Conductor*</u>	<u>Exposed Fixed Circuit Part</u>	
Less than 100 V	Not specified	Not specified	Not specified
100 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 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 Input**

See justification for removing the dc Approach Boundary Table out of Article 130. It is more appropriate to place this table in Chapter 3, as Articles 310, 320, 330, 340, 350, and 360 cover dc electrical hazards for specialized electrical equipment, and modify the requirements in Chapter 1.

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**Public Input No. 201-NFPA 70E-2021 [Section No. 310.1]****310.1 Scope.**

The requirements of this article shall apply to the electrical safety-related work practices used in the types of electrolytic cell areas.

Informational Note No. 1: See Informative Annex L for a typical application of safeguards in the cell line working zone.

Informational Note No. 2: ~~For further information about electrolytic cells, see~~ See NFPA 70, National Electrical Code, Article 668 668 for further information about electrolytic cells .

Informational Note No. 3: ~~For~~ See IEEE 463, Electrical Safety Practices in Electrolytic Cell Line Working Zones 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~~ .

Statement of Problem and Substantiation for Public Input

Revised Informational Note to comply with new 2020 NEC Style Manual.

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

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**Public Input No. 120-NFPA 70E-2021 [Section No. 310.2]****310.2– Definitions.**

For the purposes of this article, the definitions that follow shall apply.

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.

Statement of Problem and Substantiation for Public Input

Relocate definitions in 310.2 to Article 100. At the end of each definition moving from 310.2 to Article 100, add "(310)" at the end of each definition.

2.2.2 of the new 2020 NEC Style manual require locating all definitions of terms used in the requirements of the document in Article 100.

2.2.2.3.2 of the new 2020 NEC Style manual indicates where definitions apply to only one article, the article number in parenthesis should follow the definition.

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 126-NFPA 70E-2021 [Global Input]	
Public Input No. 126-NFPA 70E-2021 [Global Input]	

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**Public Input No. 202-NFPA 70E-2021 [Section No. 320.1]****320.1 Scope.**

This article covers electrical safety requirements for the practical safeguarding of employees while working with exposed stationary storage batteries that exceed 50 volts, nominal.

Informational Note: - ~~For~~ See the following documents f or 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

Statement of Problem and Substantiation for Public Input

Revised Informational Note to comply with new 2020 NEC Style Manual and to align with the language in other Informational Notes.

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

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Committee: EEW-AAA

**Public Input No. 267-NFPA 70E-2021 [Section No. 320.1]****320.1 Scope.**

This article covers electrical safety requirements for the practical safeguarding of employees while working with exposed stationary storage batteries that exceed 50 volts, nominal.

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
- (13) NFPA 855, *Standard for the Installation of Stationary Energy Storage Systems*, 2020
- (14) UL 9540, *Energy Storage Systems and Equipment*, 2020
- (15) UL 9540A, *Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems*, 2019

Statement of Problem and Substantiation for Public Input

NFPA 855 is the standard for the installation of stationary energy storage systems. NFPA 855 contains the requirements for the installation, operation, testing and maintenance of energy storage systems including battery type energy storage systems. UL 9540 is the product safety standard for energy storage systems including battery type energy storage systems, while UL 9540A reflects the test method.

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Committee: EEW-AAA

**Public Input No. 280-NFPA 70E-2021 [Section No. 320.1]****320.1 Scope.**

This article covers electrical safety requirements for the practical safeguarding of employees while working with exposed stationary storage batteries that exceed ~~50 volts~~ 100 volts , nominal, or exceeds 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

Statement of Problem and Substantiation for Public Input

Change 50 volts to 100 volts to be consistent with the rest of Article 320, e.g., 320.3(A)(1) Energy Thresholds.

Thermal hazard has been weakly covered by NFPA 70E (see Article 110.4(C) Equipment Operating at Less Than 50 Volts).

The primary electrical hazard for batteries less than 100 volts dc is the Thermal Hazard. A safety threshold of 1000 W has been published previously. See definition proposed in Article 320.2.

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Committee: EEW-AAA

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

For the purposes of this article definitions that follow shall apply.

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.”)

Statement of Problem and Substantiation for Public Input

Relocate definitions in 320.2 to Article 100. At the end of each definition moving from 320.2 to Article 100, add “(320)” at the end of each definition.

2.2.2 of the new 2020 NEC Style manual require locating all definitions of terms used in the requirements of the document in Article 100.

2.2.2.3.2 of the new 2020 NEC Style manual indicates where definitions apply to only one article, the article number in parenthesis should follow the definition.

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 126-NFPA 70E-2021 [Global Input]	
Public Input No. 126-NFPA 70E-2021 [Global Input]	

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Committee: EEW-AAA

**Public Input No. 90-NFPA 70E-2021 [Definition: Nominal Voltage.]****Nominal Voltage (as applied to cell or battery) .**

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.

Informational Note: The most common nominal cell voltages are 2 volts per cell for the 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 Input

To clarify and bring the definition up-to-date with, and to reflect, current battery technologies; two revisions should be made. First, guidance information should be added as an Informational Note (IFN) to provide clarity on the expected voltage range for Li-ion batteries that are recognized to be properly 3.2-3.8 volts to reflect current battery technologies. Secondly, the definition should be qualified with addition of "(as applied to battery or cell)" to the defined term to distinguish this 320.2 definition from the current Article 100 definition for "nominal voltage". These two definitions would then complement one another and be in harmony with related proposals to revise definitions in NFPA 70 (NEC) standard.

Related Public Inputs for This Document**Related Input**

Public Input No. 88-NFPA 70E-2021 [Definition: Voltage, Nominal.]

Public Input No. 88-NFPA 70E-2021 [Definition: Voltage, Nominal.]

Relationship

related definitions

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

a new definition to be inserted

Thermal 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. This hazard may exist at any voltage.

Statement of Problem and Substantiation for Public Input

Chapter 1 primarily deals with 60 Hz power delivery. In general, systems below 50 volts ac are current limited, as most are control circuits. However, in special equipment, such as batteries, welders, magnet systems, furnaces, etc., it is common to have a dc source with no shock or arc flash hazards that have moderate to extreme high current hazards, known as a thermal hazard. Most all batteries larger than about a brick has short circuit current in the order of several 100 amps, and present a substantial thermal hazard due to short circuit through jewelry, watches, or tools.

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**Public Input No. 203-NFPA 70E-2021 [Section No. 320.3(A)(1)]****(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~~ See DOE-HDBK-1092, Department of Energy (DOE) Electrical Safety Handbook, DOE-HDBK-1092, ~~from which this information was extracted.~~

Statement of Problem and Substantiation for Public Input

Revised Informational Note to comply with new 2020 NEC Style Manual.

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

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**Public Input No. 283-NFPA 70E-2021 [Section No. 320.3(A)(1)]****(1) ~~Energy Thresholds~~ Electrical Injury Thresholds .**

~~Energy exposure~~ Exposure levels shall not exceed those identified in the following list unless appropriate controls are implemented:

(1) AC: 50 volts and 5 milliamperes

(2) DC: 100 volts and 40 milliamperes

(3) 1000 watts short circuit power

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

Statement of Problem and Substantiation for Public Input

The thresholds given are NOT energy. Energy involves time and is measured in joules.

The voltage and current thresholds are for electrical injury.

Adding "40 milliamperes" as a part of the dc shock threshold makes this consistent with the rest of Chapter 3.

The threshold of the thermal hazard is added.

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**Public Input No. 204-NFPA 70E-2021 [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, electrical shock, and arc flash hazards and assess the risks associated with the type of tasks to be performed.

Informational Note: ~~For See F.7 and Figure F.7 in Informative Annex F for an example of a risk assessment method for work on batteries, see F.7 and Figure F.7 in Informative Annex F.~~

Statement of Problem and Substantiation for Public Input

Revised Informational Note to comply with new 2020 NEC Style Manual.

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

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Committee: EEW-AAA

**Public Input No. 284-NFPA 70E-2021 [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: For an example of a risk assessment method for work on batteries, see F.7 and Figure F.7 in Informative Annex F.

Statement of Problem and Substantiation for Public Input

adds the thermal hazard defined above and discusses below, in Article 320.3 Safety Procedures

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**Public Input No. 205-NFPA 70E-2021 [Section No. 320.3(A)(5)]****(5) Abnormal Battery Conditions.**

Instrumentation that provides alarms for early warning of abnormal conditions of battery operation, if present, shall be tested annually.

Informational Note: See IEEE 1491, Guide for the Selection and Use of Battery Monitoring Equipment in Stationary Applications for guidance on monitoring battery 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 -~~

Statement of Problem and Substantiation for Public Input

Revised Informational Note to comply with new 2020 NEC Style Manual.

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

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Committee: EEW-AAA

**Public Input No. 206-NFPA 70E-2021 [Section No. 320.3(B)(1)]****(1) Battery Activities That Include Handling of Liquid Electrolyte.**

The following protective equipment shall be available to employees performing any type of service on a battery with liquid electrolyte:

- (1) Goggles and face shield appropriate for the electrical hazard and the chemical hazard
- (2) Gloves and aprons appropriate for the chemical hazards
- (3) Portable or stationary eye wash facilities and equipment within the work area that are capable of drenching or flushing of the eyes and body for the duration necessary to mitigate injury from the electrolyte hazard.

~~Informational Note: Guidelines for the use and maintenance of eye wash facilities for vented batteries in nontelecom environments can be found in See ANSI/ISEA Z358.1, American National Standard for Emergency Eye Wash and Shower Equipment for guidelines on the use and maintenance of eye wash facilities for vented batteries in non-telecom environments .~~

Statement of Problem and Substantiation for Public Input

Revised Informational Note to comply with new 2020 NEC Style Manual.

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

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Committee: EEW-AAA

**Public Input No. 285-NFPA 70E-2021 [Section No. 320.3(C)(1)]****(1) Handles.**

Tools and equipment for work on batteries shall be equipped with handles ~~listed~~ rated as insulated for the maximum working voltage. Tools shall be designed to prevent a short circuit from battery terminal to terminal, or buss to buss, by limiting the tool length, or insulating the handle.

Statement of Problem and Substantiation for Public Input

Most battery tools are not "listed" since the typical voltage for working on a single cell is 2.8 volts dc, and for working on a battery pack is 12.8 volts dc. This section adds the design requirements typical to prevent a short circuit through the tool.

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Committee: EEW-AAA

**Public Input No. 207-NFPA 70E-2021 [Section No. 330.1]****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~~ See ANSI Z136.1, *Standard for Safe Use of Lasers* ~~for recommendations on laser safety requirements for laser use~~.

Informational Note No. 2: ~~For laser product requirements for laser manufacturers, see~~ See 21 CFR Part 1040, "Performance Standards for Light-Emitting Products," Sections 1040.10 "Laser products" and 1040.11, "Specific purpose laser products." ~~products" for laser product requirements for laser manufacturers.~~

Statement of Problem and Substantiation for Public Input

Revised Informational Note to comply with new 2020 NEC Style Manual.

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

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Committee: EEW-AAA

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

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.

Statement of Problem and Substantiation for Public Input

Relocate definitions in 330.2 to Article 100. At the end of each definition moving from 330.2 to Article 100, add "(330)" at the end of each definition.

2.2.2 of the new 2020 NEC Style manual require locating all definitions of terms used in the requirements of the document in Article 100. 2.2.2.3.2 of the new 2020 NEC Style manual indicates where definitions apply to only one article, the article number in parenthesis should follow the definition.

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 126-NFPA 70E-2021 [Global Input]	
Public Input No. 126-NFPA 70E-2021 [Global Input]	

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Committee: EEW-AAA

**Public Input No. 325-NFPA 70E-2021 [Section No. 330.3]****330.3 Hazardous Energy.****(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.

(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.

Electrical Injury Thresholds.

Exposure levels shall not exceed those identified in the following list unless appropriate controls are implemented as approved by the ESA (see Article 350):

- (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: 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.

Statement of Problem and Substantiation for Public Input

This section was inconsistent in format and content with Articles 350 and 360. It is now consistent.

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**Public Input No. 287-NFPA 70E-2021 [Section No. 330.4(B)]****(B) Electrical Safety Training for Work on or with Lasers.**

Training in electrical safe work practices shall include, but is not limited to, the following:

- (1) Chapter 1 electrical safe work practices
- (2) Electrical hazards associated with laser equipment
- (3) Stored energy hazards, including capacitors and capacitor bank explosion potential banks
- (4) Ionizing radiation ~~(including X-ray hazards from high-voltage equipment (>5 kV)~~
- (5) rays for > 10 kV in vacuum
- (6) Assessing the listing status of electrical equipment and the need for field evaluation of nonlisted equipment

Statement of Problem and Substantiation for Public Input

item 3 - lasers can have a single capacitor, several capacitors, or capacitor banks. "explosion potential" is vague. This hazard is now adequately covered in Article 360.

Item 4 and 5 were redundant. X-rays are one frequency of Ionizing Radiation. You can NOT make x-rays above 5 kV in air. That would make every power supply over 5 kV an x-ray hazard. They are NOT. X-rays are created from high voltage in vacuum due to acceleration of electrons which create Bremsstrahlung radiation when the electrons hit materials. It requires at least 10 kV and 10 mA in a vacuum to create x-rays that will penetrate the vacuum enclosure (metal or glass). 10 kV is used as the lower limit for a possible hazard. High voltage in air causes air breakdown (corona) long before electrons can reach a velocity to make x-rays. Thus, X-rays can NOT be generated in air, from man-made electrical systems (lightning creates a low level of x-rays).

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**Public Input No. 339-NFPA 70E-2021 [Section No. 330.5(E)]**

(E) Listing.

Laser system electrical equipment shall containing electrical hazards shall be listed or field evaluated prior to use.

Statement of Problem and Substantiation for Public Input

Laser pointers do not contain electrical hazards and do not need to be listed.

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Committee: EEW-AAA

**Public Input No. 208-NFPA 70E-2021 [Section No. 340.1]****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:
 - (6) Motor drives
 - (7) Uninterruptible power supply systems
 - (8) Lighting controllers

Informational Note: ~~The following standards provide specific guidance for safety-related work practices around power electronic equipment: See 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*.~~ for standards that provide specific guidance for safety-related work practices around power electronic equipment.

Statement of Problem and Substantiation for Public Input

TerraView error. Only change is to relocate reference to front of Informational Note.

Revised Informational Note to comply with new 2020 NEC Style Manual.

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

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**Public Input No. 335-NFPA 70E-2021 [Section No. 340.1]****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:
 - (6) Motor drives
 - (7) Uninterruptible power supply systems
 - (8) Lighting controllers

Informational Note: The following standards provide specific guidance for safety-related work practices around power electronic equipment: 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, 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*.

Statement of Problem and Substantiation for Public Input

Adding the key reference for exposure to Nonionizing Fields, for the US.

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Submittal Date: Tue Jun 01 14:47:26 EDT 2021
Committee: EEW-AAA

**Public Input No. 363-NFPA 70E-2021 [Section No. 340.1]****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~~ Equipment that includes rectifiers and inverters such as the following:
 - (6) Motor drives
 - (7) Uninterruptible power supply systems
 - (8) 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*.

Statement of Problem and Substantiation for Public Input

No changes are proposed to a, b, or c by this public input

Delete the word "process" in 340.1(5). Article 340 should apply to the type of equipment in a, b, or c, regardless of whether it is part of a process or not. The hazards associated with those items can exist even when there is no "process". Nothing is lost by removing the word "process".

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Submittal Date: Tue Jun 01 16:22:00 EDT 2021

Committee: EEW-AAA

**Public Input No. 123-NFPA 70E-2021 [Section No. 340.2]****340.2– Definition.**

For the purposes of this article, the definition that follows shall apply.

Radiation Worker.

A person who is required to work in electromagnetic fields, the radiation levels of which exceed those specified for nonoccupational exposure.

Statement of Problem and Substantiation for Public Input

Relocate definitions in 340.2 to Article 100. At the end of each definition moving from 340.2 to Article 100, add "(340)" at the end of each definition.

2.2.2 of the new 2020 NEC Style manual require locating all definitions of terms used in the requirements of the document in Article 100.

2.2.2.3.2 of the new 2020 NEC Style manual indicates where definitions apply to only one article, the article number in parenthesis should follow the definition.

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 126-NFPA 70E-2021 [Global Input]	
Public Input No. 126-NFPA 70E-2021 [Global Input]	

Submitter Information Verification

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Committee: EEW-AAA

**Public Input No. 296-NFPA 70E-2021 [Definition: Radiation Worker.]****Nonionizing Radiation Worker.**

A person who is required to work in electromagnetic fields, the ~~radiation levels of~~ field intensity of which exceed those specified for nonoccupational exposure.

Statement of Problem and Substantiation for Public Input

The term "Radiation Worker" is solely used throughout industry and government for those workers who work with radioactive materials and Ionizing Radiation. The term intended for this section is "Nonionizing Radiation Worker".

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Submittal Date: Tue Jun 01 11:56:30 EDT 2021

Committee: EEW-AAA



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

new definition

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 .

Statement of Problem and Substantiation for Public Input

This Article addresses both Ionizing Radiation and NonIonizing Radiation. The differences were not clear. The injury mechanisms, safety standards, training, and controls are completely different for the two hazards.

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Submittal Date: Tue Jun 01 11:59:39 EDT 2021

Committee: EEW-AAA



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

New Definition

Nonionizing Radiation. Static electric and magnetic (0 to 1 Hz), sub radiofrequency (1 Hz to 3 kHz), and radiofrequency fields (3 kHz to 300 GHz) ; and, infrared, visible light, and near UV that can ' t ionize (remove an electron) . an atom or molecule.

Statement of Problem and Substantiation for Public Input

The Article addresses both Ionizing and Nonionizing Radiation. The differences were not clear.

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Committee: EEW-AAA

**Public Input No. 338-NFPA 70E-2021 [Section No. 340.2 [Excluding any Sub-Sections]]**

For the purposes of this article, the ~~definition~~ definitions that ~~follows shall~~ follow shall apply.

Statement of Problem and Substantiation for Public Input

changed from one definition to several.

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Committee: EEW-AAA

**Public Input No. 300-NFPA 70E-2021 [Section No. 340.4]****340.4 Hazards Associated with Power Electronic Equipment.**

The employer and employees shall be aware of the hazards associated with the following:

- (1) ~~High voltages within~~ voltage dc and capacitors 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~~
~~Nonionizing RF radiation hazards from the following:~~
- (5) ~~Radar equipment~~
- (6) ~~Radio communication equipment, including broadcast transmitters~~
- (7) ~~Satellite-earth transmitters~~
- (8) Sub RF (1 to 3 kHz) and RF (3 kHz to 100 MHz) shock and burn from direct contact
- (9) RF induced shock and burn due to RF coupling into metal objects
- (10) Ionizing (e.g., X-rays) hazards from high voltage (> 10 kV) in vacuum, including magnetrons, klystrons, thyratrons, vacuum tubes, and similar high-voltage, vacuum devices
- (11) Nonionizing radiation field hazards, including static electric and magnetic fields, sub radiofrequency fields (1 Hz to 3 kHz), and radiofrequency fields (3 kHz to 300 GHz) from the following:
 - (12) Antennas and RF transmission lines
 - (13) Radar equipment
 - (14) Industrial scientific and medical equipment
 - (15) RF

induction heaters and
 - a. induction and dielectric heaters
 - b. Industrial microwave heaters and diathermy radiators
 - c. Magnetic resonance imagers (MRIs)
 - d. Large electromagnets

Statement of Problem and Substantiation for Public Input

This fixes redundancies, adds missing elements (e.g., subRF and RF shock and burn), and clarifies the hazards associated with power electronics and other similar electrical equipment.

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Submittal Date: Tue Jun 01 12:06:45 EDT 2021
Committee: EEW-AAA

**Public Input No. 328-NFPA 70E-2021 [New Section after 340.5]****insert between 340.4 and and current 340.5**

340.5 Electrical Shock Injury Thresholds. Exposure levels shall not exceed those identified in the following list unless appropriate controls are implemented:

(A) DC (0 to 1 Hz): 100 volts and 40 milliamperes

(B) 60/50 Hz power: 50 volts and 5 milliampere

(B) sub RF (1 Hz to 3 kHz, not including 60/50 Hz): 50 volts and 3 milliamperes

(C) RF (3 kHz to 100 kHz): 1 x f mA, f in kHz

(D) RF (100 kHz to 3 MHz): 100 mA

(E) RF (3 MHz to 30 MHz): 100 (f/3)*0.3, f in MHz

(F) RF (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 avaiable RF current.

Statement of Problem and Substantiation for Public Input

RF shock has been missing from NFPA 70E. Article 340, on Power Electronic Equipment, discussing Nonionizing Radiation exposure is the right place. This is based on the most recent IEEE/ANSI C95.1 standard, 2019.

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Committee: EEW-AAA



Public Input No. 304-NFPA 70E-2021 [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 research 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.

350.2 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.

350.3 Applications of Other Articles.

The electrical system for R&D and laboratory 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 laboratory, 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 laboratory, industry, laborator.y, 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 110.5(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.

(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: Refer to 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 Energy Thresholds.

