NATIONAL FIRE PROTECTION ASSOCIATION
The leading information and knowledge resource on fire, electrical and related hazards

AGENDA

NEC Code-Making Panel 17 (NEC P17)
NFPA 70 Second Draft Meeting (Annual 2025)

October 24 - 26, 2024
8:00 a.m. – 5:00 p.m. (PT)

Torrance Marriott Redondo Beach, CA

1. **Call to order.** Michael Weaver.
2. **Introductions.** See committee roster attached.
3. **Chair Report.** Michael Weaver.
4. **Staff liaison report/presentation.** Steve Kaitharath.
5. **Previous meeting minutes.** January 2024, Charleston, SC. See attached.
6. **NFPA 70 Second Draft.**
   a. **Review of Public Comments.** See attached.
      i. **Task group report(s).**
   b. **Extract updates (if applicable)**
7. **Other Business.**
8. **Future meetings.**
9. **Adjournment.**

Address List No Phone

09/27/2024
Jeffrey S. Sargent

Code-Making Panel 17

NEC-P17

National Electrical Code®

Michael Weaver **IM** 12/06/2019
Chair **NEC-P17**
M&W Electric
29889 Highway 34 SW
Albany, OR 97321-9431
National Electrical Contractor Association (NECA)
Alternate: Timothy R. O'Brien

Kenneth Castronovo **E** 03/20/2023
Principal **NEC-P17**
Board of Rules and Appeals
3201 Port Royal Drive S.
Apartment K
Fort Lauderdale, FL 33308
International Association of Electrical Inspectors
Alternate: Bruce Alan Hoffman

Jacob C. Colston **UT** 08/24/2021
Principal **NEC-P17**
Georgia Power Company
5150 Joel Lane
Dunwoody, GA 30360
Electric Light & Power Group/EEI
Alternate: Michael Kevin Blum

David A. Gray **E** 11/29/2023
Principal **NEC-P17**
Arkansas Department of Labor & Licensing
126 Wildwood Forest Road
Hot Springs, AR 71913
NFPA Electrical Inspection Section (EIS)

E. P. Hamilton, III **M** 7/23/2008
Principal **NEC-P17**
E. P. Hamilton & Associates, Inc.
Arthitects, Engineers, Technical Serivces
1406 Three Points Road
Building A, Suite 100
Pflugerville, TX 78660
Pool & Hot Tub Alliance (PHTA)
Alternate: Kenneth Lee Gregory

Ryan Jackson **U** 04/12/2022
Principal **NEC-P17**
Self-employed
5930 West Fox River Lane
West Valley City, UT 84118

Stephen R. Kuscsik **RT** 08/17/2017
Principal **NEC-P17**
UL LLC
333 Pfingsten Road
Northbrook, IL 60062-2096
Alternate: Robert Dellavalle

Armando M. Lozano **IM** 04/04/2017
Principal **NEC-P17**
MSF Electric, Inc.
10455 Fountaingate Drive
Stafford, TX 77477-4119
Independent Electrical Contractors, Inc.
Alternate: Edward Alan Brown

Brian Myers **L** 4/14/2005
Principal **NEC-P17**
IBEW Local Union 98
1909 East Moyamensing Avenue
Philadelphia, PA 19148
International Brotherhood of Electrical Workers
Alternate: Ryan Andrew

John Park **M** 08/29/2024
Principal **NEC-P17**
Association of Home Appliance Manufacturers (AHAM)
1111 19th Street, NW
Suite 1150
Washington, DC 20036
Association of Home Appliance Manufacturers
Alternate: Greg Woyczynski

Larry Reichle **E** 08/03/2016
Principal **NEC-P17**
Texas Department Of Licensing Regulation
24013 Pedernelas Drive
Spicewood, TX 78669

Chester L. Sandberg **U** 04/04/2009
Principal **NEC-P17**
C L Sandberg & Associates, LLC
758 Torreya Court
Palo Alto, CA 94303

Kenneth M. Shell **M** 11/2/2006
Principal **NEC-P17**
nVent Thermal Management
1351 Halibut Street
Foster City, CA 94404
Copper Development Association Inc.
Alternate: Paul W. Abernathy

Kam Fai Siu **RT** 10/27/2009
Principal **NEC-P17**
Intertek Testing Services
2/F, Garment Centre
576 Castle Peak Road
Kowloon, Hong Kong
Intertek Testing Services
Alternate: Brunno Prosperi Covolan

Marcelo E. Valdes **M** 10/29/2012
Principal **NEC-P17**
Asea Brown Boveri Ltd. (ABB)
412 Stoney Creek Way
Chapel Hill, NC 27517
National Electrical Manufacturers Association
Alternate: Vincent Della Croce

Paul W. Abernathy **M** 04/08/2015
Alternate **NEC-P17**
Encore Wire Corporation
1324 Millwood Road
McKinney, TX 75069
Copper Development Association Inc.
Principal: Kenneth M. Shell

Ryan Andrew **L** 08/17/2017
Alternate **NEC-P17**
Alaska Joint Electrical Apprenticeship and Training Trust
IBEW Local Union 1547
5800 B Street
Anchorage, AK 99518
International Brotherhood of Electrical Workers
Principal: Brian Myers

Michael Kevin Blum **UT** 11/29/2023
Alternate **NEC-P17**
CenterPoint Energy
14010 Grand Heights Court
Houston, TX 77062
Electric Light & Power Group/EEI
Principal: Jacob C. Colston

Edward Alan Brown **IM** 08/23/2023
Alternate **NEC-P17**
Independent Electrical Contractors, Inc. (IEC)/Indy
5736 West Woodview Trail
McCordsville, IN 46055
Independent Electrical Contractors, Inc.
Principal: Armando M. Lozano

Brunno Prosperi Covolan **RT** 12/07/2021
Alternate **NEC-P17**
Intertek Testing Services
1809 10th Street, Suite 400
Plano, TX 75074
Principal: Kam Fai Siu

Vincent Della Croce **M** 04/02/2020
Alternate **NEC-P17**
Siemens
6167 NW East Deville Circle
Port Saint Lucie, FL 34986
National Electrical Manufacturers Association
Principal: Marcelo E. Valdes

Robert Dellavalle **RT** 04/02/2020
Alternate **NEC-P17**
UL LLC
1285 Walt Whitman Road
Melville, NY 11747
Principal: Stephen R. Kuscsik

Kenneth Lee Gregory **M** 08/29/2024
Alternate **NEC-P17**
Pentair
493 E 1575 South
Washington, UT 64780
Pool & Hot Tub Alliance (PHTA)
Principal: E. P. Hamilton, III

Bruce Alan Hoffman **E** 03/20/2023
Alternate **NEC-P17**
State of Nebraska
3300 Elkhorn Street
Whitney, NE 69367
International Association of Electrical Inspectors
Principal: Kenneth Castronovo

Timothy R. O'Brien — **IM** 04/12/2022

Alternate — **NEC-P17**
Retired
PO Box 2423
Borrego Springs, CA 92004
National Electrical Contractor Association (NECA)
Principal: Michael Weaver

Greg Woyczynski — **M** 08/24/2021

Alternate — **NEC-P17**
Association of Home Appliance Manufacturers (AHAM)
1111 19th Street, NW
#402
Washington, DC 20036
Association of Home Appliance Manufacturers
Principal: John Park

Andrew M. Trotta — **C** 1/10/2002

Nonvoting Member — **NEC-P17**
US Consumer Product Safety Commission
5 Research Place
Rockville, MD 20850
US Consumer Product Safety Commission (CPSC)
Alternate: Einstein Miller

Einstein Miller — **C** 04/14/2021

Alt. to Nonvoting Member — **NEC-P17**
US Consumer Product Safety Commission (CPSC)
5 Research Place
Rockville, MD 20850
US Consumer Product Safety Commission (CPSC)
Principal: Andrew M. Trotta

Jeffrey S. Sargent — 08/31/2019

Staff Liaison — **NEC-P17**
National Fire Protection Association
1 Batterymarch Park
Quincy, MA 02169-7471

MINUTES

NEC Code-Making Panel 17
NFPA 70 First Draft Meeting
(Annual 2025)
January 24-26, 2024
8:00 AM – 5:00 PM (ET)