Energy exposure levels shall not exceed those identified in the following list unless appropriate controls are implemented as approved by the ESA:

(1) AC: 50 volts and 5 milliamperes

(2) DC: 100 volts and 40 milliamperes

Informational Note No. 1: This information is extracted from the 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.

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*

Statement of Problem and Substantiation for Public Input

Upon creation of Article 350, titled "Safety-Related Work Requirements: Research and Development Laboratories" in the 2009 version of NFPA 70E, multiple industries lamented that we should not have narrowed it down to "R&D Laboratories", as they had similar hazards and controls that we use in research laboratories, including DC, RF, capacitors, batteries, etc. This included aluminum and steel, chemical and battery manufacturers. We have long discussed changing the title of this article and the intent to a broader application, i.e., specialized electrical equipment found in industry and research.

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Submittal Date: Tue Jun 01 12:20:00 EDT 2021

Committee: EEW-AAA



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

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.

Statement of Problem and Substantiation for Public Input

Relocate definitions in 350.2 to Article 100. At the end of each definition moving from 350.2 to Article 100, add "(350)" at the end of each definition.

2.2.2 of the new 2020 NEC Style manual require locating all definitions of terms used in the requirements of the document in Article 100. 2.2.2.3.2 of the new 2020 NEC Style manual indicates where definitions apply to only one article, the article number in parenthesis should follow the definition.

Related Public Inputs for This Document

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

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Submission Date: Sat May 22 17:21:40 EDT 2021
Committee: EEW-AAA

**Public Input No. 209-NFPA 70E-2021 [Definition: Field Evaluated.]****Field Evaluated.**

A thorough evaluation of nonlisted or modified equipment in the field that is performed by persons or parties acceptable to the authority having jurisdiction. The evaluation approval ensures that the equipment meets appropriate codes and standards, or is similarly found suitable for a specified purpose.

Informational Note 1 : ~~For~~ 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; ~~see NFPA 791, Recommended Practice and Procedures for Unlabeled Electrical Equipment Evaluation . For~~

Informational Note 2: 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; ~~see NFPA 790, Standard for Competency of Third-Party Field Evaluation Bodies .~~

Statement of Problem and Substantiation for Public Input

Revised Informational Note to comply with new 2020 NEC Style Manual.
Split existing Informational Note into two in order to provide separate references.

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

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Submittal Date: Sun May 23 15:29:54 EDT 2021
Committee: EEW-AAA

**Public Input No. 210-NFPA 70E-2021 [Section No. 350.7(A)(1)]****(1) Marking.**

Marking of equipment shall be required for, but not limited to, equipment fabricated, designed, or developed for research testing and evaluation of electrical systems. Marking shall sufficiently list all voltages entering and leaving control cabinets, enclosures, and equipment.

Caution, Warning, or Danger labels shall be affixed to the exterior describing specific hazards and safety concerns.

Informational Note: ~~Refer to~~ See ANSI Z535, *Series of Standards for Safety Signs and Tags*, for more information on precautionary marking of electrical systems or equipment.

Statement of Problem and Substantiation for Public Input

Revised Informational Note to comply with new 2020 NEC Style Manual and to align language of other Informational Notes.

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

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Committee: EEW-AAA

**Public Input No. 211-NFPA 70E-2021 [Section No. 350.9]****350.9 Energy Thresholds.**

Energy exposure levels shall not exceed those identified in the following list unless appropriate controls are implemented as approved by the ESA:

- (1) AC: 50 volts and 5 milliamperes
- (2) DC: 100 volts and 40 milliamperes

Informational Note No. 1: ~~This information is extracted from the Department of Energy, DOE Electrical Safety Handbook ; DOE See DOE -HDBK-1092, DOE Electrical Safety Handbook from which this information is extracted .~~

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 Input

Revised Informational Note to comply with new 2020 NEC Style Manual.

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

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Submittal Date: Sun May 23 15:37:09 EDT 2021

Committee: EEW-AAA

**Public Input No. 321-NFPA 70E-2021 [Section No. 350.9]****350.9** ~~Energy Thresholds~~ **Electrical Injury 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: This information is extracted from the Department of Energy, *DOEElectrical Safety Handbook*, DOE-HDBK-1092.

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 Input

The thresholds given are NOT energy. Energy involves time and is measured in joules.
The voltage and current thresholds are for electrical injury.

Submitter Information Verification

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Submittal Date: Tue Jun 01 13:14:42 EDT 2021
Committee: EEW-AAA



Public Input No. 54-NFPA 70E-2021 [New Article after 360]

Article 370

Safety-Related Requirements for Electrical Vehicles

370.1 Scope. This article covers the electrical safety-related requirements for the practical safeguarding of employees while working with electrical vehicles in areas that present an electrical hazard.

370.2 Definitions.

Electric Vehicle. An automotive-type vehicle for on-road use, such as passenger automobiles, buses, trucks, vans, neighborhood electrical vehicles, electrical motorcycles, and the like, primarily powered by an electric motor that draws current from a rechargeable storage battery, fuel cell, photovoltaic array, or other source of electric current. Plug-in hybrid vehicles (PHEV) are electrical vehicles having a second source of motive power. Off-road, self-propelled electric mobile equipment, such as industrial trucks, hoists, lifts, transports, golf carts, airline ground support equipment, tractors, boats, and the like, are not considered electric vehicles.

370.3 Electrical Safety Thresholds for Electric Vehicles

(A) This article covers all electric vehicles with sources of electric power exceeding 50 volts and that present an arc flash hazard greater than 1.2 calories/cm².

370.4 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 vehicles that exceed the voltage and arc flash hazard limits listed in 370.3 shall be qualified and shall be trained in, and familiar with, with specific hazards and controls required for safe work

(2) Unqualified persons who perform work on electrical vehicles, but not directly on electric vehicle circuits, shall be trained and familiar with any electrical safety-related work practices necessary for their safety, as well as avoidance techniques to prevent exposure to shock and arc flash hazards present on the electric vehicle.

(B) Performing Risk Assessment for Electric Vehicles. The risk assessment process for electric vehicles shall follow the overall risk assessment process in Chapter 1. Additionally, qualified personnel shall be trained on the specific electric vehicle as to its electrical hazards, exposures, and safety requirements to prevent electrical shock and arc flash exposure. This training shall incorporate guidance from the vehicle manufacturer as to unique exposures involving electrical hazard and onboard hazard reduction techniques, such as cover removal that expose main battery terminals, locally-provided battery voltage reduction switches, etc.

370.5 Establishing an Electrically Safe Work Condition for Electric Vehicles

(A) Where vehicle circuitry above the thresholds mentioned in 370.3 is provided with the ability to be placed in an electrically safe condition, the electric vehicle shall be placed in such a condition per written procedure. This procedure shall be used to document the necessary steps and sequence to de-energize the electric vehicle circuit and place the circuit in an electrically safe work condition. The written procedure shall incorporate the results of the risk assessment performed in 370.4(B) and specify the following as a minimum:

(B) Safe Work Practices. In order to place an electric vehicle circuit in a safe work condition, a qualified person shall use the appropriate safe work practices and PPE and shall apply the following process to establishing and verifying an electrically safe work condition:

(1) Determine all sources of onboard electrical supply to the specific circuit being worked on. Check manufacturer drawings, prints, and schematics, as well as provided onboard diagrams.

(2) Ensure the electric vehicle has been turned off and then open all disconnecting devices provided. These devices may be voltage dividers to reduce main battery voltage, as well as local circuit disconnects. Ensure all possible sources of power for the circuit being worked on are de-energized.

(3) Where possible, verify that onboard vehicle disconnects are fully opened by visual indicators (if provided and apply lockout/tagout devices in accordance with a documented and established electric vehicle safety policy.

(4) Verify all onboard power sources have been removed from the circuit being worked on. Before and after each verification, determine that the test instrument is operating satisfactorily through verification on a known voltage source. Be cognizant of the variety on onboard sources while performing this verification, as electric vehicles may have DC sources as well as AC sources fed via a DC to AC inverter.

370.6 Energized Work on Electric Vehicles

(A) In cases where an electrically safe work condition cannot be established, an energized work permit process in accordance with 130.2 shall be required. Examples of energized work on electric vehicles include working on the main battery supply when terminals are exposed, or working on the main disconnect cabinet where onboard main propulsion battery supply conductors are present. If required activities require crossing the restricted boundary to perform tasks such as battery terminal conductor removal or similar exposures where the electric vehicle circuit cannot be placed in an electrically safe work condition, the energized work permit shall address the increased risk of shock to the maximum voltage supplied by the electric vehicle onboard battery bank or other electrical sources. Arc flash protection shall be provided in accordance with manufacturer-provided arc flash calculation methods or arc flash calculation results and/or labels provided by the manufacturer.

Statement of Problem and Substantiation for Public Input

Work on electrical vehicles in service as of now is not covered under OSHA 1910.331-335. Neither the Department of Energy nor the

Department of Transportation currently provide regulatory oversight of workers performing troubleshooting/testing or repair of electrical vehicles. As vehicles approach 1000 VDC, a need exists to add safety protocols to NFPA 70E to provide electrical safety guidance to these workers, both "qualified" and "unqualified."

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Submittal Date: Wed Feb 24 10:05:28 EST 2021

Committee: EEW-AAA

**Public Input No. 212-NFPA 70E-2021 [Section No. 360.1]****360.1 Scope.**

This article covers the electrical safety-related requirements for the practical safeguarding of employees while working with capacitors that present an electrical hazard.

Informational Note: For See Informative Annex R , Working with Capacitors for more information on working safely with capacitors, see Informative Annex R , Working with Capacitors .

Statement of Problem and Substantiation for Public Input

Revised Informational Note to comply with new 2020 NEC Style Manual.

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

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Submittal Date: Sun May 23 15:43:33 EDT 2021

Committee: EEW-AAA

**Public Input No. 228-NFPA 70E-2021 [Section No. 360.1]****360.1 Scope.**

This article covers the electrical safety-related requirements for the practical safeguarding of employees while working with capacitors that present an electrical hazard.

Informational Note: For more information on working safely with capacitors, see Informative Annex R, Working 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 servicing the equipment.

Statement of Problem and Substantiation for Public Input

Article 360 was written for research and development laboratories where large banks of capacitors are used for pulsed power applications like linear accelerators. These are very special purpose installations and only highly qualified personnel have access to this type of equipment. These are not a part of products that are listed by a NRTL. Manufacturer's of products, like VFDs or microwaves, typically install bleeder resistors that are sized for the amount of time that it would take to remove a cover and become exposed to the terminals of the capacitors.

Another good example of where Article 360 might come into play is with Static Var Compensator applications or power factor correction installations.

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

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.

Statement of Problem and Substantiation for Public Input

Relocate definitions in 360.2 to Article 100. At the end of each definition moving from 360.2 to Article 100, add "(360)" at the end of each definition.

2.2.2 of the new 2020 NEC Style manual require locating all definitions of terms used in the requirements of the document in Article 100.

2.2.2.3.2 of the new 2020 NEC Style manual indicates where definitions apply to only one article, the article number in parenthesis should follow the definition.

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 126-NFPA 70E-2021 [Global Input]	
Public Input No. 126-NFPA 70E-2021 [Global Input]	

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Committee:	EEW-AAA

**Public Input No. 341-NFPA 70E-2021 [Definition: Bleed Resistor.]****Bleed- Resistor /Bleeder Resistor .**

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

Statement of Problem and Substantiation for Public Input

"Bleeder" is the more common term in industry, laboratories, and electronics.
It can be a single resistor or a network.

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Submittal Date: Tue Jun 01 15:06:32 EDT 2021

Committee: EEW-AAA

**Public Input No. 309-NFPA 70E-2021 [Definition: Charge Transfer.]****Charge Transfer.**

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

Statement of Problem and Substantiation for Public Input

clarification. Grammar was confusing.

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Submittal Date: Tue Jun 01 12:33:49 EDT 2021

Committee: EEW-AAA

**Public Input No. 342-NFPA 70E-2021 [Definition: Dielectric Absorption.]****Dielectric Absorption.**

The property of ~~certain~~ capacitors to recharge after being discharged.

Informational Note: A voltage recharge of up to 10 percent can from 0.02 % (polystyrene and polypropylene) up to 10 % (some electrolytics) can occur a few minutes after the grounding or shorting device has been removed.

Statement of Problem and Substantiation for Public Input

10 % is the high, for a very few capacitor types. it is typically less than 1% for most capacitors.

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Submittal Date: Tue Jun 01 15:12:42 EDT 2021

Committee: EEW-AAA

**Public Input No. 311-NFPA 70E-2021 [Definition: Discharge Time.]****Discharge Time.**

The time required to discharge a capacitor to below ~~a stored energy hazard threshold~~ electrical hazard thresholds .

Statement of Problem and Substantiation for Public Input

The statement was not accurate. It is not just a stored energy threshold, but a combination of voltage and energy. This revision clarifies the intent.

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Submittal Date: Tue Jun 01 12:35:36 EDT 2021

Committee: EEW-AAA



Public Input No. 213-NFPA 70E-2021 [Section No. 360.4(B)]

(B) Performing a Risk Assessment for Capacitors.

The risk assessment process for capacitors shall follow the overall risk assessment procedures in Chapter 1. If additional protective measures are required, they shall be selected and implemented according to the hierarchy of risk control identified in 110.5(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~~ See Informative Annex R, Working Safely with Capacitors 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.

Statement of Problem and Substantiation for Public Input

Revised Informational Note to comply with new 2020 NEC Style Manual.

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

Submitter Information Verification

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Submission Date: Sun May 23 15:46:36 EDT 2021

Committee: EEW-AAA

**Public Input No. 312-NFPA 70E-2021 [Section No. 360.4(B)]****(B) Performing a Risk Assessment for Capacitors.**

The risk assessment process for capacitors shall follow the overall risk assessment procedures in Chapter 1. If additional protective measures are required, they shall be selected and implemented according to the hierarchy of risk control identified in 110.5(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 than 100 joules. Thermal PPE can include leather gloves.
- (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 dc.
- (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.

Statement of Problem and Substantiation for Public Input

Thermal PPE may be vague to many. The example of leather gloves helps.

It is important to note that we are referring to the 100 V threshold for a dc charge on the capacitor.

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Submission Date: Tue Jun 01 12:40:07 EDT 2021

Committee: EEW-AAA

**Public Input No. 314-NFPA 70E-2021 [Section No. 360.5(B)]****(B) Safe Work Practices.**

In order to place the capacitor(s) into an electrically safe work condition, a qualified person shall use the appropriate safe work practices and PPE and shall apply the following process for establishing and verifying an electrically safe work condition:

- (1) Determine all possible sources of electrical supply to the specific equipment. Check applicable up-to-date drawings, diagrams, and identification tags.
- (2) After properly interrupting the load current, open the disconnecting device(s) for each source.
- (3) Wherever possible, visually verify that all blades of the disconnecting devices are fully open or that drawout-type circuit breakers are withdrawn to the fully disconnected position.
- (4) Apply lockout/tagout devices in accordance with a documented and established policy.
- (5) If bleed resistors or automatic discharge systems are applicable, wait the prescribed time for the capacitors to discharge to less than the thresholds in 360.3 and proceed to step (6). For systems without bleed resistors or automatic discharge systems, discharge the capacitors with an adequately rated grounding device (e.g., ground stick). Soft grounding shall be performed above 1000 joules, and remote soft grounding shall be performed above 100 kJ.
- (6) Verify that the capacitors are discharged. For capacitors less than 1000 joules, verification shall be permitted to be done either by testing or by grounding. For capacitors between 1000 joules and less than 100 kJ, verification shall be done using testing or soft grounding, then hard grounding. Above 100 kJ, an engineered and redundant system shall be used for remote testing and grounding. An adequately rated grounding device (ground stick) or portable test instrument shall be used to test between each capacitor terminal and from each terminal to ground to assure that the capacitor is de-energized.
- (7) ~~Before~~ When using a test instrument, before and after each verification procedure, 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.

Statement of Problem and Substantiation for Public Input

Clarifications in item 7.

Either a ground stick or a properly rated test instrument may be used. Item 7 implied that a test instrument must always be used.

The test instrument does not need to be tested between each use in a string of capacitors, but at the beginning of the process and at the end of the process.

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Submission Date: Tue Jun 01 12:45:51 EDT 2021

Committee: EEW-AAA

**Public Input No. 365-NFPA 70E-2021 [Section No. 360.6]****360.6 Grounding- Ground Sticks.**

~~Grounding- Ground~~ sticks shall be provided for qualified persons to safely discharge any residual stored energy contained in capacitors or to hold the capacitor potential at 0 volts. The ~~grounding- ground~~ sticks shall be designed, constructed, installed, and periodically inspected so that the full energy and voltage of the capacitors can be safely discharged.

(A) Visual Inspection.

The ground stick shall be visually inspected for defects before each use. All mechanical connections shall be examined for loose connections. Resistors shall be visually inspected for cracks or other defects and electrically tested for proper resistance. The following shall occur if defects or contamination are found:

- (1) If any defect or contamination that could adversely affect the insulating qualities or mechanical integrity of the ground stick is present, the tool shall be removed from service.
- (2) If the defect or contamination exists on the grounding stick, then it shall be replaced or repaired and tested before returning to service.
- (3) If the defect or contamination exists on the cable, then it shall be replaced or repaired and tested before returning to service.

(B) Electrical Testing.

All ground sticks shall be electrically tested as follows:

- (1) The ground stick cable shall be tested to verify that the impedance is less than 0.1 ohms to ground every 2 years.
- (2) The testing shall be documented.

Exception: The test shall be performed annually if the ground stick is utilized outdoors or in other adverse conditions.

- (3) Soft grounding (High-Z) ground sticks with resistors shall be measured and compared to the specified value before each use.

(C) Storage and Disposal.

Any residual charge from capacitors shall be removed by discharging before servicing or removal.

- (1) All uninstalled capacitors capable of storing 10 joules or greater at their rated voltage shall be short-circuited with a conductor of appropriate size.
- (2) When an uninstalled capacitor is discovered without the shorting conductor attached to the terminals, it shall be treated as energized and charged to its full rated voltage until determined safe by a qualified person.

Informational Note: A capacitor that develops an internal open circuit could retain substantial charge internally even though the terminals are short-circuited. Such a capacitor can be hazardous to transport, because the damaged internal wiring could reconnect and discharge the capacitor through the short-circuiting conductor. Any capacitor that shows a significant change in capacitance after a fault could have this problem. Action should be taken to reduce the risk associated with this hazard when it is discovered.

Statement of Problem and Substantiation for Public Input

The term "grounding" should be changed to "ground" in 3 places to be consistent with the definition of "ground stick" and how it is used in Informative Annex R.

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Submit Date: Tue Jun 01 16:25:15 EDT 2021

Committee: EEW-AAA

**Public Input No. 373-NFPA 70E-2021 [Section No. 360.6]****360.6** ~~Grounding Sticks~~ Ground Sticks .

~~Grounding 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 grounding 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 Input

to make terminology consistent throughout Article 360 and Annex R. Ground stick instead of grounding stick.

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Submission Date: Tue Jun 01 16:49:37 EDT 2021

Committee: EEW-AAA

**Public Input No. 318-NFPA 70E-2021 [New Section after 360.6(C)]****(3) Oil-filled capacitor disposal**

Any oil-filled capacitor older than 30 years may contain Polychlorinated Biphenyls (PCB), unless specifically marked as No PCB. Any PCB-labeled or unmarked older capacitor shall be treated as hazardous waste and disposed of appropriately.

Statement of Problem and Substantiation for Public Input

this is an important safety note that we left out when writing this article. PCB containing capacitors are a significant environmental contamination risk, and must be managed properly. They are commonly found throughout industry in older installations.

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Committee: EEW-AAA

**Public Input No. 333-NFPA 70E-2021 [Section No. A.3.7]****A.3.7 IEEE Publications.**

Institute of Electrical and Electronics Engineers, IEEE Operations Center, 445 Hoes Lane, P. O. Box 1331, Piscataway, NJ 08855-1331.

IEEE C37.20.7, *Guide for Testing Switchgear Rated up to 52 kV for Internal Arcing Faults*, 2007/Corrigendum 1, 2010.

ANSI/IEEE C2, *National Electrical Safety Code*, 2012, 2017.

IEEE C95.1, *IEEE Standard for Safety Levels with Respect to Human Exposure to Electric, Magnetic, and Electromagnetic Fields, 0 Hz to 300 GHz*, 2019

IEEE 4, *Standard Techniques for High Voltage Testing*, 2013.

IEEE 450, *IEEE Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications*, 2010.

IEEE 463, *Electrical Safety Practices in Electrolytic Cell Line Working Zones*, 2013.

IEEE 516, *Guide for Maintenance Methods on Energized Power Lines*, 2009.

IEEE 937, *Recommended Practice for Installation and Maintenance of Lead-Acid Batteries for Photovoltaic Systems*, 2007.

IEEE 946, *Recommended Practice for the Design of DC Auxiliary Power Systems for Generating Systems*, 2004.

IEEE 1106, *Recommended Practice for Installation, Maintenance, Testing, and Replacement of Vented Nickel-Cadmium Batteries for Stationary Applications*, 2010.

IEEE 1184, *Guide for Batteries for Uninterruptible Power Supply Systems*, 2006.

IEEE 1188, *Recommended Practice for Maintenance, Testing, and Replacement of Valve-Regulated Lead-Acid (VRLA) Batteries for Stationary Applications*, 2005 (R 2010).

IEEE 1491, *Guide for Selection and Use of Battery Monitoring Equipment in Stationary Applications*, 2012.

IEEE 1584TM, *Guide for Performing Arc Flash Hazard Calculations*, 2018.

IEEE/ASHRAE 1635, *Guide for the Ventilation and Thermal Management of Batteries for Stationary Applications*, 2018.

IEEE 1657, *Recommended Practice for Personnel Qualifications for Installation and Maintenance of Stationary Batteries*, 2009.

IEEE 3007.1, *Recommended Practice for the Operation and Management of Industrial and Commercial Power Systems*, 2010.

IEEE 3007.2, *Recommended Practice for the Maintenance of Industrial and Commercial Power Systems*, 2010.

IEEE 3007.3, *Recommended Practice for Electrical Safety in Industrial and Commercial Power Systems*, 2012.

Ammerman, R. F., Gammon, T., Sen, P. K., and Nelson, J. P., "DC-Arc Models and Incident-Energy Calculations," *IEEE Transactions on Industry Applications*, Vol. 46, No. 5, 2010.

Doan, D. R., "Arc Flash Calculations for Exposures to DC Systems," *IEEE Transactions on Industry Applications*, Vol 46, No. 6, 2010.

Doughty, R. L., T. E. Neal, and H. L. Floyd II, "Predicting Incident Energy to Better Manage the Electric Arc Hazard on 600 V Power Distribution Systems," Record of Conference Papers IEEE IAS 45th Annual Petroleum and Chemical Industry Conference, September 28–30, 1998.

Lee, R., "The Other Electrical Hazard: Electrical Arc Flash Burns," *IEEE Trans. Applications*, Vol. 1A-18, No. 3, May/June 1982.

Statement of Problem and Substantiation for Public Input

Reference for Article 340

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Submittal Date: Tue Jun 01 14:43:23 EDT 2021

Committee: EEW-AAA

**Public Input No. 263-NFPA 70E-2021 [Section No. A.3.11]****A.3.11** UL Publications.

Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.

ANSI/UL 943, *Standard for Ground-Fault Circuit Interrupters*, 2006 (R 2012).

UL 943C, *Outline of Investigation for Special Purpose Ground-Fault Circuit-Interrupters*, 2012.

UL 1436, *Outlet Circuit Testers and Other Similar Indicating Devices*, 2016.

UL 61010-1, *Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use, Part 1: General Requirements*, 2012.

UL 61010-2-033, *Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use — Part 2-033: Particular Requirements for Hand-Held Multimeters and Other Meters, for Domestic and Professional use, Capable of Measuring Mains Voltage*, 2014.

Statement of Problem and Substantiation for Public Input

definition of Ground-Fault Circuit-Interrupter and Section A.3.11.

Many years ago, UL preferred the ANSI/UL reference because there was a transition of traditional UL standards towards an ANSI standards development process.

Now, years later, a large majority of UL Standards are ANSI approved and follow the ANSI development and maintenance process. However, sometimes readers are confused because they don't understand the standards are actually UL standards, not developed by ANSI. There are many other references to standards promulgated by other standards development organizations where they are considered ANSI approved but do not include ANSI in the reference.

The terms "Standard for" or "Subject" are redundant and unnecessary. All references to UL are standards.

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 262-NFPA 70E-2021 [Definition: Ground-Fault Circuit Interrupter (GFCI).]	

Submitter Information Verification

Submitter Full Name: Kelly Nicolello

Organization: UL LLC

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Submittal Date: Mon May 31 12:52:13 EDT 2021

Committee: EEW-AAA



Public Input No. 340-NFPA 70E-2021 [Annex B]

Informative Normative Annex B Reserved

This Annex contains normative requirements.

B.1 General

Normative Annex B provides a Table that is permitted to be used in lieu of Table 130.7(C)(15)(a) in accordance with 130.7(C)(15)(a). Figure B.1 provides instructions for the use of Table B.1.

Figure B.1 Arc-Flash PPE Categories Table B.1 Flow Chart

[Figure B.1 is attached in a separate file]

Table B.1**Arc-flash PPE categories for alternating current (ac) systems**

(1) <u>Equipment</u>	(2) <u>Nominal voltage</u>	(3) <u>Upstream device at same voltage in separate compartment *</u>	(4) <u>Arc flash PPE category</u>	(5) <u>Arc-flash boundary</u>
<u>Panelboard</u> <u>Motor control center (MCC)</u> <u>Disconnect switch</u> <u>Other equipment (rated ≤ 800 A)</u> <u>Minimum working Distance: 46 cm</u>	<u>240 V</u> <u>(1 φ)</u>	<u>Transformer:</u> <u>≤ 15 kVA</u> <u>≤ 50 kVA (Z ≥ 1.8 %) or ≤ 75 kVA (Z ≥ 3%)</u> <u>≤ 250 kVA</u>	<u>N/A</u> <u>2</u> <u>4</u>	<u>< 0.46 m</u> <u>1.5 m</u> <u>3.0 m</u>
		<u>Fuses:</u> <u>≤ 150 A</u> <u>≤ 600 A</u> <u>≤ 800 A</u>	<u>N/A</u> <u>2</u> <u>4</u>	<u>< 0.46 m</u> <u>1.5 m</u> <u>3.0 m</u>
		<u>Circuit breaker with fixed or adjustable T/M or M trip unit:</u> <u>≤ 80 A</u> <u>≤ 300 A</u> <u>≤ 800 A</u>	<u>N/A</u> <u>2</u> <u>4</u>	<u>< 0.46 m</u> <u>1.5 m</u> <u>3.0 m</u>
	<u>208 V</u> <u>(3 φ)</u>	<u>Transformer:</u> <u>≤ 10 kVA</u> <u>≤ 45 kVA (3 φ) or 3 x 10 kVA (1 φ)</u> <u>≤ 150 kVA (3 φ) or 3 x 25 kVA (1 φ)</u>	<u>N/A</u> <u>2</u> <u>4</u>	<u>< 0.46 m</u> <u>2.0 m</u> <u>4.5 m</u>
		<u>Fuses:</u> <u>≤ 60 A</u> <u>≤ 200 A</u> <u>≤ 800 A</u>	<u>N/A</u> <u>2</u> <u>4</u>	<u>< 0.46 m</u> <u>2.0 m</u> <u>4.5 m</u>
		<u>Circuit breaker with T/M or M trip unit:</u> <u>Fixed or Adjustable magnetic not set at lowest setting:</u> <u>≤ 30 A</u> <u>≤ 90 A</u> <u>≤ 400 A</u> <u>Adjustable magnetic set at lowest setting:</u> <u>≤ 225 A</u> <u>≤ 600 A</u>	<u>N/A</u> <u>2</u> <u>4</u> <u>2</u> <u>4</u>	<u>< 0.46 m</u> <u>2.0 m</u> <u>4.5 m</u> <u>2.0 m</u> <u>4.5 m</u>

(1) <u>Equipment</u>	(2) <u>Nominal voltage</u>	(3) <u>Upstream device at same voltage in separate compartment *</u>	(4) <u>Arc flash PPE category</u>	(5) <u>Arc-flash boundary</u>
<u>Panelboard</u> <u>Motor control center (MCC)</u> <u>Disconnect switch</u> <u>Other equipment (rated ≤ 800 A)</u> <u>Minimum working distance: 46 cm</u>	<u>480 V</u> <u>600 V</u> <u>(3Φ)</u>	<u>Transformer:</u> <u>≤ 45 kVA (3 Φ) or 3 x 10 kVA (1 Φ)</u> <u>≤ 225 kVA (3 Φ) or 3 x 50 kVA (1 Φ)</u>	<u>2</u> <u>4</u>	<u>2.0 m</u> <u>4.5 m</u>
		<u>Fuses:</u> <u>≤ 40 A</u> <u>≤ 200 A</u> <u>≤ 800 A</u>	<u>N/A</u> <u>2</u> <u>4</u>	<u>< 0.46 m</u> <u>2.0 m</u> <u>4.5 m</u>
		<u>Circuit breaker with T/M or M trip unit:</u> <u>Fixed or Adjustable magnetic not set at lowest setting:</u> <u>≤ 20 A</u> <u>≤ 80 A</u> <u>≤ 350 A</u> <u>Adjustable magnetic set at lowest setting:</u> <u>≤ 225 A</u> <u>≤ 600 A</u>	<u>N/A</u> <u>2</u> <u>4</u> <u>2</u> <u>4</u>	<u>< 0.46 m</u> <u>2.0 m</u> <u>4.5 m</u> <u>2.0 m</u> <u>4.5 m</u>
		<u>Circuit breaker with adjustable LSIG trip unit:</u> <u>ST Pickup: ≤ 6500 A / ST Delay: 0.5 sec.</u> <u>INST Pickup: ≤ 18 000 A (a)</u> <u>ST Pickup: ≤ 6500 A / ST Delay: 0.3 sec.</u> <u>INST Pickup: ≤ 28 000 A (b)</u> <u>ST Pickup: ≤ 6500 A / ST Delay: 0.1 sec.</u>	<u>4</u> <u>4</u> <u>4</u>	<u>4.5 m</u> <u>4.5 m</u> <u>4.5 m</u>
<u>Switchgear</u> <u>Switchboard</u> <u>Other equipment (rated > 800 A)</u> <u>Minimum working distance: 46 cm</u>	<u>480 V</u> <u>600 V</u> <u>(3Φ)</u>	<u>Fuses:</u> <u>≤ 400 A</u>	<u>4</u>	<u>4.5 m</u>
		<u>Circuit breaker with fixed or adjustable T/M or M:</u> <u>Fixed or Adjustable magnetic NOT set at LOWEST setting:</u> <u>≤ 175 A</u> <u>Adjustable set at LOWEST setting:</u> <u>≤ 400 A</u>	<u>4</u> <u>4</u>	<u>4.5 m</u> <u>4.5 m</u>

(1) <u>Equipment</u>	(2) <u>Nominal voltage</u>	(3) <u>Upstream device at same voltage in separate compartment *</u>	(4) <u>Arc flash PPE category</u>	(5) <u>Arc-flash boundary</u>
		Circuit breaker with adjustable LSIG trip unit: <u>ST Pickup: ≤ 3500 A / ST Delay: ≤ 0.5 sec.</u> <u>INST Pickup: $\leq 9\,500$ A (a)</u> <u>ST Pickup: ≤ 3500 A / ST Delay: ≤ 0.3 sec.</u> <u>INST Pickup: $\leq 16\,000$ A (b)</u> <u>ST Pickup: ≤ 3500 A / ST Delay: ≤ 0.1 sec.</u> <u>INST Pickup: $\leq 30\,000$ A (c)</u>	<u>4</u> <u>4</u> <u>4</u>	<u>4.5 m</u>
Switchgear Motor control centre (MCC) Enclosed disconnect switch	<u>1 to 15 kV (3Φ)</u>	Fuses: <u>≤ 400 A</u>	<u>4</u>	<u>9.0 m</u>
Minimum working distance: <u>91 cm</u>		Circuit breaker (5 cycles) with protection relay: <u>Instantaneous (50) or definite time (50 or 51)</u> <u>Pickup: ≤ 7500 A / Time delay: ≤ 0.1 sec.</u>	<u>4</u>	<u>9.0 m</u>

Legend:

T/M = thermal magnetic trip unit

M = magnetic (instantaneous only) trip unit

LSIG = long time, short time, instantaneous, and ground fault protection trip unit

ST = short time protection function

INST = instantaneous protection function

* The upstream fuses or circuit breaker, at the same voltage, shall be installed outside the equipment or in a fully separated compartment. For overcurrent protection and differential protection, the current transformers used for the current measurement shall be located outside the equipment.

The upstream protection device shall be at the same voltage and shall not be located at primary side of upstream transformer.

An upstream transformer is considered at the same voltage of the equipment because the secondary nominal voltage is at the same voltage.

Upstream overcurrent protection devices shall be in a normal equipment condition in accordance with Clause 4.1.7.8.4..

The upstream protection device (fuses or circuit breaker) shall have the required short circuit interrupting capacity for the location where it is installed.

Notes

(1) See Table 6C for a list of protective clothing and PPE for each arc flash PPE category.

(2) Three-phase equipment based on typical IEEE 1584 parameters.

(3) A 2 s arc duration at the stated working distance is assumed if the upstream protective device fault clearing time is expected to be longer than 2 s. It is assumed the worker's movement is not restrained in front of the equipment.

(4) Fault clearing time of overcurrent protection device at primary side of transformer is assumed to be longer than 2 s.

(5) Fault clearing times are conservative. An incident energy analysis could provide more representative and lower results.

(6) The arc flash PPE category is valid for an available three-phase bolted short circuit at the equipment of

(7) ≤ 600 V: 500 A to 106 kA; and

(8) 601 to 15 kV: 200 A to 65 kA.

(9) Typical fuse specifications:

- (1) 208 V to 600 V: Fast acting or time delay fuse of Class CC, J, L, T, RK1, or RK5; and
- (2) 1 to 15 kV: E or R rated fuses.
- (1) Typical circuit breaker used at 600 V and less:
- (1) MCCB: moulded case circuit breaker;
- (2) MCP: motor control protector combined with motor overload protection;
- (3) ICCB: insulated case circuit breaker; and
- (4) LVPCB: low voltage power circuit breaker.
- (1) Typical circuit breaker trip unit used at 600 V and less:
- (1) T/M: fixed or adjustable thermal (overload) magnetic (instantaneous) trip unit;
- (2) M: fixed or adjustable magnetic (instantaneous only) trip unit; and
- (3) LSIG: long time (I_r, t_r), short time (I_{sd}, t_{sd}), instantaneous (I_i), and ground fault (I_g, t_g) trip unit.
- (1) For short time (ST) protection on LSIG trip unit, the I^2t function can be turned on or off.
- (2) Low voltage circuit breaker override is equivalent of an instantaneous.
- (3) The PPE category based on upstream three phase transformers in this Table shall have an impedance equal to 3% or higher. When based on the three times single phase transformers rating, the transformer shall have an impedance of 1.8 % and higher. The PPE Category based on upstream three phase transformers with an impedance lower than 3% may be based on the three times single phase transformer rating.

Additional Proposed Changes

<u>File Name</u>	<u>Description</u>	<u>Approved</u>
Figure_V.1.pdf	Annex B Figure B.1	

Statement of Problem and Substantiation for Public Input

This is one of two parallel proposals to add an alternate PPE category table for ac equipment. This Table and the proposed revisions to 130.7(C)(15) are published in CSA Z462-2021.

One of the challenges faced by users of Table 130.7(C)(15)(a) are verifying the parameters of available fault current and fault clearing time are not exceeded for the equipment at the work location. The proposed alternate Table is based on the constant energy line method. Papers, for which IEEE holds copyright, discussing this method are:

"Application of Incident Energy Reference Boundary Area Plots in TCCs Considering IEEE 1584-2018 Input Parameter Variability", published in IEEE Transactions on Industry Applications, vol. 56, no. 5, pp. 4640-4651, Sept.-Oct. 2020, doi: 10.1109/TIA.2020.3004769, by A. Marroquin and A. Parsons

"Arc-Flash Ppe – A Simplified Constant Energy Line Table Method", Presented at the IEEE 2021 ESW by R. Hallé, K. Gray, D. Roberts, and M. Valdes

The purpose of this alternate method is to simplify the information gathering to require only one of two possibilities:

Supply transformer rating

Overcurrent protective device rating (e.g., fuse) or setting (e.g., relay operated circuit breaker)

A flow chart is included that explains how to use the method.

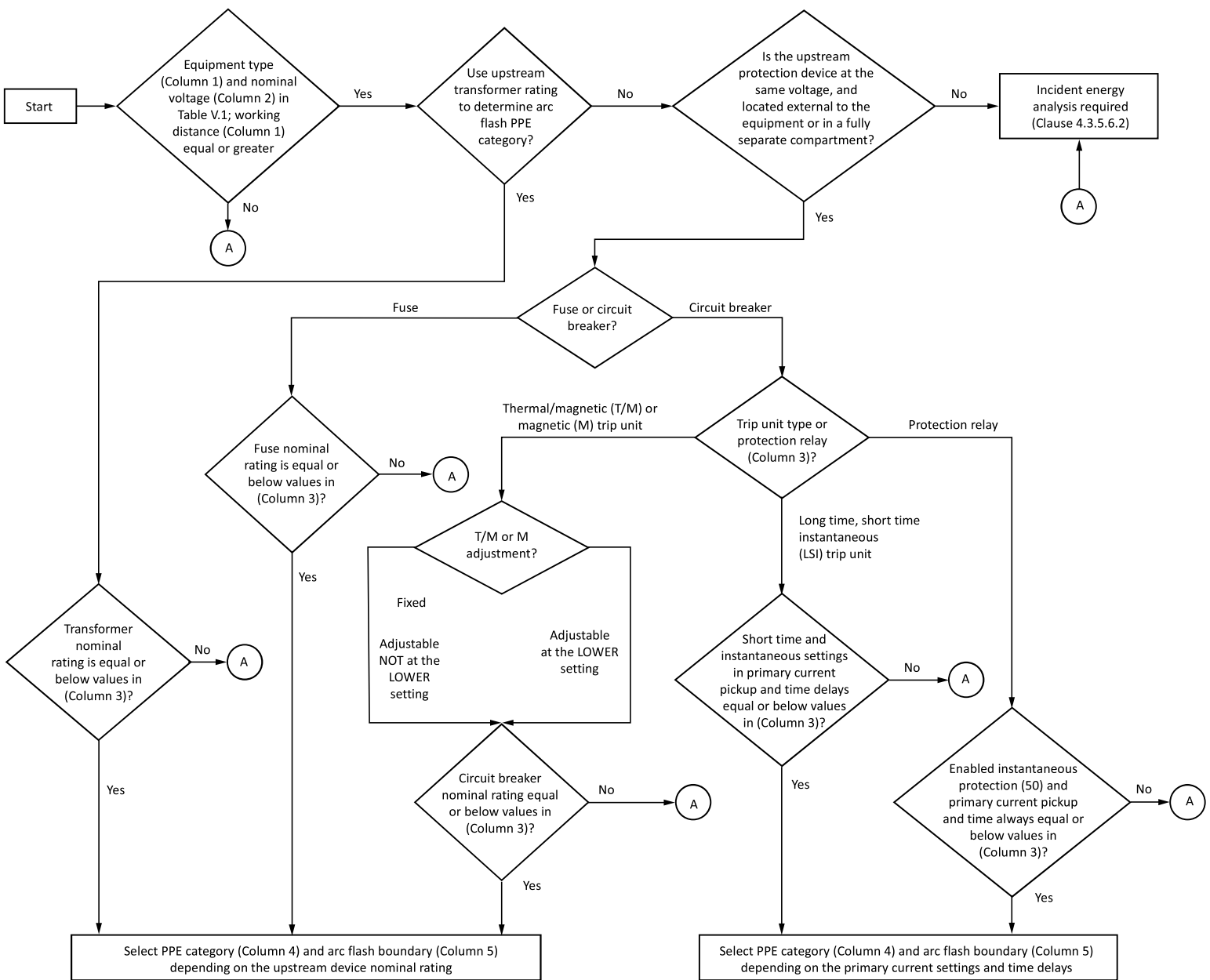
Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 332-NFPA 70E-2021 [Section No. 130.7(C)(15)]	Parallel proposal
Public Input No. 332-NFPA 70E-2021 [Section No. 130.7(C)(15)]	

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Figure V.1
Table V.1 Arc-flash PPE categories selection flow chart
 (See Clause V.1.)



**Public Input No. 31-NFPA 70E-2020 [Section No. C.1.1]****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 electric shock protection techniques and equipment are required.

Statement of Problem and Substantiation for Public Input

"Electric" is added before "shock" to distinguish electric shock from the type of shock used in Article 360 including within the definition of Arc Blast Hazard (A source of possible injury or damage to health from the energy deposited into acoustical shock-wave and high-velocity shrapnel.) and correlate with its use throughout NFPA 70E such as how it is presently used in numerous locations throughout 130.7.

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 15-NFPA 70E-2020 [Definition: Shock Hazard.]	related issue
Public Input No. 30-NFPA 70E-2020 [Chapter 3]	related issue
Public Input No. 28-NFPA 70E-2020 [Section No. 130.7]	related issue

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Public Input No. 382-NFPA 70E-2021 [Section No. D.5]

D.5 Direct-Current Incident Energy Calculations.**D.5.1** Maximum Power Method.

The following method of estimating dc arc flash incident energy that follows was published in the *IEEE Transactions on Industry Applications* (see reference 2 of D.5.2). This method is based on the concept that the maximum power possible in a dc arc will occur when the arcing voltage is one-half the system voltage. Testing completed for Bruce Power (see reference 3 of D.5.3) has shown that this calculation is conservatively high in estimating the arc flash value. This method applies to dc systems rated up to 1000 volts. For photovoltaic (PV) systems, it has been shown through testing (see reference 4 and 5 of D.5.2), that the methods described here will overestimate incident energies.

$$\begin{aligned} I_{arc} &= 0.5 \times I_{bf} \\ IE_m &= 0.01 \times V_{sys} \times I_{arc} \times T_{arc} / D^2 \end{aligned} \quad [D.5.1]$$

where:

I_{arc} = arcing current, amperes

I_{bf} = system bolted fault current, amperes

IE_m = estimated dc arc flash incident energy at the maximum power point, cal/cm²

V_{sys} = system voltage, volts

T_{arc} = arcing time, sec

D = working distance, cm

For exposures where the arc is in a box or enclosure, it would be prudent to consider additional PPE protection beyond the values shown in Table 130.7(C)(15)(b).