Charleston, SC

1. **Call to order.** Michael Weaver, chair, called the meeting to order at 8:00 AM on 1/24/24.
2. **Introductions.** Attendees introduced themselves and identified their affiliation and NFPA staff took attendance.
3. **Chair report.** Michael Weaver welcomed attendees and provided an overview of the meeting.
4. **Staff liaison report.** Matthew Barker provided an overview of the standards development process and the revision cycle schedule.
5. **Previous meeting minutes.** The minutes from October 2021 Second Draft virtual meeting were approved without revision.
6. **NFPA 70 First Draft.**
   a. **Review of Public Inputs.** The Technical Committee reviewed the Public Inputs and developed First Revisions and Committee Inputs as necessary. These will be available in the First Draft Report at www.nfpa.org/70.
   b. **Task group reports.** The following task groups provided their reports and recommendations.
      i. **CMP 17 Task Group 1**. Vincent Della Croce, Chair. The task group provided a report and revisions were made. The task group was reconstituted to continue work. See attached.
      ii. **CMP 17 Task Group 2**. Ryan Jackson, Chair. The task group provided a report and revisions were made. The task group was reconstituted to continue work. See attached.
      iii. **CMP 17 Task Group 3.** Stephen Kuscsik, Chair. The task group provided a report and revisions were made. The task group was reconstituted to continue work. See attached.
      iv. **Task Group on PI 3733.** Ryan Jackson, Ken Shell, Steve Kuscsik, Ed Brown, Bobby Dellavalle, Bill Hamilton. The task group provided a report, and a revision was made. The task group has been discharged with thanks.

v. **Task Group on PI 4465**. Jacob Colston, Ed Brown, Bill Hamilton, Steve Kuscsik. The task group provided a report, and a revision was made. The task group has been discharged with thanks.

vi. **Task Group on PI 1325**. Ryan Jackson, Bill Hamilton, Ryan Andrew, David Gray, Marcelo Valdes, Steve Kuscsik, Ken Shell. The task group provided a report, and a revision was made. The task group has been discharged with thanks.

vii. **Task Group on 680.26/PI 1624/TIA 23-9**. Ryan Jackson, Bobby Dellaville, Bill Hamilton, Vince Della Croce, Steve Kuscsik, Jacob Colston, Ryan Andrew, Steve Gates, Ed Brown, Mike Weaver. The task group provided a report, and revisions were made. The task group has been discharged with thanks.

c. **Presentation(s).** The committee heard presentations from the following individuals.

i. **PI 2484.** Mark Earley, Alumni Code Consulting Group, LLC. Approximately 1 minute. Verbal presentation.

ii. **PIs 4486, 4570, 4571, 4518, 4520, 4527.** Mark Pollock, Littelfuse. 5 minutes. Presentation attached.

iii. **Pis 3479, 4168.** Chuck Mello, CDC Mello Consulting, LLC. 5 minutes/15 minutes Q&A. Presentation attached.

iv. **Proposed Reorganization of NEC®.** Alan Manche Approximately 35 minutes including Q&A. Presentation attached.

7. **Other Business.** There was no other business taken up by the CMP.

8. **Future meetings.** The next committee meeting will be October 14-26/2024. A meeting notification will be posted at www.nfpa.org/70next when the meeting is scheduled.

9. **Adjournment.** The meeting was adjourned at [Time] on 1/26/24.

Attendees
Committee Members:

✓	**Michael Weaver**	Chair	NECA
✓	**Kenneth Castronovo**	Principal	IAEI
✓	**Jacob Colston**	Principal	Electric Light & Power Group/EEI
✓	**Stephen Gatz**	Principal	Whirlpool Corporation
✓	**David Gray**	Principal	NFPA Electrical Inspectors Section
✓	**E.P. Hamilton**	Principal	Pool & Hot Tub Alliance (PHTA)
✓	**Ryan Jackson**	Princpal	Self-employed
✓	**Stephen Kuscsik**	Principal	UL Solutions
✓	**Armando Lozano**	Principal	IEC, Inc.

✓	**Brian Myers**	Principal	IBEW
✓	**Larry Reichle**	Principal	TX Department of Licensing & Regulation
✓	**Chester Sandberg**	Principal	C.L. Sandberg & Associates, LLC
✓	**Kenneth Shell**	Principal	Copper Development Association Inc.
	Kam Fai Siu	Principal	Intertek Testing Services
✓	**Marcelo Valdes**	Principal	NEMA
✓	**Greg Woyczynski**	Voting Alternate	Association of Home Appliance Manufacturers
✓	**Paul Abernathy**	Alternate	Copper Development Association Inc.
✓	**Ryan Andrew**	Alternate	IBEW
✓	**Michael Blum**	Alternate	Electric Light & Power Group/EEI
✓	**Edward Brown**	Alternate	IEC, Inc.
	Brunno Covolan	Alternate	Intertek Testing Services
✓	**Vincent Della Croce**	Alternate	NEMA
✓	**Robert Dellavalle**	Alternate	UL Solutions
✓	**Bruce Hoffman**	Alternate	IAEI
✓	**Timothy O'Brien**	Alternate	NECA
✓	**Andrew Trotta**	Nonvoting	US Consumer Product Safety Commission
✓	**Einstein Miller**	Nonvoting alternate	US Consumer Product Safety Commission
✓	**Matthew Barker**	Staff	NFPA
✓	**Steve Kaitharath**	Staff	NFPA