D.5.2 Detailed Arcing Current and Energy Calculations Method.

A thorough theoretical review of dc arcing current and energy was published in the *IEEE Transactions on Industry Applications*. Readers are advised to refer to that paper (see reference 1) for those detailed calculations.

References:

1. "DC-Arc Models and Incident-Energy Calculations," Ammerman, R.F.; et al.; *IEEE Transactions on Industry Applications*, Vol. 46, No.5.
2. "Arc Flash Calculations for Exposures to DC Systems," Doan, D.R., *IEEE Transactions on Industry Applications*, Vol. 46, No.6.
3. "DC Arc Hazard Assessment Phase II", Copyright Material, Kinectrics Inc., Report No. K-012623-RA-0002-R00.
4. "Methods for Evaluating DC Arc Incident Energy in PV Systems", William Sekulic, Albert Marroquin, Peter McNutt, *IEEE IAS Electrical Safety Workshop (ESW)*, Virtual, USA, 2021
5. "Measurement of DC Arc-Flash Incident Energy in Large-Scale Photovoltaic Plants: A Basis for Standardization", Bijaya Paudyal, Michael Bolen, Tom A. Short, Justin M. Woodard, *Industry Applications IEEE Transactions on*, vol. 56, no. 6, pp. 6033-6040, 2020

D.5.3 Short Circuit Current.

The determination of short circuit current is necessary in order to use Table 130.7(C)(15)(b). The arcing current is calculated at 50 percent of the dc short-circuit value. The current that a battery will deliver depends on the total impedance of the short-circuit path. A conservative approach in determining the short-circuit current that the battery will deliver at 25°C is to assume that the maximum available short-circuit current is 10 times the 1 minute ampere rating (to 1.75 volts per cell at 25°C and the specific gravity of 1.215) of the battery. A more accurate value for the short-circuit current for the specific application can be obtained from the battery manufacturer.

References:

1. IEEE 946, *Recommended Practice for the Design of DC Auxiliary Powers Systems for Generating Stations*.

Statement of Problem and Substantiation for Public Input

The current model overestimated the energy for a PV system. The referenced papers provide details to indicate there is a need for a new model, but is not published yet due to limited testing, but the testing that is complete and the evidence in the paper do indicate the DC model currently used is not a one size fits all model.

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Tue Jun 01 17:48:41 EDT 2021

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**Public Input No. 32-NFPA 70E-2020 [Section No. E.1]****E.1 Typical Electrical Safety Program Principles.**

Electrical safety program principles include, but are not limited to, the following:

- (1) Inspecting and evaluating the electrical equipment
- (2) Maintaining the electrical equipment's insulation and enclosure integrity
- (3) Planning every job and document first-time procedures
- (4) De-energizing, if possible (*see 120.5*)
- (5) Anticipating unexpected events
- (6) Identifying the electrical hazards and reduce the associated risk
- (7) Protecting employees from electric shock, burn, blast, and other hazards due to the working environment
- (8) Using the right tools for the job
- (9) Assessing people's abilities
- (10) Auditing the principles

Statement of Problem and Substantiation for Public Input

"Electric" is added before "shock" to distinguish electric shock from the type of shock used in Article 360 including within the definition of Arc Blast Hazard (A source of possible injury or damage to health from the energy deposited into acoustical shock-wave and high-velocity shrapnel.) and correlate with its use throughout NFPA 70E such as how it is presently used in numerous locations throughout 130.7.

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 15-NFPA 70E-2020 [Definition: Shock Hazard.]	related issue
Public Input No. 28-NFPA 70E-2020 [Section No. 130.7]	related issue
Public Input No. 30-NFPA 70E-2020 [Chapter 3]	related issue

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**Public Input No. 33-NFPA 70E-2020 [Annex F]****Informative Annex F Risk Assessment and Risk Control**

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

F.1 Introduction to Risk Management.

Risk management is the logical, systematic process used to manage the risk associated with any activity, process, function, or product including safety, the environment, quality, and finance. The risk management process and principles can be used by organizations of any type or size.

The following risk management principles can readily be applied to electrical safety. Risk management:

- (1) Is an integral part of all organizational processes and decision making
- (2) Is systematic, structured, and timely
- (3) Is based on the best available information
- (4) Takes human and cultural factors into account
- (5) Is dynamic, iterative, and responsive to change
- (6) Facilitates continual improvement of the organization

Informational Note: For more information on risk management principles see ISO 31000:2009, *Risk Management — Principles and Guidelines*.

The risk management process includes the following:

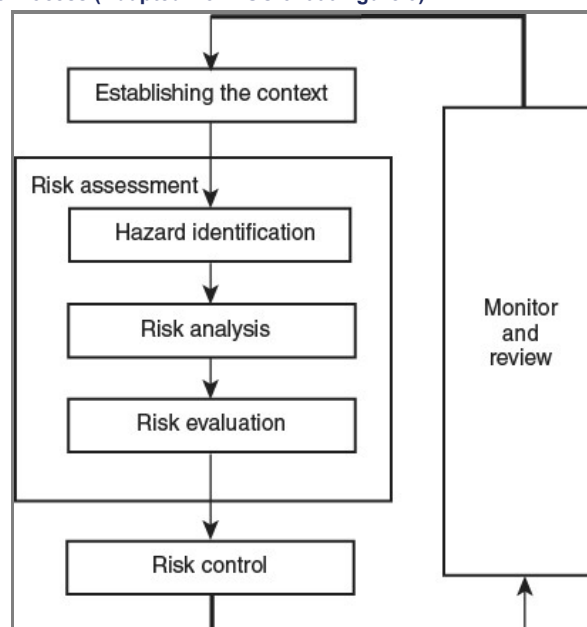
- (1) Communication and consultation
- (2) Establishing the risk assessment context and objectives
- (3) Risk assessment
- (4) Risk treatment
- (5) Recording and reporting the risk assessment results and risk treatment decisions
- (6) Monitoring and reviewing risks

Risk assessment is the part of risk management that involves the following:

- (1) Identifying sources of risk
- (2) Analyzing the sources of risk to estimate a level of risk
- (3) Evaluating the level of risk to determine if risk treatment is required

(See Figure F.1.)

Figure F.1 Risk Management Process (Adapted from ISO 31000 figure 3).



F.1.1 Occupational Health and Safety (OHS) Risk Management.

The same logical, systematic process and the same principles apply to risk management in the OHS sphere of activity. However, it is more focused and the terminology more narrowly defined, as follows:

- (1) The OHS objective is freedom from harm (i.e., injury or damage to health).
- (2) Sources of risk are referred to as hazards.
- (3) Analyzing and estimating the level of risk is a combination of the estimation of the likelihood of the occurrence of harm and the severity of that harm.
- (4) The level of risk is evaluated to determine if it is reasonable to conclude that freedom from harm can be achieved or if further risk treatment is required.
- (5) Risk treatment is referred to as risk control.

Therefore, OHS risk assessment involves the following:

- (1) Hazard identification: Find, list, and characterize hazards.
- (2) Risk analysis: Sources, causes, and potential consequences are analyzed to determine the following:
 - (3) The likelihood that harm might result
 - (4) The potential severity of that harm
 - (5) Estimate the level of risk
- (6) Risk evaluation: The level of risk is evaluated to determine if the objective of freedom from harm can reasonably be met by the risk control that is in place or if further risk control is required?

F.2 Relationship to Occupational Health and Safety Management System (OHSMS).

As discussed in Annex P, the most effective application of the requirements of this standard can be achieved within the framework of an OHSMS. Using a management system provides a methodical approach to health and safety by means of goal setting, planning, and performance measurement.

Risk management shares the six management system process elements of the following:

- (1) Leadership. If any venture is to succeed it needs to be sponsored at the highest levels of the organization.
- (2) Policy. The organization should articulate its vision and establish relevant, attainable goals.
- (3) Plan. A plan is developed in line with the organization's vision and to achieve its goals. The plan must include mechanisms to measure and monitor the success of the plan.
- (4) Do. The plan is executed.
- (5) Check (Monitor). The success of the plan in achieving the organization's goals is continuously monitored.
- (6) Act (Review). The measuring and monitoring results are compared to the organization's goals for the purposes of reviewing and revising goals and plans to improve performance.

As noted in F.1, risk management is iterative. The repeating nature of the management system plan-do-check-act (PDCA) cycle is intended to promote continuous improvement in health and safety performance.

Risk assessment fits into the "plan" and "do" stages of the PDCA cycle, as follows:

- (1) Planning: Information used during the planning stage comes from sources that can include workplace inspections, incident reports, and risk assessments.
- (2) Do: Risk assessment is an ongoing activity.

F.3 Hierarchy of Risk Control.

The purpose of specifying and adhering to a hierarchy of risk control methods is to identify the most effective individual or combination of preventive or protective measures to reduce the risk associated with a hazard. Each risk control method is considered less effective than the one before it. Table F.3 lists the hierarchy of risk control identified in this and other safety standards and provides examples of each.

Table F.3 The Hierarchy of Risk Control Methods

<u>Risk Control Method</u>	<u>Examples</u>
(1) Elimination	Conductors and circuit parts in an electrically safe working condition
(2) Substitution	Reduce energy by replacing 120 V control circuitry with 24 Vac or Vdc control circuitry
(3) Engineering controls	Guard energized electrical conductors and circuit parts to reduce the likelihood of electrical contact or arcing faults
(4) Awareness	Signs alerting of the potential presence of hazards
(5) Administrative controls	Procedures and job planning tools
(6) PPE	<u>Shock- Electric shock</u> and arc flash PPE

F.4 Hazard-Based Risk Assessment.

In a hazard-based risk assessment, workplace hazards are identified and characterized for materials, processes, the worksite, and the environment. Activities that might be affected by those hazards are identified. The risk associated with each activity is analyzed for likelihood of harm and severity of harm. An organization uses this information to prioritize risk reduction decisions.

The information from hazard-based risk assessments is useful to organizations when designing, specifying, and purchasing electrical distribution equipment. Risk control is much more effective when it is applied at the beginning of the equipment or process lifecycle. Risk can be reduced by specifying “substitution” and “engineering” risk control methods that affect the likelihood of occurrence of harm or severity of harm.

F.5 Task-Based Risk Assessment.

In a task-based risk assessment, a job is broken down into discrete tasks. Hazards are identified for each task (often referred to as task-hazard pairs). The risk associated with each hazard is analyzed and evaluated.

The task-based risk assessment is the most commonly used when performing a field level risk assessment.

F.6 Risk Assessment Methods.

There are many risk assessment methods. The method or combination of methods should be chosen based on the following:

- (1) The application
- (2) The desired result
- (3) The skill level of the persons performing the assessment

Some risk assessment methods include the following:

- (1) Brainstorming. An open group discussion regarding hazards, the associated risk, and risk control methods can be used as part of pre-job planning and during a job briefing session.
- (2) Checklists. A list of common hazards and possible control methods is a useful tool for pre-job planning and for job briefing purposes. See Annex I for an example of a job briefing and planning checklist.
- (3) Risk assessment matrix. A risk assessment matrix is commonly used to quantify levels of risk. The matrix can be in a multilevel or a simple two-by-two format. See Figure F.6 for an example of a risk assessment matrix.

Figure F.6 Example of a Qualitative Two-by-Two Risk Assessment Matrix.

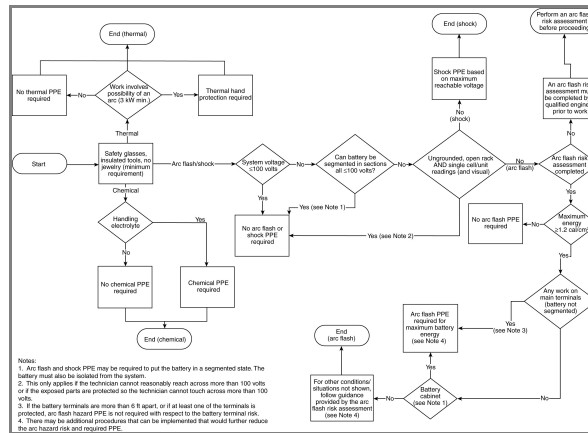
Likelihood of Occurrence of Harm	Severity of Harm	
	Energy ≤ [Selected Threshold]	Energy > [Selected Threshold]
Improbable	Low	Low
Possible	Low	High
Legend		
Likelihood of Occurrence of Harm Improbable: Source of harm is adequately guarded to avoid contact with hazardous energy Possible: Source of harm is not adequately guarded to avoid contact with hazardous energy		Severity of Harm Energy ≤ [Selected Threshold]: Level of hazardous energy insufficient to cause harm Energy > [Selected Threshold]: Level of hazardous energy insufficient to cause harm
Risk Evaluation Identify the risk controls in place and evaluate the effectiveness of the controls. Prioritize actions taken to control risk based on the level of risk as follows: Low: Risk Acceptable — Further risk control discretionary High: Risk Unacceptable — Further risk control required before proceeding		

Informational Note: See ISO 31010, Risk management — *Risk assessment techniques*, and ANSI/AIHA Z10-2012, *Occupational Health and Safety Management Systems*, for further information regarding risk assessment methods.

F.7 Battery Risk Assessment.

Multiple hazards may be encountered when working on batteries (electric 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.



Statement of Problem and Substantiation for Public Input

"Electric" is added before "shock" to distinguish electric shock from the type of shock used in Article 360 including within the definition of Arc Blast Hazard (A source of possible injury or damage to health from the energy deposited into acoustical shock-wave and high-velocity shrapnel.) and correlate with its use throughout NFPA 70E such as how it is presently used in numerous locations throughout 130.7.

Related Public Inputs for This Document

Related Input

Public Input No. 15-NFPA 70E-2020 [Definition: Shock Hazard.]

Public Input No. 28-NFPA 70E-2020 [Section No. 130.7]

Public Input No. 30-NFPA 70E-2020 [Chapter 3]

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**Public Input No. 214-NFPA 70E-2021 [Section No. F.1 [Excluding any Sub-Sections]]**

Risk management is the logical, systematic process used to manage the risk associated with any activity, process, function, or product including safety, the environment, quality, and finance. The risk management process and principles can be used by organizations of any type or size.

The following risk management principles can readily be applied to electrical safety. Risk management:

- (1) Is an integral part of all organizational processes and decision making
- (2) Is systematic, structured, and timely
- (3) Is based on the best available information
- (4) Takes human and cultural factors into account
- (5) Is dynamic, iterative, and responsive to change
- (6) Facilitates continual improvement of the organization

Informational Note: For more information on risk management principles see See ISO 31000:2009, Risk Management — Principles and Guidelines for more information on risk management principles.

The risk management process includes the following:

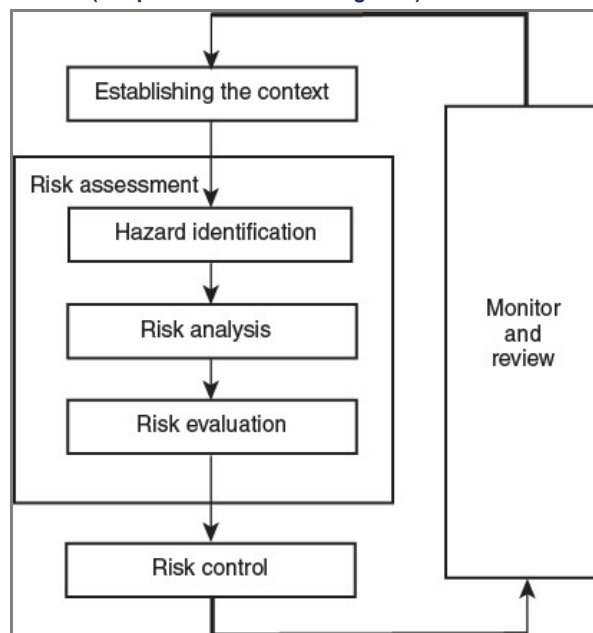
- (1) Communication and consultation
- (2) Establishing the risk assessment context and objectives
- (3) Risk assessment
- (4) Risk treatment
- (5) Recording and reporting the risk assessment results and risk treatment decisions
- (6) Monitoring and reviewing risks

Risk assessment is the part of risk management that involves the following:

- (1) Identifying sources of risk
- (2) Analyzing the sources of risk to estimate a level of risk
- (3) Evaluating the level of risk to determine if risk treatment is required

(See Figure F.1.)

Figure F.1 Risk Management Process (Adapted from ISO 31000 figure 3).

**Statement of Problem and Substantiation for Public Input**

Revised Informational Note to comply with new 2020 NEC Style Manual.

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

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**Public Input No. 368-NFPA 70E-2021 [Section No. F.3]****F.3 Hierarchy of Risk Control.**

The purpose of specifying and adhering to a hierarchy of risk control methods is to identify the most effective individual or combination of preventive or protective measures to reduce the risk associated with a hazard. Each risk control method is considered less effective than the one before it. Table F.3 lists the hierarchy of risk control identified in this and other safety standards and provides examples of each.

Table F.3 The Hierarchy of Risk Control Methods

<u>Risk Control Method</u>	<u>Examples</u>
(1) Elimination	~~Conductors and circuit parts in an electrically safe working condition~~ <u>Completely removing electrical energy</u>
(2) Substitution	Reduce energy by replacing 120 V control circuitry with 24 Vac or Vdc control circuitry
(3) Engineering controls	Guard energized electrical conductors and circuit parts to reduce the likelihood of electrical contact or arcing faults
(4) Awareness	Signs alerting of the potential presence of hazards
(5) Administrative controls	Procedures and job planning tools
(6) PPE	Shock and arc flash PPE

Statement of Problem and Substantiation for Public Input

People can be injured if electricity exists, even though it might be temporarily controlled. Understanding that concept is an important part of an effective electrical safety program. Completely removing electrical energy is often not a feasible approach as it might be when dealing with non-electrical hazards. This PI is related to 347 and 348.

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 347-NFPA 70E-2021 [Definition: Electrically Safe Work Condition.]	
Public Input No. 348-NFPA 70E-2021 [Section No. 110.1]	

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**Public Input No. 127-NFPA 70E-2021 [Annex G]****Informative Annex G Sample Lockout/Tagout Program**

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

Lockout is the preferred method of controlling personnel exposure to electrical energy hazards. Tagout is an alternative method that is available to employers. The sample program and procedures that follow are provided to assist employers in developing a lockout/tagout program and procedures that meet the requirements of Article 120 of NFPA 70E. The sample program and procedures can be used for a simple lockout/tagout or as part of a complex lockout/tagout. A more comprehensive procedure will need to be developed, documented, and used for the complex lockout/tagout.

LOCKOUT/TAGOUT PROGRAM

FOR [COMPANY NAME]

OR

TAGOUT PROGRAM FOR [COMPANY NAME]

1 G.0- 1 Purpose.

This procedure establishes the minimum requirements for lockout /tagout of electrical energy sources. It is to be used to ensure that conductors and circuit parts are disconnected from sources of electrical energy, locked (tagged), and tested before work begins where employees could be exposed to dangerous conditions. Sources of stored energy, such as capacitors or springs, shall be relieved of their energy, and a mechanism shall be engaged to prevent the reaccumulation of energy.

2 G.0- 2 Responsibility.

All employees shall be instructed in the safety significance of the lockout/tagout procedure. All new or transferred employees and all other persons whose work operations are or might be in the area shall be instructed in the purpose and use of this procedure. *[Name(s) of the person(s) or the job title(s) of the employee(s) with responsibility]* shall ensure that appropriate personnel receive instructions on their roles and responsibilities. All persons installing a lockout/tagout device shall sign their names and the date on the tag *[or state how the name of the individual or person in charge will be available]*.

3 G.0- 3 Preparation for Lockout/Tagout.**G. 3.1**

Review current diagrammatic drawings (or their equivalent), tags, labels, and signs to identify and locate all disconnecting means to determine that power is interrupted by a physical break and not de-energized by a circuit interlock. Make a list of disconnecting means to be locked (tagged).

G. 3.2

Review disconnecting means to determine adequacy of their interrupting ability. Determine if it will be possible to verify a visible open point, or if other precautions will be necessary.

G. 3.3

Review other work activity to identify where and how other personnel might be exposed to electrical hazards. Review other energy sources in the physical area to determine employee exposure to those sources of other types of energy. Establish energy control methods for control of other hazardous energy sources in the area.

G. 3.4

Provide an adequately rated test instrument to test each phase conductor or circuit part to verify that they are de-energized (see Section G.11.3). Provide a method to determine that the test instrument is operating satisfactorily.

G. 3.5

Where the possibility of induced voltages or stored electrical energy exists, call for grounding the phase conductors or circuit parts before touching them. Where it could be reasonably anticipated that contact with other exposed energized conductors or circuit parts is possible, call for applying ground connecting devices.