Guests:

1. Patty Barron — STYX Platforms
2. Amy Cronin — Strategic Code Solutions/STYX
3. Joel Martinez — MSF Electric
4. Gerry O'Connor — Eaton
5. Mark Pollock — Littelfuse
6. Kenneth Gregory — PHTA/Pentair
7. Scott Harding — FB Harding/IEC
8. Chuck Mello — cdc Mello Consulting, LLC
9. John McCamish — Eaton
10. Mark Earley — Alumni Code Consulting Group, LLC
11. Brian Baughman — NEMA
12. Chad Roberts — Flour-BWXT
13. Don Iverson — Schneider Electric

Total number in attendance: 40

NEC® Code-Making Panel 17 First Draft Chair Report

Signature:

Date of Meeting: 1-24-24 to 1-26-24

1. List names of NEC® Code-Making Panel Members in Attendance: See attached.

2. List names of Guests in Attendance: See attached.

3. List names of Guests who addressed the Panel, the subject of their presentation and the length of time they spoke:

   Mark Early spoke for less than a minute on PI 2484
   Mark Pollock spoke for 5 minutes on PI's 4486,4570,4571,4518,4520, and 4527..
   Chuck Mello spoke for 5 minutes on PI's 3479 and 4168, followed by a 15 minute question and answer period regarding conductive pavement heating systems followed.

4. Number of Public Inputs/Comments acted upon:171.

5. Number of First/Second Revisions Created: 99.

6. List any Task Groups appointed to work subsequent to the First/Second Draft Meeting, along with the names of Task Group Chair/members:

   A TG was formed to work on PI 3733 with regards to 424.6 and 424.102. The group consisted of Ryan Jackson, Ken Shell, Steve Kuscsik, Ed Brown, Bobby Dellavalle, and Bill Hamilton.

   A TG was formed to work on PI 4465 with regards to 680.10(B). The group consisted of Jacob Colston, Ed Brown, Bill Hamilton, and Steve Kuscsik.

   A TG was formed to work on PI 1325 with regards to 680.21(D). The group consisted of Ryan Jackson, Bill Hamilton, Ryan Andrew, David Gray, Marcelo Valdes, Steve Kuscsik, and Ken Shell.

   A TG was formed that worked until 9:07 pm one evening on several PI's with regards to 680.26 and the global PI 1624 and TIA 23-9. The Group consisted of Ryan Jackson, Bobby Dellavalle, Bill Hamilton, Vince Della Croce, Steve Kuscsik, Jacob Colston, Ryan Andrew, Steve Gates, Ed Brown, and Mike Weaver.

7. List any Public Input/Comment or First/Second Revision that may need to be referred to another Panel for information or correlation: None.

8. List any Public Input/Comment that requires NEC® Correlating Committee attention:

CMP 17 reviewed Global Input 3085 and reviewed informational notes to comply with NEC style manual 2.1.10. The following revisions were made to comply. FR 8871, FR 9200, and FR 9239.

CMP 17 reviewed Global Input 3086 and reviewed numbering conventions to comply with the NEC Style manual 2.2.1. The following first revision was made to comply. FR 9044.

CMP 17 reviewed Global Input 3099 and reviewed definitions within CMP 17 purview and the following first revision was made. FR 8950.

CMP 17 reviewed Global Input 4050 on the terms regarding overcurrent protection and the following first revision was made to comply. FR 8877.

CMP 17 reviewed Global Input 4287 on ac and dc circuits and no changes were made as CMP 17 believes the Articles within its purview are clear on the use of ac and dc circuits.

CMP 17 reviewed Global Input 1624 with regards to TIA 23-9 and 680.26(A). CMP 17 Made First Revision 9239 which incorporated the language of the TIA and other language requested in PI's. that was non-controversial, and then created 5 ballotable details for the remaining changes.

9. List any general requests for information or assistance from the NEC® Correlating Committee:

CMP2 has purview of the requirements in 210.8(D) and CMP 17 has purview of the requirements in 422.5(A). CMP 17 asks for guidance from the Correlating Committee as to if there is purview or correlation issue that should be addressed.

10. List any issues that should be brought to the attention of the NFPA Research Foundation:

None

11. List any additional information that would be helpful to the NEC® Correlating Committee, NFPA Staff, or process in general:

The internet was lacking and dropped individuals from their devices continually or would lag updating on their screen making it very hard to follow. Improved internet access and returning to the big screen in the room is requested as it is difficult to look up various forms of information on the topic we are working on and also follow staff and what they were doing. If big screen is not possible more room at the table per person and 120 volt receptacles is requested.

The food and snacks at the hotel were good but a venue closer to downtowns and other options for food would be appreciated.

2026 NEC® Public Input Task Group Report

CMP #	**17**
TG#	**1**
TG Chair	**Vince Della Croce**
TG Members	**Jerry Lee Daniel, Stephen Gatz, Robert Dellavalle Armando Lozano, Andrew Trotta, Brunno Prosperi Covolan Greg Woyczynski, Ryan Andrew, Michael Blum Michael Weaver, Paul Abernathy, Stephen Kuscsik Larry Reichle, Ryan Jackson, Mark Early David Gray, Marcelo Valdes**

Article/Section	Public Input #	PI Report Page #	TG Recommendation & Statement
422.6	**3730**	**55**	**Recommendation:** FR XXXX **Statement:** Listing requirements are relocated to 422.2 to comply with the NEC Style Manual Section 2.2.1 **Vote:** 14-0

Article/Section	Public Input #	PI Report Page #	TG Recommendation & Statement
422.6	**3462**	**44**	**Recommendation: Resolve** **Statement:** If this type of protection is needed the requirements would need to be coordinated with the applicable product safety standards for the appliance it is used with. The public input seeks to require a "listed safety interlock outlet," but the CMP is not aware of specific product safety standards that exist for such an outlet. The device shown in the substantiation is listed to UL 498 and UL 60730-2-9, neither of which address "safety interlock outlet" or smoke detection capabilities. Smoke detection in localized areas may be better addressed in NFPA 72 or the applicable building code. **Vote: 11-0**

Article/Section	Public Input #	PI Report Page #	TG Recommendation & Statement
422.10(A)	**2685**	**56**	**Recommendation:** FR XXXX **Statement:** The text is revised to comply with the NEC Style Manual Section 4.1.4 **Vote:** 14-0

Article/Section	Public Input #	PI Report Page #	TG Recommendation & Statement
422.11(E)	**3138**	**57**	**Recommendation:** Resolve **Statement:** Item three is a maximum value, not an absolute value. By removing the text of "not exceed," the number becomes absolute. There are instances where 125% could be desired and should remain code compliant. **Vote:** 14-0

Article/Section	Public Input #	PI Report Page #	TG Recommendation & Statement
422.11(G)	**2686**	**58**	**Recommendation:** FR XXXX **Statement:** The text is revised to comply with the NEC Style Manual Section 4.1.4 **Vote:** 14-0

Article/Section	Public Input #	PI Report Page #	TG Recommendation & Statement
422.11(G)	**4421**	**59**	**Recommendation:** Resolve **Statement:** The references enhance usability and are valuable to users of the Code. Although the text contains requirements from another article, it is the CMP's opinion that it does not violate 4.1.1 of the 2023 NEC Style Manual. **Vote:** 14-0

Article/Section	Public Input #	PI Report Page #	TG Recommendation & Statement
422.16(B)(1)	**2117**	**68**	**Recommendation:** FR XXXX **Statement:** "Power-supply" is added to correlate with the existing defined term power-supply cord in Article 100 **Vote:** 14-0

Article/Section	Public Input #	PI Report Page #	TG Recommendation & Statement
422.16(B)(2)	**2118**	**69**	**Recommendation:** FR XXXX **Statement:** "Power-supply" is added to correlate with the existing defined term power-supply cord in Article 100 **Vote:** 14-0

Article/Section	Public Input #	PI Report Page #	TG Recommendation & Statement
422.16(B)(3)	**2119**	**70**	**Recommendation:** FR XXXX **Statement:** "Power-supply" is added to correlate with the existing defined term power-supply cord in Article 100 **Vote:** 14-0

Article/Section	Public Input #	PI Report Page #	TG Recommendation & Statement
422.16(B)(4)	**2234**	**71**	**Recommendation: FRXXXX** **Statement:** The receptacle is typically installed in a location that reduces the likelihood of it being used for other purposes, so a single receptacle is not needed. A duplex receptacle is permitted on an individual branch circuit, provided it does not supply other utilization equipment. "Power-supply" is added to correlate with the existing defined term power-supply cord in Article 100. **Vote:** 13-1