4 G.0- 4 Simple Lockout/Tagout.

The simple lockout/tagout procedure will involve G.1.0 through G.3.0, G.5.0 through G.9.0, and G.11.0 through G.13.0.

5 G.0- 5 Sequence of Lockout/Tagout System Procedures.**G. 5.1**

The employees shall be notified that a lockout/tagout system is going to be implemented and the reason for it. The qualified employee implementing the lockout/tagout shall know the disconnecting means location for all sources of electrical energy and the location of all sources of stored energy. The qualified person shall be knowledgeable of hazards associated with electrical energy.

G. 5.2

If the electrical supply is energized, the qualified person shall de-energize and disconnect the electric supply and relieve all stored energy.

G. 5.3

Wherever possible, the blades of disconnecting devices should be visually verified to be fully opened, or draw-out type circuit breakers should be verified to be completely withdrawn to the fully disconnected position.

G. 5.4

Lockout/tagout all disconnecting means with lockout/tagout devices.

Informational Note: For tagout, one additional safety measure must be employed, such as opening, blocking, or removing an additional circuit element.

G. 5.5

Attempt to operate the disconnecting means to determine that operation is prohibited.

G. 5.6

A test instrument shall be used. (See G.11.3.) Inspect the instrument for visible damage. Do not proceed if there is an indication of damage to the instrument until an undamaged device is available.

G. 5.7

Verify proper instrument operation on a known source of voltage and then test for absence of voltage.

G. 5.8

Verify proper instrument operation on a known source of voltage after testing for absence of voltage.

G. 5.9

Where required, install a grounding equipment/conductor device on the phase conductors or circuit parts, to eliminate induced voltage or stored energy, before touching them. Where it has been determined that contact with other exposed energized conductors or circuit parts is possible, apply ground connecting devices rated for the available fault duty.

G. 5.10

The equipment, electrical source, or both are now locked out (tagged out).

6 G.0– 6 Restoring the Equipment, Electrical Supply, or Both to Normal Condition.**G. 6.1**

After the job or task is complete, visually verify that the job or task is complete.

G. 6.2

Remove all tools, equipment, and unused materials and perform appropriate housekeeping.

G. 6.3

Remove all grounding equipment/conductors/devices.

G. 6.4

Notify all personnel involved with the job or task that the lockout/tagout is complete, that the electrical supply is being restored, and that they are to remain clear of the equipment and electrical supply.

G. 6.5

Perform any quality control tests or checks on the repaired or replaced equipment, electrical supply, or both.

G. 6.6

Remove lockout/tagout devices. The person who installed the devices is to remove them.

G. 6.7

Notify the owner of the equipment, electrical supply, or both, that the equipment, electrical supply, or both are ready to be returned to normal operation.

G. 6.8

Return the disconnecting means to their normal condition.

7 G.0– 7 Procedure Involving More Than One Person.

For a simple lockout/tagout and where more than one person is involved in the job or task, each person shall install his or her own personal lockout/tagout device.

8 G.0– 8 Procedure Involving More Than One Shift.

When the lockout/tagout extends for more than one day, it shall be verified that the lockout/tagout is still in place at the beginning of the next day. When the lockout/tagout is continued on successive shifts, the lockout/tagout is considered to be a complex lockout/tagout.

For a complex lockout/tagout, the person in charge shall identify the method for transfer of the lockout/tagout and of communication with all employees.

9 G.0– 9 Complex Lockout/Tagout.

A complex lockout/tagout plan is required where one or more of the following exist:

- (1) Multiple energy sources (more than one)
- (2) Multiple crews
- (3) Multiple crafts
- (4) Multiple locations
- (5) Multiple employers
- (6) Unique disconnecting means
- (7) Complex or particular switching sequences
- (8) Lockout/tagout for more than one shift; that is, new shift workers

G. 9.1

All complex lockout/tagout procedures shall require a written plan of execution. The plan shall include the requirements in G.1.0 through G.3.0, G.5.0, G.6.0, and G.8.0 through G.12.0.

G. 9.2

A person in charge shall be involved with a complex lockout/tagout procedure. The person in charge shall be at the procedure location.

G. 9.3

The person in charge shall develop a written plan of execution and communicate that plan to all persons engaged in the job or task. The person in charge shall be held accountable for safe execution of the complex lockout/tagout plan. The complex lockout/tagout plan must address all the concerns of employees who might be exposed, and they must understand how electrical energy is controlled. The person in charge shall ensure that each person understands the electrical hazards to which they are exposed and the safety-related work practices they are to use.

G. 9.4

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

One of the following methods is to be used:

- (1) Each individual shall install his or her own personal lockout or tagout device.
- (2) The person in charge shall lock his/her key in a lock box.
- (3) The person in charge shall maintain a sign-in/sign-out log for all personnel entering the area.
- (4) Another equally effective methodology shall be used.

G. 9.5

The person in charge can install locks/tags or direct their installation on behalf of other employees.

G. 9.6

The person in charge can remove locks/tags or direct their removal on behalf of other employees, only after all personnel are accounted for and ensured to be clear of potential electrical hazards.

G. 9.7

Where the complex lockout/tagout is continued on successive shifts, the person in charge shall identify the method for transfer of the lockout and the method of communication with all employees.

10 G.0–10 Discipline.

G. 10.1

Knowingly violating the requirements of this program will result in *[state disciplinary actions that will be taken]*.

G. 10.2

Knowingly operating a disconnecting means with an installed lockout device (tagout device) will result in *[state disciplinary actions to be taken]*.

11 G.0–11 Equipment.

G. 11.1

Locks shall be *[state type and model of selected locks]*.

G. 11.2

Tags shall be *[state type and model to be used]*.

G. 11.3

The test instrument(s) to be used shall be *[state type and model]*.

12 G.0–12 Review.

This program was last reviewed on [date] and is scheduled to be reviewed again on [date] (not more than 1 year from the last review).

43 G.0– 13 Lockout/Tagout Training.

Recommended training can include, but is not limited to, the following:

- (1) Recognition of lockout/tagout devices
- (2) Installation of lockout/tagout devices
- (3) Duty of employer in writing procedures
- (4) Duty of employee in executing procedures
- (5) Duty of person in charge
- (6) Authorized and unauthorized removal of locks/tags
- (7) Enforcement of execution of lockout/tagout procedures
- (8) Simple lockout/tagout
- (9) Complex lockout/tagout
- (10) Use of single-line and diagrammatic drawings to identify sources of energy
- (11) Alerting techniques
- (12) Release of stored energy
- (13) Personnel accounting methods
- (14) Temporary protective grounding equipment needs and requirements
- (15) Safe use of test instruments

Statement of Problem and Substantiation for Public Input

This proposal adds "G" in front of each section number of Annex G. While the new 2020 NEC Style Manual does not specifically address section numbering of Annexes, adding G as shown aligns the numbering of sections within Annex G with other annexes and simplifies direct references to Annex G sections.

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**Public Input No. 215-NFPA 70E-2021 [Section No. G.5.4]****5.4**

Lockout/tagout all disconnecting means with lockout/tagout devices._

Informational Note: - ~~For tagout, one additional safety measure must be employed, such as~~ [Examples of additional safety measures when tagout only is used include](#) opening, blocking, or removing an additional circuit element.

Statement of Problem and Substantiation for Public Input

Revised Informational Note to remove requirement.

3.1.3 of the 2020 NEC Style Manual requires Informational Notes to only contain explanatory information.

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**Public Input No. 223-NFPA 70E-2021 [Annex G [Excluding any Sub-Sections]]**

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

Lockout is the preferred method of controlling personnel exposure to electrical energy hazards. Tagout is an alternative method that is available to employers. The sample program and procedures that follow are provided to assist employers in developing a lockout/tagout program and procedures that meet the requirements of Article 120 of 120.1 through 120.4 of NFPA 70E. The sample program and procedures can be used for a simple lockout/tagout or as part of a complex lockout/tagout. A more comprehensive procedure will need to be developed, documented, and used for the complex lockout/tagout.

LOCKOUT/TAGOUT PROGRAM

FOR [COMPANY NAME]

OR

TAGOUT PROGRAM FOR [COMPANY NAME]

Statement of Problem and Substantiation for Public Input

General reference to Article 120 is changed to a specific reference to 120.1 through 120.4

4.1.4 of the new 2020 NEC Style Manual prohibits references to entire articles.

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Public Input No. 34-NFPA 70E-2020 [Section No. H.3]

H.3 Arc-Rated Clothing and Other Personal Protective Equipment (PPE) for Use with Risk Assessment of Electrical Hazards.

Table H.3 provides a summary of specific sections within the NFPA 70E standard describing PPE for electrical hazards.

Table H.3 Summary of Specific Sections Describing PPE for Electrical Hazards

<u>Electric Shock Hazard PPE</u>	<u>Applicable Section(s)</u>
Rubber insulating gloves and leather protectors, unless the requirements of ASTM F496 are met	130.7(C)(7)(a)
Rubber insulating sleeves as needed	130.7(C)(7)(a)
Class G or E hard hat as needed	130.7(C)(3)
Safety glasses or goggles as needed	130.7(C)(4)
Dielectric overshoes as needed	130.7(C)(8)
<i>Incident Energy Exposures Greater than or Equal to 1.2 cal/cm² (5 J/cm²)</i>	-
Clothing:	
Arc-rated clothing system with an arc rating appropriate to the anticipated incident energy exposure	130.7(C)(1), 130.7(C)(2), 130.7(C)(6), 130.7(C)(9)(d)
Clothing underlayers (when used):	130.7(C)(9)(c), 130.7(C)(11), 130.7(C)(12)
Arc-rated or nonmelting untreated natural fiber	
Gloves:	130.7(C)(7)(b), 130.7(C)(10)(d)
Exposures greater than or equal to 1.2 cal/cm ² (5 J/cm ²) and less than or equal to 8 cal/cm ² (33.5 J/cm ²): heavy-duty leather gloves	-
Exposures greater than 8 cal/cm ² (33.5 J/cm ²): rubber insulating gloves with their leather protectors or arc-rated gloves	-
Hard hat:	
Class G or E	130.7(C)(1), 130.7(C)(3)
Face shield:	
Exposures greater than or equal to 1.2 cal/cm ² (5 J/cm ²) and less than or equal to 12 cal/cm ² (50.2 J/cm ²): Arc-rated face shield that covers the face, neck, and chin and an arc-rated balaclava or an arc-rated arc flash suit hood	130.7(C)(1), 130.7(C)(3), 130.7(C)(10)(a), 130.7(C)(10)(b), 130.7(C)(10)(c)
Exposures greater than 12 cal/cm ² (50.2 J/cm ²): arc-rated arc flash suit hood	
Safety glasses or goggles	130.7(C)(4), 130.7(C)(10)(c)
Hearing protection	130.7(C)(5)
Footwear:	130.7(C)(10)(e)
Exposures less than or equal to 4 cal/cm ² (16.75 J/cm ²): Heavy-duty leather footwear (as needed)	-
Exposures greater than 4 cal/cm ² (16.75 J/cm ²): Heavy-duty leather footwear	-

Statement of Problem and Substantiation for Public Input

"Electric" is added before "shock" to distinguish electric shock from the type of shock used in Article 360 including within the definition of Arc Blast Hazard (A source of possible injury or damage to health from the energy deposited into acoustical shock-wave and high-velocity shrapnel.) and correlate with its use throughout NFPA 70E such as how it is presently used in numerous locations throughout 130.7.

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 15-NFPA 70E-2020 [Definition: Shock Hazard.]	related issue
Public Input No. 28-NFPA 70E-2020 [Section No. 130.7]	related issue
Public Input No. 30-NFPA 70E-2020 [Chapter 3]	related issue

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Public Input No. 36-NFPA 70E-2020 [Section No. I.1]

I.1 Job Briefing Checklist.

Figure I.1 illustrates considerations for a job briefing checklist.

Figure I.1 Sample Job Briefing Checklist.

Identify ☐ Hazards ☐ Voltage levels involved ☐ Skills required ☐ Any "foreign" (secondary source) voltage source ☐ Any unusual work conditions ☐ Number of people needed to do the job ☐ Shock protection boundaries ☐ Available incident energy ☐ Potential for arc flash (Conduct an arc flash risk assessment.) ☐ Arc flash boundary ☐ Any evidence of impending failure?	
Ask ☐ Can the equipment be de-energized? ☐ Are backfeeds of the circuits to be worked on possible? ☐ Is an energized electrical work permit required? ☐ Is a standby person required? ☐ Is the equipment properly installed and maintained?	
Check ☐ Job plans ☐ Single-line diagrams and vendor prints ☐ Status board ☐ Information on plant and vendor resources is up to date ☐ Safety procedures ☐ Vendor information ☐ Individuals are familiar with the facility	
Know ☐ What the job is ☐ Who else needs to know — Communicate! ☐ Who is in charge	
Think ☐ About the unexpected event . . . What if? ☐ Lock — Tag — Test — Try ☐ Test for voltage — FIRST ☐ Use the right tools and equipment, including PPE ☐ Install and remove temporary protective grounding equipment ☐ Install barriers and barricades ☐ What else . . . ?	
Prepare for an emergency ☐ Is the standby person CPR/AED trained? ☐ Is the required emergency equipment available? Where is it? ☐ Where is the nearest telephone? ☐ Where is the fire alarm? ☐ Is confined space rescue available? ☐ What is the exact work location? ☐ How is the equipment shut off in an emergency? ☐ Are the emergency telephone numbers known? ☐ Where is the fire extinguisher? ☐ Are radio communications available? ☐ Is an AED available?	

Statement of Problem and Substantiation for Public Input

Add "electric" before "shock" in the locations where shock is mentioned in Figure I.1 to distinguish electric shock from the type of shock used in Article 360 including within the definition of Arc Blast Hazard (A source of possible injury or damage to health from the energy deposited into acoustical shock-wave and high-velocity shrapnel.) and correlate with its use throughout NFPA 70E such as how it is presently used in numerous locations throughout 130.7. I had no way to modify the text in Figure I.1.

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 15-NFPA 70E-2020 [Definition: Shock Hazard.]	related issue
Public Input No. 28-NFPA 70E-2020 [Section No. 130.7]	related issue
Public Input No. 30-NFPA 70E-2020 [Chapter 3]	related issue

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**Public Input No. 35-NFPA 70E-2020 [Section No. J.1]****J.1 Energized Electrical Work Permit Sample.**

Figure J.1 illustrates considerations for an energized electrical work permit.

Figure J.1 Sample Permit for Energized Electrical Work.

ENERGIZED ELECTRICAL WORK PERMIT	
PART I: TO BE COMPLETED BY THE REQUESTER:	
Job/Work Order Number _____	
(1) Description of circuit/equipment/job location: _____	
(2) Description of work to be done: _____	
(3) Justification of why the circuit/equipment cannot be de-energized or the work deferred until the next scheduled outage: _____	
Requester/Title _____	Date _____
PART II: TO BE COMPLETED BY THE ELECTRICALLY QUALIFIED PERSONS DOING THE WORK:	
(1) Detailed description of the job procedures to be used in performing the above detailed work: _____	Check when complete ☐
(2) Description of the safe work practices to be employed: _____	☐
(3) Results of the shock risk assessment: _____	☐
(a) Voltage to which personnel will be exposed _____	☐
(b) Limited approach boundary _____	☐
(c) Restricted approach boundary _____	☐
(d) Necessary shock, personal, and other protective equipment to safely perform assigned task _____	☐
(4) Results of the arc flash risk assessment: _____	☐
(a) Available incident energy at the working distance or arc flash PPE category _____	☐
(b) Necessary arc flash personal and other protective equipment to safely perform the assigned task _____	☐
(c) Arc flash boundary _____	☐
(5) Means employed to restrict the access of unqualified persons from the work area: _____	☐
(6) Evidence of completion of a job briefing, including discussion of any job-related hazards: _____	☐
(7) Do you agree the above-described work can be done safely? ☐ Yes ☐ No (If no, return to requester.)	
Electrically Qualified Person(s) _____	Date _____
Electrically Qualified Person(s) _____	Date _____
PART III: APPROVAL(S) TO PERFORM THE WORK WHILE ELECTRICALLY ENERGIZED:	
Manufacturing Manager _____	Maintenance/Engineering Manager _____
Safety Manager _____	Electrically Knowledgeable Person _____
General Manager _____	Date _____
Note: Once the work is complete, forward this form to the site Safety Department for review and retention.	
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NFPA 70E	

Statement of Problem and Substantiation for Public Input

Add "electric" before "shock" in the locations where shock is mentioned in Figure J.1 to distinguish electric shock from the type of shock used in Article 360 including within the definition of Arc Blast Hazard (A source of possible injury or damage to health from the energy deposited into acoustical shock-wave and high-velocity shrapnel.) and correlate with its use throughout NFPA 70E such as how it is presently used in numerous locations throughout 130.7. I had no way to modify the text in Figure J.1.

Related Public Inputs for This Document**Related Input**

[Public Input No. 15-NFPA 70E-2020 \[Definition: Shock Hazard.\]](#)

[Public Input No. 28-NFPA 70E-2020 \[Section No. 130.7\]](#)

[Public Input No. 30-NFPA 70E-2020 \[Chapter 3\]](#)

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Public Input No. 319-NFPA 70E-2021 [Annex K]

Informative Annex K General Categories of Electrical Hazards

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

K.1 General.

Electrical injuries represent a serious workplace health and safety issue to electrical and non-electrical workers. Data from the U.S. Bureau of Labor Statistics (BLS) indicate that there were nearly 6000 fatal electrical injuries to workers in the United States from 1992 through 2012. BLS data also indicate that there were 24,100 non-fatal electrical injuries from 2003 through 2012. From 1992 to 2013, the number of fatal workplace electrical injuries has fallen steadily and dramatically from 334 in 1992 to 139 in 2013. However, the trend with non-fatal electrical injuries is less consistent. Between 2003 and 2009, non-fatal injury totals ranged from 2390 in 2003 to 2620 in 2009, with a high of 2950 injuries in 2005. Non-fatal injury totals between 2010 through 2012 were the lowest over this 10-year period, with 1890 non-fatal injuries in 2010, 2250 in 2011, and 1700 in 2012.

~~There are two general categories of electrical injury: electrical shock and electrical burns. Electrical burns can be further subdivided into burns caused by radiant energy (arc burns), burns caused by exposure to ejected hot gases and materials (thermal burns), and burns caused by the conduction of electrical current through body parts (conduction burns). In addition, hearing damage can occur from acoustic energy, and traumatic injury can be caused by toxic gases and pressure waves associated with an arcing event.~~

About 98 percent of fatal occupational electrical 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.

There are two general categories of electrical hazards: electric shock events and arcing events commonly called arc flash, each of which are discussed separately in this Annex.

K.2 Electric Shock.

Over 40 percent of all electrical fatalities in the U.S. involved overhead power line contact. This includes overhead power line fatalities from direct contact by a worker, contact through hand-carried objects, and contact through machines and vehicles. Comparing the ratio of total electrical fatalities to total electrical injuries (fatal and nonfatal), it was noticed that electrical injuries are more often fatal than many other injury categories. For example, from 2003 to 2009 there were 20,033 electrical injuries of which 1573 were fatalities. One worker died for every 12.74 electrical injuries. For the same period there were 1,718,219 fall injuries of which 5279 were fatalities — one worker died for every 325 injuries.

Of those, 1573 were electrical fatalities. A more detailed look at the demographics for 168 electrical fatalities in 2009 showed that 99 percent of deaths were the result of electrocution, and 70 percent occurred while the worker was performing a constructing, repairing, or cleaning activity.

Shock injuries can be divided into the thermal effect of electric current on the human body and the effect of electric current on the body's nervous system. The thermal effect can result in skin burns that may require skin grafting, and if deep enough into subcutaneous tissue may require amputation of the affected body part. The effect on the nervous system can include loss of voluntary muscle control, asphyxiation, ventricular fibrillation and cardiac arrest.

K.5—

K.3 Arc Flash.

In the recently issued 29 CFR Subpart V, OSHA identified 99 injuries that involved burns from arcs from energized equipment faults or failures, resulting in 21 fatalities and 94 hospitalized injuries for the period January 1991 through December 1998.

Based on this data, OSHA estimated that an average of at least eight burn injuries from arcs occur each year involving employees doing work covered by OSHA rules, leading to 12 non-fatal injuries and two fatalities per year. Of the reports indicating the extent of the burn injury, 75 percent reported third-degree burns.

During the period involved, Federal OSHA only required non-fatal injuries to be reported when there were three or more workers hospitalized. OSHA found that there were six injuries for every fatality in California, which requires the reporting of every hospitalized injury.

Using that data, OSHA estimated that would be at least 36 injuries to every fatality, and probably many more. Also, many non-fatal electric shocks involve burns from associated electric arcs.

Starting January 1, 2015, Federal OSHA requires every hospitalized injury to be reported.

K.4 Arc Blast.

~~The tremendous temperatures of the arc cause the explosive expansion of both the surrounding air and the metal in the arc path. For example, copper expands by a factor of 67,000 times when it turns from a solid to a vapor. The danger associated with this expansion is one of high pressures, sound, and shrapnel. The high pressures can easily exceed hundreds or even thousands of pounds per square foot, knocking workers off ladders, rupturing eardrums, and collapsing lungs. Finally, material and molten metal are expelled away from the arc at speeds exceeding 1120 km/hr (700 mph), fast enough for shrapnel to completely penetrate the human body.~~

Four types of energies are released by an arcing event, each with different effects on the human body.