Article/Section	Public Input #	PI Report Page #	TG Recommendation & Statement
422.18	**2484**	**72**	**Recommendation:** Resolve **Statement:** Existing text in the NEC already provides for use of a weight supporting ceiling receptacle or factory installed weight supporting fitting as an option, and not a required construction. Although these devices may improve safety and ease of installation, requiring these devices as the only method may restrict other options which are still in use and supported by manufacturers, installers and AHJs. CMP 17 reaffirms not including the proposed exception, see Public Comment 1136 from the 2023 NEC revision cycle. **Vote:** 11-1 (Earley)

Article/Section	Public Input #	PI Report Page #	TG Recommendation & Statement
422.18(B)	**242**	**126**	**Recommendation:** FR XXXX **Statement:** The reference to metal parts is removed to correlate with the requirements in 410.10(D)(1) **Vote:** 12-0

Article/Section	Public Input #	PI Report Page #	TG Recommendation & Statement
100 Definitions-Appliance	**4233**	**14**	Appliance. Utilization equipment, generally other than industrial, that is normally built in a standardized size or type; and is installed or connected as a unit to perform one or more functions such as clothes washing, air-conditioning, food mixing, deep frying, and so forth. (CMP-17) **Note to NFPA staff**: A word doc copy of Article 100 was not provided so the proposed changes to the definition are noted above **Recommendation:** FR XXXX **Statement:** The existing list items were removed to improve clarity as they could be viewed as all-inclusive and unintentionally omit other types of appliances. **Vote:** 12-0

Article/Section	Public Input #	PI Report Page #	TG Recommendation & Statement
422.13	**1295**	**65**	**Recommendation: FR XXXX**

	3266	66	**Statement:** This section was revised to clarify that the load is considered continuous. The text now applies to feeders, not just branch circuits, and recognizes 210.19, 210.20, 215.2 and 215.3 for conductor ampacity and overcurrent protective device rating. **Vote: 13-0**

Article/Section	Public Input #	PI Report Page #	TG Recommendation & Statement
422.13	**741**	**67**	**Recommendation: Resolve** **Statement**: CMP 17 reaffirms, notwithstanding weather conditions, that water heaters may operate for more than 3 hours. Insufficient technical substantiation has been submitted to support the proposed exception. **Vote: 13-0**

Article/Section	Public Input #	PI Report Page #	TG Recommendation & Statement
422.31	**1872**	**127**	**Recommendation: FR XXXX**

	2527	130	**Statement:** The text concerning lockable is revised to comply with the NEC Style Manual Section 3.2.5. Sections 422.31(A) and (B) are consolidated as the requirements were redundant. The title of 422.31(A) is revised for clarity to address appliances of any volt-ampere or appliances not over 1/8 horsepower. Additionally, the language in (A) is revised to "branch-circuit overcurrent protective device" to correlate with the defined term in Article 100. **Vote: 13-0**

Article/Section	Public Input #	PI Report Page #	TG Recommendation & Statement
422.31	2343	128	**Recommendation:** Resolve **Statement:** Section 4.1.1 of the NEC Style Manual states that the use of redundant references be avoided. Section 240.24 requires circuit breakers to be readily accessible, and 404.8 requires switches and circuit breakers used as switches to be readily accessible. Because appliances include a broad range of equipment and their disconnecting means vary, 110.26(A) requirements should be determined by the AHJ on a case-by-case basis. **Vote: 13-0**

Article/Section	Public Input #	PI Report Page #	TG Recommendation & Statement

422.12	**3467** **4424** **1292** **4108**	**62** **64** **60** **63**	**Recommendation: FRXXXX** **Statement:** CMP 17 reaffirms that the requirements for central heating equipment are necessary to be retained in this article in order to provide specific installation requirements to industry. The permission to connect other loads to the central heating equipment individual branch circuit in Exception No. 2 was expanded to include the receptacle required in 210.63(A) and the lighting outlet required in 210.70(C) as these loads would not typically overload an individual branch circuit. In order to not continually expand the list, Exception No.1 was revised to include “similar equipment” which will permit equipment such as germicidal irradiation luminaires to be connected to the branch circuit. Mike Weaver- Chair Report? NFPA Staff...Correlation issue 210.8 **Vote: 11-0**

Article/Section	Public Input #	PI Report Page #	TG Recommendation & Statement

422.5(A)	**1548** **1770**	**46** **48**	**Recommendation:** Resolve Insufficient technical substantiation has been submitted to expand the list. Additionally, representatives for both UL 101 Leakage Current for Utilization Equipment and UL 943 GFCIs, as well as other industry stakeholders, are engaged in ongoing discussions concerning GFCI protection and appliance compatibility. A timeframe for compatibility within these product standards has not been established. Code Making Panel 2 has purview of the branch circuit requirements in 210.8(D) and Code Making Panel 17 has purview over the requirements in 422.5(A). Mike Weaver- Chair Report? Code Making Panel 2 has purview of the requirements in 210.8(D) and Code Making Panel 17 has purview over the requirements in 422.5(A). Code Making Panel 17 is asking the Correlating Committee for guidance as to if there is a purview or correlation issue that needs to be addressed. **Vote: 13-1 (Valdes)**