Thermal Energy . The thermal energy developed by an arcing event is conveyed radiantly, convectively and conductively from the arc to a worker. Depending on the thermal density of this energy, skin burns can result to skin directly exposed to the energy, and from clothing ignition and burning transferring additional thermal energy. Internal burns can occur in the upper respiratory system such as the mouth, throat and nose due to inhalation of hot gasses produced by burning clothing.

Blast Pressure Energy . At one time it was proposed that the vaporization of copper or other metals by the arc produced life-threatening blast pressures. Recent research into arc pressure phenomena does not support this theory. While it is true that copper expands several thousand times in volume when transformed from a metal to a vapour, only a small amount of copper that is in or is immediately adjacent to the arc plasma stays in a vapour state. Beyond the plasma, the copper vapor drops below the vaporization temperature and condenses into molten copper or reacts chemically and becomes a copper compound. Research has shown that arc blast pressure is primarily a function of containment of the expanding air surrounding the arc in an enclosure. When the pressure exceeds the sheer strength of the enclosure hardware the enclosure can fail resulting in a sudden release of pressure and possibly door ejection. This can cause physical trauma either directly (i.e., struck by) or indirectly (i.e., pushed into or over).

Research also indicates that the arc blast pressures that result for containment and enclosure failure are substantially less than pressures previously proposed by the vaporization of copper theory, and that the pressure is negligible for an open enclosure (i.e., if the enclosure door is open). Research has also shown that there is no correlation of pressure to incident energy.

Arcing fault pressure should be considered in the risk assessment process. Until such time that this hazard can be quantified as is currently done with the thermal component of arc energy, workers should operate equipment with high potential fault current while standing to the side of the equipment or should use remote racking or other measures to prevent "line-of-fire" injuries. Arc blast pressure injuries can be prevented by arc resistant equipment that is designed to contain and shunt the arc energies away from the worker, provided the equipment is in the arc-resistant configuration.

Acoustic (Sound) Energy . The instantaneous conversion of metal and gasses to plasma can produce sound pressure levels in excess of 130 dB. According to the Centers for Disease Control and Prevention (CDC) an instantaneous sound pressure level of 120 dB or more can cause immediate harm hearing.

Light energy . The name of the phenomenon, "arc flash" came from the intense light produced by an electric arc. Documented test research indicates that the light intensity produced by an arcing event depends on a variety of factors such as voltage, current.

Tests also indicate that the relative luminosity (i.e., the brightness which is observed by someone in front of the arcing event) is affected by the proximity to the arc, conductor configuration (vertical or horizontal) and whether the arc is in an enclosure, and if so, the enclosure dimensions. Tests conducted at various measuring distances indicate that light intensity increases exponentially when the measurement distance was reduced. The light produced during arcing events in enclosures tend to be less visible as it becomes blocked by smoke.

A series of tests in enclosures performed at 2.7 kV with available fault currents between 20 and 40 kA the measured light intensity at 3.4 m varied from 1.9 million to 19 million lux. In another series of tests in enclosures conducted at 600 V with an available fault current of 20 kA the measured light intensity at 3 m was 2.6 million lux. By way of comparison, bright sunlight provides an illuminance of approximately 98,000 lux on a perpendicular surface at sea level.

K.4 Other Information.

For additional information, the following documents are available:

Occupational Injuries From Electrical Shock and Arc Flash Events Final Report , by Richard Campbell, and David Dini, Sponsored by The Fire Protection Research Foundation, Quincy, MA.

Occupational Electrical Injuries in the US, 2003–2009 , by James Cawley and Brett C. Banner, ESFI.

Technical paper ESW 2012-24 presented at IEEE ESW conference, *Arc Flash Hazards, Incident Energy, PPE Ratings and Thermal Burn Injury — A Deeper Look* , by Tammy Gammon, Wei-Jen Lee, and Ben Johnson.

Technical Paper ESW 2015-17 presented at IEEE ESW conference, OSHA Subpart V, *Electric Power and Distribution* , April 11, 2014.

"Arc Flash Pressure Measurement by the Physical Method, Effect of Metal Vapor on Arc Blast" published in IEEE Transactions on Industry Applications, vol. 53, no. 2, pp. 1576-1582, March-April 2017, by E. H. Hoagland, C. Maurice, A. Haines and A. Maurice

"Arc Flash Pressure and Door Ejection Measurement" published in IEEE Transactions on Industry Applications, vol. 56, no. 4, pp. 3297-3305, July-Aug. 2020, by H. Hoagland, C. Maurice, A. Haines and A. Maurice

"Arc Flash Light Intensity Measurement System Design" published in IEEE Transactions on Industry Applications, vol. 51, no. 5, pp. 4267-4274, Sept.-Oct. 2015, by W. Lee, Z. Zhang, S. Rau, T. Gammon, B. C. Johnson and J. Beyreis

"Arc Flash Visible Light Intensity as Viewed From Human Eyes" published in IEEE Transactions on Industry Applications, vol. 53, no. 5, pp. 5068-5077, Sept.-Oct. 2017, by S. Rau, Z. Zhang, W. Lee and D. A. Dini

Statement of Problem and Substantiation for Public Input

Note: It appears that Terra View has made a bit of a mess of this input. Several paragraphs have been underlined although they are existing and not new.

Rationale: The proposed revision to K.1 more accurately states that there are two general types of hazards rather than injuries. There are in fact a broad spectrum of injuries that can result from the two hazards. Relevant information from the deleted paragraph has been

relocated to other sections of Annex K.

The proposed revisions to K.2 through K.4 are based on updated understanding of arcing event energies and related injuries found in peer reviewed published information, the citations of which are provided.

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**Public Input No. 37-NFPA 70E-2020 [Annex K]****Informative Annex K** General Categories of Electrical Hazards

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

K.1 General.

Electrical injuries represent a serious workplace health and safety issue to electrical and non-electrical workers. Data from the U.S. Bureau of Labor Statistics (BLS) indicate that there were nearly 6000 fatal electrical injuries to workers in the United States from 1992 through 2012. BLS data also indicate that there were 24,100 non-fatal electrical injuries from 2003 through 2012. From 1992 to 2013, the number of fatal workplace electrical injuries has fallen steadily and dramatically from 334 in 1992 to 139 in 2013. However, the trend with non-fatal electrical injuries is less consistent. Between 2003 and 2009, non-fatal injury totals ranged from 2390 in 2003 to 2620 in 2009, with a high of 2950 injuries in 2005. Non-fatal injury totals between 2010 through 2012 were the lowest over this 10-year period, with 1890 non-fatal injuries in 2010, 2250 in 2011, and 1700 in 2012.

There are two general categories of electrical injury: ~~electrical~~ electric shock and electrical burns. Electrical burns can be further subdivided into burns caused by radiant energy (arc burns), burns caused by exposure to ejected hot gases and materials (thermal burns), and burns caused by the conduction of electrical current through body parts (conduction burns). In addition, hearing damage can occur from acoustic energy, and traumatic injury can be caused by toxic gases and pressure waves associated with an arcing event.

About 98 percent of fatal occupational electrical injuries are ~~electrical~~ electric 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.

K.2 Electric Shock.

Over 40 percent of all electrical fatalities in the U.S. involved overhead power line contact. This includes overhead power line fatalities from direct contact by a worker, contact through hand-carried objects, and contact through machines and vehicles. Comparing the ratio of total electrical fatalities to total electrical injuries (fatal and nonfatal), it was noticed that electrical injuries are more often fatal than many other injury categories. For example, from 2003 to 2009 there were 20,033 electrical injuries of which 1573 were fatalities. One worker died for every 12.74 electrical injuries. For the same period there were 1,718,219 fall injuries of which 5279 were fatalities — one worker died for every 325 injuries.

Of those, 1573 were electrical fatalities. A more detailed look at the demographics for 168 electrical fatalities in 2009 showed that 99 percent of deaths were the result of electrocution, and 70 percent occurred while the worker was performing a constructing, repairing, or cleaning activity.

K.3 Arc Flash.

In the recently issued 29 CFR Subpart V, OSHA identified 99 injuries that involved burns from arcs from energized equipment faults or failures, resulting in 21 fatalities and 94 hospitalized injuries for the period January 1991 through December 1998.

Based on this data, OSHA estimated that an average of at least eight burn injuries from arcs occur each year involving employees doing work covered by OSHA rules, leading to 12 non-fatal injuries and two fatalities per year. Of the reports indicating the extent of the burn injury, 75 percent reported third-degree burns.

During the period involved, Federal OSHA only required non-fatal injuries to be reported when there were three or more workers hospitalized. OSHA found that there were six injuries for every fatality in California, which requires the reporting of every hospitalized injury.

Using that data, OSHA estimated that would be at least 36 injuries to every fatality, and probably many more. Also, many non-fatal electric shocks involve burns from associated electric arcs.

Starting January 1, 2015, Federal OSHA requires every hospitalized injury to be reported.

K.4 Arc Blast.

The tremendous temperatures of the arc cause the explosive expansion of both the surrounding air and the metal in the arc path. For example, copper expands by a factor of 67,000 times when it turns from a solid to a vapor. The danger associated with this expansion is one of high pressures, sound, and shrapnel. The high pressures can easily exceed hundreds or even thousands of pounds per square foot, knocking workers off ladders, rupturing eardrums, and collapsing lungs. Finally, material and molten metal are expelled away from the arc at speeds exceeding 1120 km/hr (700 mph), fast enough for shrapnel to completely penetrate the human body.

K.5 Other Information.

For additional information, the following documents are available:

Occupational Injuries From Electrical Shock and Arc Flash Events Final Report, by Richard Campbell, and David Dini, Sponsored by The Fire Protection Research Foundation, Quincy, MA.

Occupational Electrical Injuries in the US, 2003–2009, by James Cawley and Brett C. Banner, ESFI.

Technical paper ESW 2012-24 presented at IEEE ESW conference, *Arc Flash Hazards, Incident Energy, PPE Ratings and Thermal Burn Injury — A Deeper Look*, by Tammy Gammon, Wei-Jen Lee, and Ben Johnson.

Technical Paper ESW 2015-17 presented at IEEE ESW conference, OSHA Subpart V, *Electric Power and Distribution*, April 11, 2014.

Statement of Problem and Substantiation for Public Input

"Electrical" was revised to "electric" to correlate with the use of the term electric shock as used in K.2 and elsewhere throughout NFPA 70E including numerous existing locations in 130.7.

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 15-NFPA 70E-2020 [Definition: Shock Hazard.]	related issue
Public Input No. 28-NFPA 70E-2020 [Section No. 130.7]	related issue

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**Public Input No. 226-NFPA 70E-2021 [Annex O]****Informative Annex O Safety-Related Design Requirements Considerations**

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

O.1 Introduction.

This informative annex addresses the responsibilities of the facility owner or manager or the employer having responsibility for facility ownership or operations management to perform a risk assessment during the design of electrical systems and installations.

O.1.1

This informative annex covers employee safety-related design concepts for electrical equipment and installations in workplaces covered by the scope of this standard. This informative annex discusses design considerations that have impact on the application of the safety-related work practices only.

O.1.2

This informative annex does not discuss specific design requirements. The facility owner or manager or the employer should choose design options that eliminate hazards or reduce risk and enhance the effectiveness of safety-related work practices.

O.2 General Design Considerations.**O.2.1**

Employers, facility owners, and managers who have responsibility for facilities and installations having electrical energy as a potential hazard to employees and other personnel should ensure that electrical hazard risk assessments are performed during the design of electrical systems and installations.

O.2.2

Design option decisions should facilitate the ability to eliminate hazards or reduce risk by doing the following:

- (1) Reducing the likelihood of exposure
- (2) Reducing the magnitude or severity of exposure
- (3) Enabling achievement of an electrically safe work condition

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.
- (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.

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.

Statement of Problem and Substantiation for Public Input

In accordance with 90.4(D) of this standard, Annex O is informative and does not provide any requirements. The title should reflect the design-related considerations and content.

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**Public Input No. 38-NFPA 70E-2020 [Annex O]****Informative Annex O Safety-Related Design Requirements**

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

O.1 Introduction.

This informative annex addresses the responsibilities of the facility owner or manager or the employer having responsibility for facility ownership or operations management to perform a risk assessment during the design of electrical systems and installations.

O.1.1

This informative annex covers employee safety-related design concepts for electrical equipment and installations in workplaces covered by the scope of this standard. This informative annex discusses design considerations that have impact on the application of the safety-related work practices only.

O.1.2

This informative annex does not discuss specific design requirements. The facility owner or manager or the employer should choose design options that eliminate hazards or reduce risk and enhance the effectiveness of safety-related work practices.

O.2 General Design Considerations.**O.2.1**

Employers, facility owners, and managers who have responsibility for facilities and installations having electrical energy as a potential hazard to employees and other personnel should ensure that electrical hazard risk assessments are performed during the design of electrical systems and installations.

O.2.2

Design option decisions should facilitate the ability to eliminate hazards or reduce risk by doing the following:

- (1) Reducing the likelihood of exposure
- (2) Reducing the magnitude or severity of exposure
- (3) Enabling achievement of an electrically safe work condition

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 electric 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.
- (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.

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 electric 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.

Statement of Problem and Substantiation for Public Input

Add "electric" before "shock" in the locations where shock is mentioned to distinguish electric shock from the type of shock used in Article 360 including within the definition of Arc Blast Hazard (A source of possible injury or damage to health from the energy deposited into acoustical shock-wave and high-velocity shrapnel.) and correlate with its use throughout NFPA 70E such as how it is presently used in numerous locations throughout 130.7.

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 15-NFPA 70E-2020 [Definition: Shock Hazard.]	related issue
Public Input No. 28-NFPA 70E-2020 [Section No. 130.7]	related issue
Public Input No. 30-NFPA 70E-2020 [Chapter 3]	related issue

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**Public Input No. 55-NFPA 70E-2021 [Annex O]****Informative Annex O— Annex O Employee Safety-Related Design Requirements Concepts and Facility Responsibilities**

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

O.1 Introduction.

This informative annex addresses the responsibilities of the facility owner or manager or the employer having responsibility for facility ownership or operations management to perform a risk assessment during the design of electrical systems and installations.

O.1.1

This informative annex covers employee safety-related design concepts for electrical equipment and installations in workplaces covered by the scope of this standard. This informative annex discusses design considerations that have impact on the application of the safety-related work practices only.

O.1.2

This informative annex does not discuss specific design requirements. The facility owner or manager or the employer should choose design options that eliminate hazards or reduce risk and enhance the effectiveness of safety-related work practices.

O.2 General Design Considerations.**O.2.1**

Employers, facility owners, and managers who have responsibility for facilities and installations having electrical energy as a potential hazard to employees and other personnel should ensure that electrical hazard risk assessments are performed during the design of electrical systems and installations.

O.2.2

Design option decisions should facilitate the ability to eliminate hazards or reduce risk by doing the following:

- (1) Reducing the likelihood of exposure
- (2) Reducing the magnitude or severity of exposure
- (3) Enabling achievement of an electrically safe work condition

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.
- (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.

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.

Statement of Problem and Substantiation for Public Input

This recommendation is only to modify the title of Informative Annex O. The word "requirements" must be deleted as an informational annex cannot contain requirements. Further, O.1.2 states that "[t]his informative annex does not discuss specific design requirements." The phrase title of Informative Annex O is further modified to recognize that purpose and responsibilities set forth in the Introduction (O.1) and Section O.1.1 of Informative Annex O as follows:

O.1 Introduction.

This informative annex addresses the responsibilities of the facility owner or manager or the employer having responsibility for facility ownership or operations management to perform a risk assessment during the design of electrical systems and installations.

O.1.1

This informative annex covers employee safety-related design concepts for electrical equipment and installations in workplaces covered by the scope of this standard. This informative annex discusses design considerations that have impact on the application of the safety-related work practices only.

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Submission Date: Wed Feb 24 14:48:07 EST 2021

Committee: EEW-AAA

**Public Input No. 376-NFPA 70E-2021 [New Section after O.2.4]****Add additional content**

(13) use of High impedancxe protected test points for volatge measurment thorough door Permananetly mounted accessories that are listed to UI 61010. also allows for phase sequence test and rotation

Statement of Problem and Substantiation for Public Input

Safety-by-design methods for voltage testing

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**Public Input No. 331-NFPA 70E-2021 [Section No. O.2.4]****O.2.4 Additional Safety-by-Design Methods.**

The following methods have proven to be effective in reducing risk associated with an arc flash or shock hazard:

- (1) Installing finger-safe components, covers, and insulating barriers reduces exposure to energized parts.
- (2) Installing ~~disconnects~~ Energy Isolation devices within sight of each ~~motor or driven machine~~ machinery or electrical equipment such as motors and transformers increases the likelihood that the equipment will be put into an electrically safe work condition before work has begun. ~~It also reduces potential of human error of incorrect identification of energy isolation devices.~~
- (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 by providing short circuit protection..~~
- (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.

Statement of Problem and Substantiation for Public Input

In item (2), Disconnect has been replaced by Energy Isolation device. Motors and driven machinery has been replaced by machinery or equipment to align text with 120.3

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 320-NFPA 70E-2021 [Article 100]	

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**Public Input No. 39-NFPA 70E-2020 [Annex R]****Informative Annex R** Working with Capacitors**R.1** Introduction.

Capacitors have the ability to store electrical energy after the source power has been disconnected. While many systems with capacitors are built with bleed resistors that automatically discharge the stored energy within a set time, these systems can sometimes fail, leaving a thermal, electric shock, arc flash, or arc blast hazard. Some capacitor systems might not have built-in bleed resistors. This informative annex provides detailed guidance on how to properly assess the risk in working with capacitors and implement suitable controls.

R.2 Qualification and Training.**R.2.1** Qualifications.

Employees who perform work on electrical equipment with capacitors that exceed the energy thresholds in 360.3 should be qualified persons as required in Chapter 1 and should be trained in, and familiar with, the specific hazards and controls required for safe work.

R.2.2 Unqualified Persons.

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

R.3– 3 Electric Shock Hazard.

R.3.1 General.

The ~~capacitor~~ electric shock hazard from a capacitor to a person is an impulse electric shock with an exponential decay curve. The severity of the electric shock is related to the amount of energy (joules) delivered and the time in which the energy is delivered. Injuries from electric shock caused by a 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 electric 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 electric shock circuit and Figure R.3.1(b) for a capacitive discharge curve.]

Figure R.3.1(a) Capacitor Electric Shock Circuit.

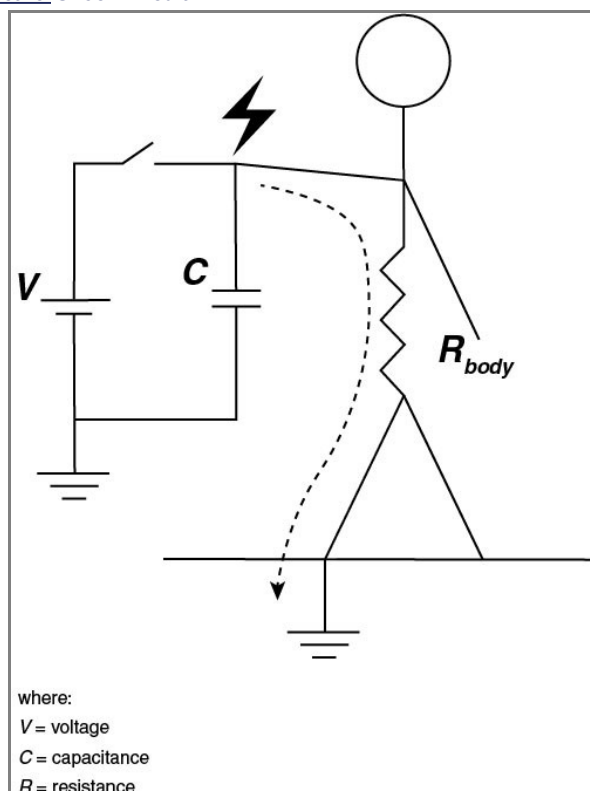
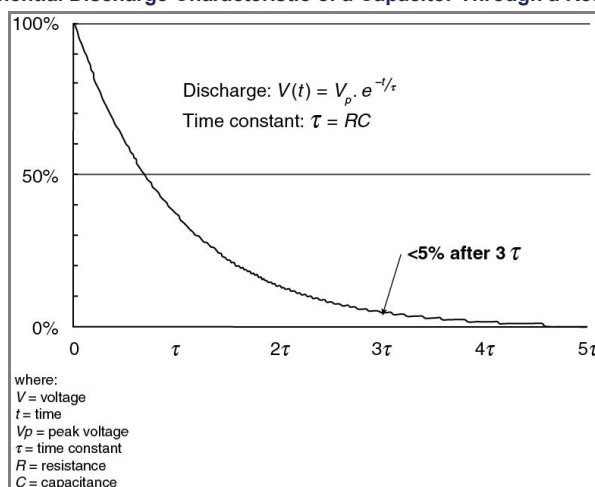


Figure R.3.1(b) Typical Exponential Discharge Characteristic of a Capacitor Through a Resistor.



R.3.2 Duration of Discharge.

The duration of a capacitive discharge electric shock is independent of voltage and is generally assumed to be three times the time constant of the electric shock circuit. After three time constants, the voltage is reduced by 95 percent, and the energy has been reduced by 99.25 percent. The time constant, τ , is equal to body electric shock pathway resistance times capacitance, as follows:

$$\tau = RC \quad [\text{R.3.2}]$$

R.3.3 Current Delivered.

The current delivered by the electric shock is independent of capacitance and is proportional to the initial peak voltage and inversely proportional to electric shock pathway resistance. Assuming that all of the stored energy is delivered in 3τ , the rms equivalent current can be expressed as follows:

$$I_{rms} = \frac{V_p}{R\sqrt{6}} \quad [\text{R.3.3}]$$

where:

I_{rms} = rms current

V_p = peak voltage

R = pathway resistance

R.3.4–4 Electric Shock Pathway.

The electric shock pathway resistance depends on skin resistance, entry and exit locations, and internal body resistance. The severity of a capacitor discharge electric shock depends on the time of delivery (quickly or slowly) and the energy delivered. A capacitor disconnected from a live voltage source has only a finite amount of energy and can deliver that energy either quickly or slowly, depending on specific electric shock pathway resistance. As electric shock pathway resistance increases, the current lowers but the time to discharge also takes longer, and vice versa. Below 400 volts, skin breakdown is less likely and skin resistance (over 10,000 ohms for intact skin) will significantly reduce the electric shock current and extend discharge time. For punctured, broken, or very wet skin, the contact resistance is 0 ohms to 100 ohms.

R.3.5 Response to Electric Shock Levels.

For a given stored energy, there is a difference in response to whether it is a high-voltage, low-capacitance electric shock, or a low-voltage, high-capacitance electric shock. At high voltage and low capacitance, a hazardous electric shock will fully discharge nearly instantaneously (in microseconds) and could miss the vulnerable part of the heart cycle. However, the full energy is delivered to the person and there could be nerve or other tissue damage. At low voltage and high capacitance, the total discharge time can extend several seconds (multiple heart beats), behaving more like a dc electric shock. Both scenarios remain highly hazardous as fibrillation could still occur.

Informational Note: For more information on impulse electric shock hazards, see IEC TS 60479-2, *Effects of Current on Humans and Livestock, Part 2, Special Aspects*.

R.3.6 Reflex Hazard.

Even when fibrillation does not occur, there remains the potential for serious bodily injury, especially above 400 volts. The reflex action to an impulse electric shock can be severe, causing persons to fall off of elevated platforms or ladders, knock a body part into nearby objects, or in some cases cause severe muscle clenching, temporary paralysis, or dislocated joints. This reflex hazard extends to lower energies even where fibrillation is unlikely. The lower threshold for hazardous reflex shocks is 0.25 joules for over 400 volts.

R.3.7–7 Electric Shock Hazard Thresholds.

Capacitors connected to conductors or circuit parts operating at voltages equal to or greater than 100 volts and containing a stored energy equal to or greater than 10 joules present a significant risk of electric shock and fibrillation. Below 10 joules, a significant risk of reflex action leading to injury could exist in the following situations:

- (1) 100 volts–400 volts: if the stored energy is greater than 1 joule
- (2) >400 volts: if the stored energy is greater than 0.25 joules

R.4 Short-Circuit Hazard.

Capacitors have the unique ability to discharge very rapidly in a shorted condition due to their low internal impedance. In ac power systems, faults typically occur on the order of milliseconds and are limited by transformer impedances. Battery faults take seconds or minutes to discharge. In contrast, capacitors have very little internal impedance and can fully discharge in microseconds, with very high discharge current. This current can cause heating of metals, arc flash injury, and arc blast injury, dependent on the stored energy in the capacitor. The electric shock injuries, including reflex and fibrillation, are discussed in R.3.7. Additional hazards that can result from capacitor energy include those discussed in R.4.1 through R.4.3.

R.4.1 Thermal Hazard.

At around 100 joules, a short through a metal object in contact with the worker, such as a ring or tool, can cause rapid heating and burns to the skin. Above 1 kJ, there can be substantial heating of metal, arcing, and magnetic forces causing mechanical deformation. Above 10 kJ, there is massive conductor melting, massive magnetic/mechanical motion, and an arc blast hazard.

R.4.2 Arc Flash Hazard.

At approximately 120 kJ, there exists sufficient stored energy to create an arc flash hazard (greater than 1.2 cal/cm² at a working distance of 18 in.). This is a conservative lower bound that assumes all of the stored energy has been converted to radiant heat. The threshold of 120 kJ could be lower for a capacitor in a box. There could be an additional contribution to the arc flash energy from an ac or dc source connected to the capacitor or capacitor bank.

R.4.3 Arc Blast Hazard.

Capacitors can have a significant arc blast hazard due to the very high short-circuit current involved. The effects of the acoustic shock wave can rupture eardrums and collapse lungs. While hearing protection should be used above 100 joules to mitigate against hearing damage, there is no PPE for protection against lung collapse, which becomes a hazard above 122 kJ.

R.5 Internal Rupture.**R.5.1 High Currents.**

When a capacitor is subjected to high currents, such as a short circuit condition, internal stresses could result in violent rupture of the capacitor enclosure.

R.5.2 Internal Failure.

When capacitors are used to store large amounts of energy, internal failure of one capacitor in a bank could result in the rupture and explosion of the failed capacitors when all other capacitors in the bank discharge into the fault. Fuses or inductive elements are often used to limit the fault current from a capacitor bank into a faulted individual capacitor. Improperly sized fuses or inductive elements for this application could explode.

R.5.3 Fire Hazard.

Rupture of a capacitor can create a fire hazard from ignition of the dielectric fluids. Dielectric fluids can release toxic gases when decomposed by fire or the heat of an electric arc.

R.6 Performing a Risk Assessment for Capacitors.**R.6.1 Annex F.**

The risk assessment process for capacitors can follow the overall risk management process found in Annex F. This risk assessment should be coordinated with the electric shock risk assessment of 130.4 and the arc flash risk assessment of 130.5.

R.6.2 Exposure to Stored Energy.

Whether there is an exposure to capacitor stored energy hazard should be determined. An exposure would exist when a conductor or circuit part that could potentially remain energized with hazardous stored energy is not properly guarded, enclosed, or insulated. All circuit parts that are electrically connected to a capacitor or capacitor bank could present this hazard. For example, a power factor correction bank could be in a completely separate enclosure; however, should the bank remained charged for some reason, the switchgear to which it is connected could also deliver the stored energy hazard.

R.6.3 Determining Shock Hazard.

The shock hazard should be determined using both the voltage and stored energy of the capacitor. A high-voltage capacitor is not a shock hazard below the energy threshold of 0.25 joules. Use the shock risk assessment process of 130.4 and the dc shock approach boundaries (for capacitors above 100 volts and 0.25 joules) and PPE ratings.

R.6.4 Determining Total Stored Energy.

The total capacitor stored energy (see R.8) of the system should be determined.

R.6.5 Determining Arc Flash.

The arc flash hazard (see R.9) should be determined. If stored energy is greater than 120 kJ, the arc flash incident energy and the arc flash boundary should be determined at the appropriate working distance. Appropriate arc flash PPE should be selected accordingly, but workers should always remain out of the arc blast lung protection boundary (see R.6.6).

R.6.6 Determining Arc Blast Hazard.

The arc blast hazard (see R.10) should be determined. Hearing protection should be used where the stored energy exceeds 100 joules. Where the stored energy exceeds 10 kJ, the hearing protection boundary should be calculated. If stored energy is above 122 kJ, determine the arc blast boundary for lung hazards. A lung collapse hazard could exist above 122 kJ. DO NOT ENTER THE LUNG PROTECTION BOUNDARY. There is no PPE for lung protection.

R.6.7 Determine the Test and Grounding Method.

(See R.11.)

R.6.8 Determining Discharge Time.

If capacitors are equipped with bleed resistors, or if using a soft grounding system, the required discharge wait time should be determined where applicable (see R.12). After the discharge time a hard ground stick or hard grounding system should be applied.

R.6.9 Written Discharge Procedure.

A written discharge procedure should be developed that captures all of the steps to place the equipment into an electrically safe work condition. 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 energy, and what to do if there is still stored energy present should be included.

R.6.10 Labeling.

Labeling the equipment with a hazard warning label (see R.15) should be considered so that qualified persons are made aware of the potential for stored energy and the need for a written discharge procedure. The maximum voltage and stored energy should be included.

R.7 Determining the Electric Shock Hazard.

R.7.1 Risk Assessment.

A- An electric shock risk assessment should be performed for capacitors exceeding the thresholds in 360.3 in accordance with 130.4. Shock- Electric shock approach boundaries are based on the peak voltage and the dc electric shock approach boundaries of Table 130.4(E)(b). Appropriately rated electric shock protection PPE, such as voltage-rated gloves and dielectric insulating sheeting, should be selected. The dc ratings for rubber insulated products should be used. (See ASTM D120, *Standard Specification for Rubber Insulating Gloves*, for dc ratings.) The restricted approach boundary should be used to assist in the selection of the length and voltage rating of the ground stick. Capacitors below the thresholds defined in 360.3 are not electric shock hazards, and 130.4 does not apply. This includes capacitors from 0 volts to 100 volts and less than 100 joules, capacitors 100 volts to 400 volts and less than 1 joule, and capacitors greater than 400 volts and less than 0.25 joules.

R.7.2–2 _ Electric Shock PPE.

Shock- Electric shock protection PPE is required for all parts of the body that enter the restricted approach boundary for capacitor electric shock hazards defined in R.7.1. [See Table 130.4(E)(b).]

R.8 Determining Capacitor Stored Energy.**R.8.1 Capacitor Stored Energy.**

Determining capacitor stored energy could require detailed examination of schematics or manufacturer's information to properly determine both the peak voltage that will be applied to the capacitors and the total capacitance. The value of capacitance and the capacitor voltage rating can also be obtained from the labels on the capacitor, if done safely. Commercial capacitors often use unit labels of mF for millifarads and MF for microfarads.

R.8.2

The stored energy in a capacitor is calculated as follows:

$$E = \frac{1}{2} CV^2 \quad [\text{R.8.2}]$$

where:

E = capacitive stored energy in joules

C = total capacitance in farads

V = peak voltage in volts

R.8.3 Capacitor Calculations.

Total capacitance of capacitor banks is calculated as follows:

- (1) For capacitors in parallel, add the capacitance as follows:

$$C_{total} = C_1 + C_2 + C_3 + \dots \quad [\text{R.8.3a}]$$

- (2) For capacitors in series, use the following:

$$\frac{1}{C_{total}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \dots \quad [\text{R.8.3b}]$$

- (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:

$$C = \frac{Q}{2\pi fV^2} \quad [\text{R.8.3c}]$$

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 (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.

R.8.4 Voltage.

For peak voltage, the voltage applied across the capacitors that would cause the maximum charge should be used. For disconnected capacitors in storage or for disposal, the capacitor rated voltage should be used.

R.8.4.1

For dc systems, use the maximum available terminal voltage that could be applied to the capacitor by the system.

R.8.4.2

For ac systems, nominal system voltage is normally expressed in volts rms (root mean square). For capacitor stored energy calculations, use the peak amplitude of the voltage, V_p , as follows:

$$V_{rms} = \frac{1}{\sqrt{2}} V_p = 0.707 V_p \quad [\text{R.8.4.2a}]$$

(1) For single-phase ac systems, use peak ac voltage, as follows:

$$V_p = V_{rms} \sqrt{2} \quad [\text{R.8.4.2b}]$$

(2) For 3-phase wye-connected systems, use the peak phase-to-neutral ac voltage, as follows:

$$V_p = V_{\phi-N} \sqrt{2} \quad [\text{R.8.4.2c}]$$

(3) For 3-phase delta-connected systems, use the peak phase-to-phase ac voltage, as follows:

$$V_{cap} = V_{\phi-\phi} \sqrt{2} \quad [\text{R.8.4.2d}]$$

Informational Note: For the same capacitance, a delta-connected system will have a total energy three times higher than a wye-connected system. Always check the configuration as design requirements vary.

R.9 Determining the Arc Flash Hazard.**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.

$$IE_{open\ air} = \frac{\text{Energy}}{\text{Area}} = \frac{\frac{1}{2} CV^2}{4\pi r^2} = \frac{CV^2}{8\pi r^2} J / cm^2 \quad [\text{R.9.1a}]$$

Converting to cal/cm² (1 cal = 4.184 joules) we obtain the following:

$$IE_{open\ air} = \frac{CV^2}{105.1 r^2} = \frac{E}{52.6 r^2} cal / cm^2 \quad [\text{R.9.1b}]$$

where:

IE = incident energy

E = energy

C = capacitance

V = voltage

r = radius

R.9.2 Arc Flash Boundary.

The arc flash boundary, where $IE = 1.2 \text{ cal/cm}^2$, is then as follows:

$$AFB_{open\ air} = 0.126 \sqrt{E} (cm) = 0.05 \sqrt{E} (in.) \quad [\text{R.9.2a}]$$

In a box, we can apply a three times factor over the open-air incident energy calculation, as follows:

$$IE_{box} = 3 \times IE_{open\ air} \quad [\text{R.9.2b}]$$

$$AFB_{box} = \sqrt{3} \times AFB_{open\ air} \quad [\text{R.9.2c}]$$

where:

AFB = arc flash boundary

IE = incident energy

Thus, the minimum stored energy (lower bound) required to obtain 1.2 cal/cm^2 at a working distance of 18 in. is roughly 44 kJ in a box or 120 kJ in open air. Extreme caution should be used with the open-air calculation, as the arc flash boundary can fall inside the lung protection boundary for arc blast. A better practice is to always use the box arc flash boundary as a minimum approach distance.

R.10 Determining the Arc Blast Hazard.

R.10.1 Hazard.

The arc blast hazard is directly related to the instantaneous (initial) short circuit current. Since capacitors can discharge very rapidly, the shockwave generated by a capacitor discharge can cause barotrauma (overpressure injury) to persons in the area. The most sensitive organs are the ears, lungs, and brain. When a differential pressure across the eardrums exceeds around 20–35 kilopascals (3–5 psi), the eardrum can rupture. At 200 kilopascals (29 psi), lung damage can occur. The following formulas are used to estimate safe boundaries based on total stored energy, where “safe” is less than a 1 percent probability of eardrum rupture or lung injury:

$$R_{ear} = 49.29 \sqrt[3]{\frac{E}{1000}} - 5.09 \quad [\text{R.10.1a}]$$

$$R_{lung} = 31.32 \sqrt[3]{\frac{E}{1000}} - 155.45 \quad [\text{R.10.1b}]$$

where:

R_{ear} = eardrum rupture boundary (1 percent probability) in cm

R_{lung} = lung collapse boundary (1 percent probability) in cm

E = capacitor stored energy in joules

Informational Note: For more information about the derivation of these formulas, see Charles R. Hummer, Richard J. Pearson, and Donald H. Porschet, “*Safe Distances From a High-Energy Capacitor Bank for Ear and Lung Protection*,” Army Research Laboratory Report, ARL-TN-608, July 2014.

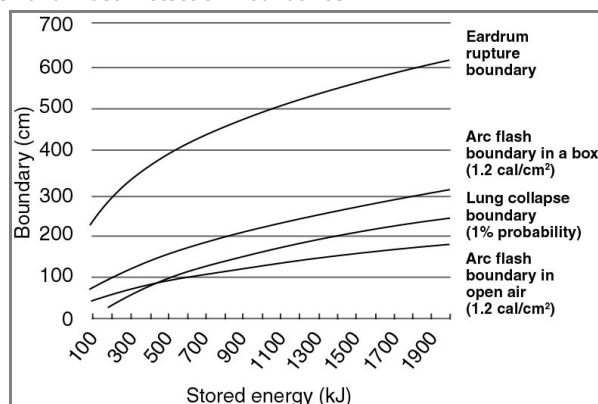
R.10.2 Above 122 kJ.

Above 122 kJ a lung collapse hazard can exist. It is not sufficient to wear arc flash PPE, as this will not protect against lung injury. Remain outside of the lung collapse boundary.

R.10.3 Above 448 kJ.

Above 448 kJ, the lung protection boundary will be greater than the arc flash boundary in open air calculated in R.9. A better practice is to always use the box arc flash boundary as a minimum approach distance. (See Figure R.10.3.)

Figure R.10.3 Plot of Arc Flash and Blast Protection Boundaries.

**R.11 Selecting the Appropriate Test and Grounding Method.****R.11.1 Method Selection.**

The method to safely discharge or verify discharge of a capacitor will vary depending on the degree of hazard. Low-voltage, low-energy capacitors can be verified de-energized with a properly rated test instrument meeting the requirements of 110.8 and/or hard grounded. At higher energy and voltage, soft grounding through a resistor could be needed to limit the discharge current. At very high energies (>100 kJ), manual testing or grounding can become a serious arc blast hazard, and remote metering and grounding should be performed.

R.11.2 Bleed Systems.

For systems with permanently installed bleed systems, testing for absence of voltage after the prescribed discharge time can be performed instead of applying grounds. Testing can also be performed as a means to verify absence of voltage after an automatically switched bleed system has grounded the system. In all cases, the test device must be rated for the system. (See Table R.11.9 for the appropriate test method.)

R.11.2.1

Below 1000 volts and below 10 kJ, a properly rated, high-impedance digital voltmeter (DVM) can be used.

R.11.2.2

Above 1000 volts and below 100 joules, a properly rated, high-impedance digital voltmeter (DVM) can be used with an approved attachment for measuring high-voltage dc on non-utility systems. On utility systems, a utility-grade, dc, resistive-type voltmeter must be used with a live-line tool.

R.11.2.3

Above 1000 volts and between 100 joules and 100 kJ, a utility-grade, dc, resistive-type voltmeter can be used with a live-line tool.

R.11.2.4

Above 100 kJ, engineered method can be used only for verifying absence of voltage.

R.11.3 Hard Grounding.

Hard grounding is the practice of shorting a capacitor from terminal to terminal and then directly to ground. Since the resistance is typically <0.1 ohm, the discharge time is rapid and the discharge current can be high. An intense spark and a loud noise can happen at higher energies. Above 100 joules there is a hearing damage hazard. The voltage reversal associated with using a hard ground can put excessive voltage stress on the capacitor. Since this is an equipment issue, check with the manufacturer for their recommendations.

R.11.4 Soft Grounding.

Soft grounding is the practice of discharging a capacitor through a resistor rated for the power. The resistor raises the time constant ($\tau = RC$) and reduces the peak discharge current ($I = V/R$) to safer levels. Soft discharge is necessary above 1000 joules.

R.11.5 End of Discharge Time.

At the conclusion of the specified discharge time, there is still voltage on the capacitors. A properly matched resistor and capacitor will reduce the voltage to less than 50 volts and the energy to less than 5 joules. At this point hard grounding is applied to fully short the capacitors to ground.

R.11.6 Resistor Connection Point.

Sometimes the grounding resistor is attached directly to the grounding stick. Other times, there are two separate grounding points built into the equipment itself. The grounding point labeled "High-Z" is the soft grounding point, where "High-Z" stands for high impedance. The grounding point labeled "Low-Z" is the hard grounding point, directly to ground. In this case the same ground stick is applied, first to the High-Z point, then to the Low-Z ground point. See Figure R.11.9.

R.11.7 Lung Protection Boundary.

The grounding method should keep all personnel clear of the lung protection boundary. For this reason, above 100 kJ, remote soft grounding is necessary.

R.11.8 Ground Sticks.

All ground sticks should meet the construction and periodic inspection requirements of R.16.

R.11.9 Use of Table for Method Selection.

See Table R.11.9, Figure R.11.9(a), and Figure R.11.9(b) for selection of the proper test and grounding methods.