Article/Section	Public Input #	PI Report Page #	TG Recommendation & Statement
422.5(A)	**4486**	**50**	**Recommendation:** Resolve **Statement:** Insufficient technical substantiation has been submitted to support the proposed change. **Vote: 13-1 (Valdes)**

Article/Section	Public Input #	PI Report Page #	TG Recommendation & Statement
422.5(A)	**3205** **1677** **91** **98**	**49** **47** **51** **54**	**Recommendation: FR XXXX** **Statement:** This section is editorially revised by creating sub-divisions (A), (B) and (C), including a charging statement. The permission for multiple GFCI devices is now in the charging statement and Class A is revised to the defined term acronym GFCI. First level sub-division (A) is retitled to “circuit rating” to more accurately describe the requirements that follow. This sub-division is also revised to base the appliance GFCI protection on the branch circuit rating and not the rating of the appliance. The voltage and rating thresholds are put into list item form for clarity. A reference to the low voltage contact limit, a defined term in Article 100, is added to clarify that GFCI protection is not required when the branch circuit voltage is below the defined thresholds. First level sub-division (B) is created for clarity and includes the appliances that require GFCI protection. List item (1) is revised to “branch-circuit overcurrent protective device” to correlate with the defined term in Article 100. An informational note is added to provide guidance to industry that an electrically cooled drinking water fountain is a type of water cooler. The existing informational note is revised to comply with the NEC Style Manual, Section 2.1.10. Insufficient technical substantiation has been submitted to expand the list. Additionally, representatives for both UL 101 Leakage Current

			for Utilization Equipment and UL 943 GFCIs, as well as other industry stakeholders, are engaged in ongoing discussions concerning GFCI protection and appliance compatibility. A timeframe for compatibility within these product standards has not been established. Code Making Panel 2 has purview of the branch circuit requirements in 210.8(D) and Code Making Panel 17 has purview over the requirements in 422.5. Existing sub-division (B) is changed to (C) for editorial purposes. **Vote: 11-1**

Article/Section	Public Input #	PI Report Page #	TG Recommendation & Statement
422.11	**TG1 FR Based on Global PI4050**	**5**	**Recommendation: FRXXX** **Statement:** The language at 422.11(A) is revised to “branch-circuit overcurrent protective device” to correlate with the defined term in Article 100. **Vote:**

Article/Section	Public Input #	PI Report Page #	TG Recommendation & Statement
Global	3085		**Recommendation:** Reviewed **Statement:** None **Mike Weaver- Chair Report** TG1 reviewed Article 422 and took action as necessary. See FR XXXX which includes revising Informational Note No.1 at 422.5(B) to comply with the NEC Style Manual **Vote:**

Article/Section	Public Input #	PI Report Page #	TG Recommendation & Statement
Global	3086		**Recommendation:** Reviewed **Statement:** None **Mike Weaver- Chair Report** CMP17 considered the input and considers the existing requirements in 110.20 as adequate. Including redundant requirements in 422.3 would not add to or change the existing requirements in 110.20. **Vote: 12-0**

Article/Section	Public Input #	PI Report Page #	TG Recommendation & Statement
Global	3099		**Recommendation:** Reviewed **Statement:** None **Mike Weaver- Chair Report**

			TG1 reviewed the definitions associated with Article 422 and determined no action was necessary. **Vote:**

Article/Section	Public Input #	PI Report Page #	TG Recommendation & Statement
Global	**4050**		**Recommendation:** Reviewed **Statement:** None **Mike Weaver- Chair Report** TG1 reviewed the definitions associated with Article 422 and took action as necessary. See FRXXXX, FRXXXX and FRXXXX. **Vote:**

Article/Section	Public Input #	PI Report Page #	TG Recommendation & Statement
Global	**4287**	**6**	**Recommendation:** Reviewed **Statement:** None **Mike Weaver- Chair Report** TG1 reviewed Article 422 and determined no action was necessary. **Vote:**