Table R.11.9 Capacitor Test and Grounding Matrix to Establish Safe Discharge

Test Method				Grounding Method					
		0–100 volts	100–1 kV	>1 kV			0–100 volts	100–1 kV	>1 kV
< 0.25 joules	Not applicable	Not applicable	Not applicable	-	< 0.25 joules	Not applicable	Not applicable	Not applicable	
0.25–100 joules	Not applicable	DVM	DVM with HV adapter	-	0.25–100 joules	Not applicable	Hard ground ok	Hard ground ok	
100 joules–1 kJ	DVM	DVM	HV utility grade dc voltmeter	-	100 joules–1 kJ	Hard ground ok	Hard ground ok	Hard ground ok	
1 kJ–100 kJ	DVM	DVM	HV utility grade dc voltmeter	-	1 kJ–100 kJ	Soft ground then hard ground	Soft ground then hard ground	Soft ground then hard ground	
>100 kJ	Engineered method	Engineered method	Engineered method	-	>100 kJ	Remote grounding only	Remote grounding only	Remote grounding only	

Figure R.11.9(a) Illustration of Hard and Soft Grounding Examples

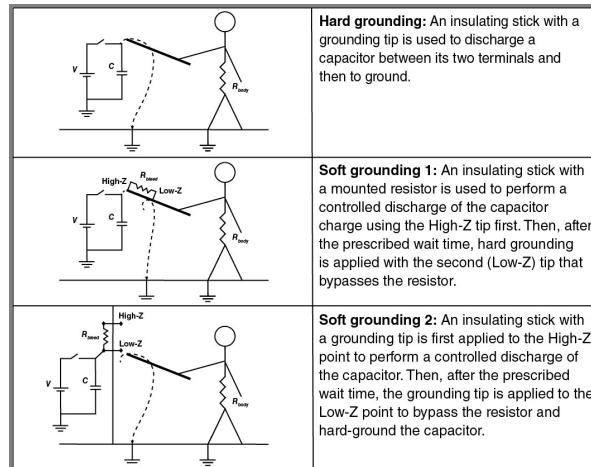
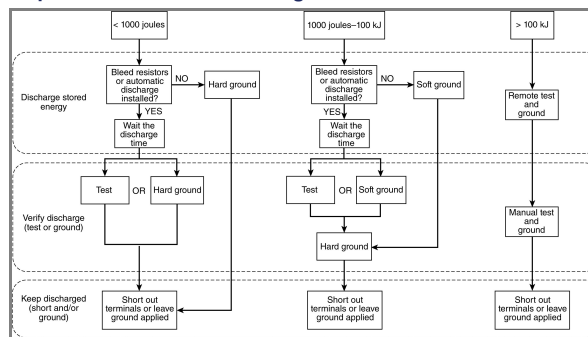


Figure R.11.9(b) Flowchart of Capacitor Test and Grounding Methods to Establish Safe Discharge



R.11.10 Other Considerations.

Other considerations are as follows:

- (1) Charge transfer: Grounding capacitors in series may transfer charge between capacitors rather than discharge the stored energy. Special precaution should be taken in selecting the tools and sequence necessary to discharge capacitors connected in series. Improper grounding can result in moving charge around and not fully discharging to ground. Capacitor cases are not always grounded and should be considered charged unless otherwise determined.
- (2) Dielectric absorption: Not all the energy in a capacitor is dissipated when it is short-circuited for a short time. Although the charge on the plates may be initially removed, dielectric polarization can cause charge to accumulate after the ground is removed. A voltage recharge of up to 10 percent can occur a few minutes after the grounding or shorting device has been removed. This can occur in capacitors with liquid dielectrics, such as an electrolytic capacitor, and in capacitors with solid dielectrics, such as polyethylene film capacitors.
- (3) High-voltage capacitors can build a charge in the presence of high electric fields.
- (4) A momentary hazardous voltage can exist at the moment of contact across the inductance of a few feet of the grounding cable of a ground stick at the moment of contact with a charged capacitor. This is why a worker should never hold the grounding cable during a discharge event.

R.12 Determining the Capacitor Discharge Time.**R.12.1 Discharge Time.**

The discharge time, T_d , of a capacitor is the time it takes to reduce to less than 100 volts. It is related to the time constant, τ . The discharge resistance can be permanently installed on the capacitors (e.g., a bleeder resistor), automatically switched in after power shutoff (e.g., a resistor dump bank), or applied through a soft grounding stick.

R.12.2 Voltages 1000 Volts and Less.

For voltages up to 1000 volts, it is sufficient to wait three times the time constant, or one minute, whichever is greater. That is because after 3τ , the residual voltage is less than 5 percent of the initial voltage.

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:

$$\tau = RC \quad \text{[R.12.3a]}$$

$$T_d = -\ln\left(\frac{100}{V_p}\right)\tau \quad \text{[R.12.3b]}$$

where:

τ = time constant

R = discharge path resistance

C = total capacitance

T_d = discharge time (wait time)

V_p = peak voltage

R.13 Establishing an Electrically Safe Work Condition.**R.13.1 Written Discharge Procedure.**

Where a conductor circuit part is operating at or above 100 volts and 10 joules, a written discharge procedure (such as a complex LOTO procedure) should be used to document the necessary steps to place the equipment in an electrically safe work condition. The written discharge procedure should incorporate the results of the risk assessment performed in R.6 and specify the following at a minimum:

- (1) Voltage in volts
- (2) Energy in joules
- (3) Specific steps to safely discharge the capacitor or verify that it is discharged
- (4) Specific tool(s) (e.g., ground stick) or engineering system to discharge the capacitors, if necessary
- (5) Specific test instruments (e.g., DVM) or engineered systems used to verify a de-energized state

R.13.2 Electrically Safe Work Condition.

In order to place the equipment with stored hazardous energy in an electrically safe work condition, a qualified person should follow the steps in 120.5 as well as the specific sequence outlined in the written discharge procedure. The process to remove stored energy in a capacitor is a part of the overall process to establish an electrical safe work condition in 120.5. These would then be as follows:

- (1) Review the scope of work and the written discharge procedure. Determine all safe approach boundaries and necessary PPE and tools for the task.
- (2) Perform a job briefing with the personnel involved and notify affected persons that the equipment will be de-energized.
- (3) After properly interrupting the supply current, open the disconnecting device(s) for each source feeding the equipment.
- (4) 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.
- (5) Apply lockout/tagout devices in accordance with a documented and established policy, or use plug control on smaller equipment.
- (6) If bleed resistors or automatic discharge systems are applicable, wait the prescribed time for the capacitors to fully discharge to less than the thresholds in 360.3.
- (7) Perform the test and ground method selected in R.11.

To ensure that recharging does not occur, all of the capacitor terminals should be connected together (shorted) and grounded with a non-insulated wire of sufficient gauge to withstand handling. For series capacitors these shorting wires should be attached across each individual capacitor and to case. For single capacitors or for a parallel capacitor bank, the grounding device should be permitted to be left hanging on the capacitor terminal during the work (e.g., a ground stick/hook).

R.14 Storage and Disposal.**R.14.1 Residual Charge.**

Any residual charge from capacitors should be removed by discharging the terminals before servicing or removal.

R.14.2 Stored Capacitors.

All uninstalled capacitors capable of storing energy exceeding the thresholds of 360.3 at their rated voltage should be short-circuited with a conductor of appropriate size.

R.14.3 Capacitors Without Shorting Wire.

When an uninstalled capacitor is discovered without a shorting wire attached to the terminals, it should be treated as energized and charged to its full rated voltage until determined otherwise. A qualified person should be contacted to determine the appropriate steps to safely discharge the capacitor.

R.14.4 Change in Initial Capacitance.

Large, high-voltage capacitors are often formed of a network of smaller capacitor elements connected inside a case. When such a capacitor develops an internal open circuit, it can retain a substantial charge internally even though the external terminals are short-circuited. Such a capacitor can be hazardous to transport because the damaged internal wiring can reconnect and discharge the capacitor through the short-circuiting wires. Any capacitor that shows a significant change in capacitance after a fault can have this problem. Action should be taken to reduce the risk associated with this hazard when it is discovered.

R.15 Capacitor Hazard Labeling.**R.15.1 Labeling.**

Electrical equipment operating at or above 100 volts and 10 joules should be field marked with a label containing all the following information:

- (1) A warning about the potential for capacitive stored energy, with the word "WARNING" on an orange colored background
- (2) Stored energy in joules and the maximum voltage for that stored energy
- (3) The required wait time before opening the enclosure (the wait time needs to be greater than the discharge time)
- (4) Date of the stored energy hazard analysis
- (5) An instruction that a qualified person is necessary and that they should use a written discharge procedure

R.15.2

Labeling should conform to the requirements of ANSI Z535.4, *Product Safety Signs and Labels*.

R.16 Ground Sticks.**R.16.1 Use of Ground Sticks.**

Ground sticks should be provided for qualified persons to safely discharge any residual stored energy contained in capacitor(s). The ground sticks should be designed, constructed, installed, and periodically inspected so that the full energy of a capacitor(s) can be safely discharged. See Table R.11.9 for selection guidance.

R.16.2 Construction.

Design and construction are as follows:

- (1) Ground stick rod: When built of fiber reinforced plastic (FRP), the rod in the ground stick assembly should meet ASTM F711, *Standard Specification for Fiberglass-Reinforced Plastic (FRP) Rod and Tube Used in Live Line Tools*, specifications. Other insulating materials may be used provided they are of acceptable insulation and durability for the application. The stick should be long enough to be handled effectively and also to keep a person's hands out of the restricted approach boundary. This should include a non-moveable hand stop to remind the worker during use where to hold the ground stick.
- (2) Ground stick tip: The ground stick connection to discharge points may be chain links, bare conductor, or solid copper bar in various geometries. The selection of the grounding tip should match the requirements of the intended application and ensure that all necessary circuit parts are fully discharged and grounded at the same time in order to avoid charge transfer. The grounding tips can be designed to remain applied (e.g., a hook) in order to safely prevent recharging from dielectric absorption. Alternatively, shorting straps may be applied while the grounding sticks are applied. Discharge points should be clearly marked and caution should be used to prevent transferring charge to other capacitors or reversing the charge on affected capacitors.
- (3) Ground stick resistor: Soft grounding should be provided where stored energy exceeds 1000 joules. The resistor used to soft ground a capacitor(s) should be fully rated to handle power, voltage, and current. An engineering safety margin would be to calculate peak power, voltage and current, and double the resistor rating for each parameter. The resistor should be able to discharge the capacitor bank to less than 50 volts and less than 5 joules in less than 1 minute (less than 1000 volts) or less than 5 minutes (greater than 1000 volts). Ideally, the current should be limited to 500 amperes peak in order to reduce the magnetic force on the ground stick and its cable. This can require a discharge time longer than 5 minutes. Note that soft grounding is always followed by hard grounding to complete the discharge.
- (4) Ground stick cable: The cable should be grounding or welding cable, flexible rope lay, soft drawn copper. The individual strands should not be larger than #30 AWG. Grounding cables have flexible, transparent elastomer or thermoplastic jackets primarily for mechanical protection of the conductor it covers and to allow visual examination of stranding degradation. Connections should be crimped according to manufacturer instructions. The lugs should be rated for the cables to be clamped. In permanent equipment installations the cable conductor size should be sized no smaller than #10 AWG stranded and capable of safely carrying the potential discharge current. For temporary or benchtop situations, the conductor should be capable of safely carrying any potential discharge current. Ground sticks should never be fused.

R.16.3 Installation.

Installation is as follows:

- (1) Connection to building grounding system: Ground sticks should be connected to the building grounding electrode system where practicable. A qualified engineer should evaluate the connection point to the building grounding system to ensure the integrity of the ground stick system. This connection should be in a location accessible to and visible to the operator of the ground stick. Ground sticks should be connected such that impedance is less than 0.1 ohms to ground. High-Z ground sticks should be connected such that impedance is less than 0.1 ohms between the resistor and the ground connection.
- (2) Operator access: The ground sticks should be permanently grounded and stored in the immediate area of the equipment in a manner that ensures they are used. The approach path to the equipment being grounded should be perpendicular to the equipment and clear of debris or obstructions. The ground stick operator will then always be facing the potential hazard and have the grounded conductor between them and the potentially energized equipment. For cases of capacitors in a field situation, or in portable equipment, a portable ground stick may be used. The ground stick must be effectively connected to the system ground, by a bolt or heavy-duty clamp, before opening the enclosure.

R.16.4 Visual Inspection.

Visual inspection is as follows:

- (1) The ground stick should be visually inspected for defects before use each day.
- (2) If any defect or contamination that could adversely affect the insulating qualities or mechanical integrity of the ground stick is present, the tool should be removed from service. All mechanical connections should be examined for loose connections. Ground sticks should have a hand guard that reduces the risk of improper hand position.
- (3) If the defect or contamination exists on the grounding stick, then it should be replaced.
- (4) If the defect or contamination exists on the cable, then it should be replaced or repaired and tested before return to service.

R.16.5 Biennial Testing (every 2 years).

A ground stick system places a grounded conductor at the end of the rod between the operator and the electrical hazard. The low impedance (Low-Z) ground stick system is not a live line tool, and there will not be a voltage potential at the end of the ground stick rod. High-impedance (High-Z) ground sticks can have a voltage potential at the end of the rod and should be treated as live line tools.

- (1) For all ground sticks: The ground stick system should be tested to verify that impedance is less than 0.1 ohms to ground. This test should be performed annually when it is located outside or under any other adverse conditions.
- (2) All High-Z ground stick insulating rods should be removed from service to be recertified to the ASTM F711, *Standard Specification for Fiberglass-Reinforced Plastic (FRP) Rod and Tube Used in Live Line Tools*, standard or equivalent.
- (3) High-Z ground sticks with resistors: The resistor on the High-Z ground stick should be measured and compared to the specified value.

R.17 References.

IEC TS 60479-1, 4th Edition (2005), *Effects of Current on Human Beings and Livestock, Part 1, General Aspects*, Geneva, Switzerland.

IEC TS 60479-2, 3rd Edition (2007), *Effects of Current on Human Beings and Livestock, Part 2, Special Aspects*, Geneva, Switzerland.

DOE-HDBK-1092-2013, *DOE Handbook for Electrical Safety*, U.S. Department of Energy, Washington, DC.

Dalziel, Charles F., "A Study of the Hazards of Impulse Currents," *Transactions of the American Institute of Electrical Engineers. Part III: Power Apparatus and Systems*, Volume 72, Issue 2, 1953, DOI: 10.1109/AIEEPAS.1953.4498738.

Gordon, Lloyd B. and Cartelli, Laura, "A Complete Electrical Hazard Classification System and Its Application," IEEE *Transactions on Industry Applications*, Vol. 54, pp. 6554–6565, November/December 2018.

Hummer, Charles R., Pearson, Richard J., and Porschet, Donald H., "Safe Distances From a High-Energy Capacitor Bank for Ear and Lung Protection," Army Research Laboratory Report, ARL-TN-608, July 2014.

Richmond, D.R., Yelverton, J.T., Fletcher, E.R., and Phillips, YY, "Physical Correlates of Eardrum Rupture," *Annals of Otology Rhinology and Laryngology*, Vol. 109 (May 1989): 35–41.

Scott, Mark, "Working Safely with Hazardous Capacitors: Establishing Practical Thresholds for Risks Associated With Stored Capacitor Energy," IEEE *Industry Applications Magazine*, Vol. 25, Issue 3, 2019: 44–53.

Statement of Problem and Substantiation for Public Input

Add "electric" before "shock" in the locations where shock is mentioned in to distinguish electric shock from an acoustical shock as a component of an arc blast hazard as described in R.4.3 and in Article 360 including within the definition of Arc Blast Hazard (A source of possible injury or damage to health from the energy deposited into acoustical shock-wave and high-velocity shrapnel.) and correlate with its use throughout NFPA 70E such as how it is presently used in numerous locations throughout 130.7.

Related Public Inputs for This Document

<u>Related Input</u>	<u>Relationship</u>
Public Input No. 15-NFPA 70E-2020 [Definition: Shock Hazard.]	related issue
Public Input No. 28-NFPA 70E-2020 [Section No. 130.7]	related issue
Public Input No. 30-NFPA 70E-2020 [Chapter 3]	related issue
Public Input No. 15-NFPA 70E-2020 [Definition: Shock Hazard.]	

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Public Input No. 229-NFPA 70E-2021 [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.

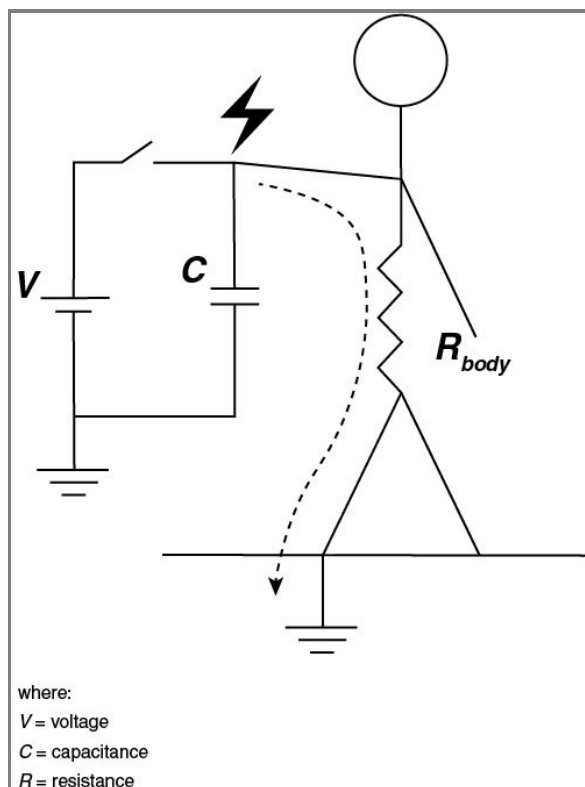
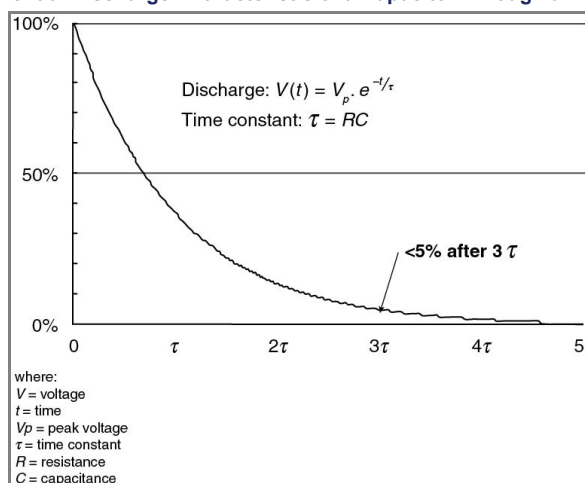


Figure R.3.1(b) Typical Exponential Discharge Characteristic of a Capacitor Through a Resistor.



Statement of Problem and Substantiation for Public Input

Concerning figure R31a. The circuit should be shown as a complete circuit back to the power supply. The dotted line should not go to 'ground' it should curve back around and end at the power supply. Evidently, the creator of this schematic assumed that the 'ground' symbols are connected together. The 'ground' symbol used, however, could be construed to mean 'earth' or 'soil.' This lends unnecessary confusion to the graphic. If the 'ground' systems remain, they should at least be connected together and the dotted current line should still go back to the source. There are other graphics in this appendix that have the same situation.

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**Public Input No. 345-NFPA 70E-2021 [Section No. R.3.2]****R.3.2** Duration of Discharge.

The duration of a capacitive discharge shock is independent of voltage and is generally assumed to be three times the time constant of the shock circuit. After three time constants, the voltage is reduced by 95 percent, and the energy has been reduced by 99.25 percent. The time constant, τ (in seconds), is equal to body shock pathway resistance (ohms) times capacitance (farads), as follows:

$$\tau = RC$$

[R.3.2]**Statement of Problem and Substantiation for Public Input**

units are important for clarity

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**Public Input No. 216-NFPA 70E-2021 [Section No. R.3.5]****R.3.5 Response to Shock Levels.**

For a given stored energy, there is a difference in response to whether it is a high-voltage, low-capacitance shock, or a low-voltage, high-capacitance shock. At high voltage and low capacitance, a hazardous shock will fully discharge nearly instantaneously (in microseconds) and could miss the vulnerable part of the heart cycle. However, the full energy is delivered to the person and there could be nerve or other tissue damage. At low voltage and high capacitance, the total discharge time can extend several seconds (multiple heart beats), behaving more like a dc shock. Both scenarios remain highly hazardous as fibrillation could still occur.

Informational Note: ~~For more information on impulse shock hazards, see~~ See IEC TS 60479-2, *Effects of Current on Humans and Livestock, Part 2, Special Aspects* for more information on impulse shock hazards.

Statement of Problem and Substantiation for Public Input

Revised Informational Note to comply with new 2020 NEC Style Manual.

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

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**Public Input No. 217-NFPA 70E-2021 [Section No. R.10.1]****R.10.1 Hazard.**

The arc blast hazard is directly related to the instantaneous (initial) short circuit current. Since capacitors can discharge very rapidly, the shockwave generated by a capacitor discharge can cause barotrauma (overpressure injury) to persons in the area. The most sensitive organs are the ears, lungs, and brain. When a differential pressure across the eardrums exceeds around 20–35 kilopascals (3–5 psi), the eardrum can rupture. At 200 kilopascals (29 psi), lung damage can occur. The following formulas are used to estimate safe boundaries based on total stored energy, where “safe” is less than a 1 percent probability of eardrum rupture or lung injury:

$$R_{ear} = 49.29 \sqrt[3]{\frac{E}{1000}} - 5.09 \quad [\text{R.10.1a}]$$

$$R_{lung} = 31.32 \sqrt[3]{\frac{E}{1000}} - 155.45 \quad [\text{R.10.1b}]$$

where:

R_{ear} = eardrum rupture boundary (1 percent probability) in cm

R_{lung} = lung collapse boundary (1 percent probability) in cm

E = capacitor stored energy in joules

Informational Note: For more information about the derivation of these formulas, see See Charles R. Hummer, Richard J. Pearson, and Donald H. Porsch, “*Safe Distances From a High-Energy Capacitor Bank for Ear and Lung Protection*,” Army Research Laboratory Report, ARL-TN-608, July 2014 ~~2014~~ for more information about the derivation of these formulas .

Statement of Problem and Substantiation for Public Input

Revised Informational Note to comply with new 2020 NEC Style Manual.

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

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