2026 NEC® Public Input Task Group Report

CMP #	**17**
TG#	**2**
TG Chair	**Ryan Jackson**
TG Members	**Kenneth Shell, Timothy O'Brien, Kam Fai Sui, Paul Abernathy, Kenneth Castronovo, Chester Sandberg, David Gray, Micheal Weaver, Vincent Della Croce, Robert Dellavalle, Armando Lozano, Stephen Kuscsik, Larry Reichle, Chuck Mello**

Article/Section	**Public Input #**	**PI Report Page #**	**TG Recommendation & Statement**
424.3	**3734**	**131**	Create FR TG2-1 The section and associated table were renumbered to 424.8, in accordance with section 2.2.1 of the 2023 *NEC Style Manual.*
424.4(B)	**3207**	**132**	Resolve. The sizing of the overcurrent protective device is already addressed in other sections and would be redundant. Section 4.1.1 of the 2023 *NEC Style Manual* prohibits such redundancy.
424.6	**3733**	**133**	Create FR TG2-2 The listing requirements of this article were relocated to 424.2 to comply with section 2.2.1 of the 2023 *NEC Style Manual*.
424.12(C)	**1910**	**134**	Resolve The CMP shares the concerns that equipment should be properly rated for the environment. A blanket prohibition on equipment in or near bathtubs or showers is overly broad. Some types of heating equipment are listed for use in bathrooms, including near the shower or bathtub. Section 424.12(B) requires equipment to be listed for a wet or damp location if installed in one.

424.19(A)(2)	**2**697	**1**35	Create FR TG2-3 Editorial revisions were made to comply with section 4.1.4 of the 2023 *NEC Style Manual*.
424.19(B)(1)	**2528**	**136**	Create FR TG2-4 Editorial revisions were made to comply with section 3.2.5.3 of the 2023 *NEC Style Manual* requirements for *consistent application of terms* as it relates to "lockable open".
424.22(A)	**2698**	**137**	Create FR TG2-5 Editorial revisions were made to comply with section 4.1.4 of the 2023 *NEC Style Manual.*
424.44(E)	**99**	**138**	Create FR TG2-6 Editorial revisions were made to use the acronym "GFCI" in accordance with section 2.1.2.9 of the 2023 *NEC Style Manual*.
424.45(E)	**100**	**139**	Create FR TG2-7 Editorial revisions were made to use the acronym "GFCI" in accordance with section 2.1.2.9 of the 2023 *NEC Style Manual*.
424.47	**235**	**140**	Create FR TG2-8 The term "panelboard" was used incorrectly in previous versions of this section. The panelboard is the busbar assembly, aka the "guts." The intent of this requirement is for the label to be applied to the panelboard's enclosure, not the panelboard itself. Editorial revisions were made to add clarity. A portion of the existing text was rewritten as an exception, as the previous language provided an alternative to the general requirement. Additional reference to 110.21

			was added to ensure that the label is appropriate for the intended environment.
424.65	**3209**	**142**	Create FR TG2-9 The duct heater may or may not have supplemental overcurrent protection, so 424.19(A) or (B) could apply.
424.80	**2699**	**143**	Create FR TG2-10 Editorial revisions were made to comply with section 4.1.4 of the 2023 *NEC Style Manual*.
424.99(B)(5)			Create FR TG2-11 Editorial revisions were made to properly use the acronym "GFCI" in accordance with 2.1.2.9 of the 2023 *NEC Style Manual*. The phrase "for personnel" was removed, as it is included in the definition of GFCI in Article 100.
425.3	**3738** **996**	**144** **145**	Create FR TG2-12 The section and associated table were renumbered to 425.8, in accordance with section 2.2.1 of the 2023 *NEC Style Manual*. Specific Parts of Article 430 were added to comply with section 4.1.4 of the 2023 *NEC Style Manual*.
425.6	**3739**	**146**	Create FR TG2-13 The listing requirements of this article were relocated to 425.2 to comply with section 2.2.1 of the 2023 *NEC Style Manual*.
425.19	**2529** **2530** **2531** **2700** **2532**	**151** **152** **148** **149** **150**	Create FR TG2-14 Editorial revisions were made to comply with sections 3.2.5.3 and 4.1.4 of the 2023 *NEC Style Manual.*
425.22(A)	**2701**	**152**	Create FR TG2-15

			Editorial revisions were made to comply with section 4.1.4 of the 2023 *NEC Style Manual*.
426.3	**3741** **987**	**286** **287**	Create FR TG2-16 This section was deleted because reference to Article 422 is not needed as it applies regardless. The existing language also violated section 4.1.4 of the 2023 *NEC Style Manual*.
426.50(A)			Create FR TG2-17 Editorial revisions were made to comply with section 3.2.5.3 of the 2023 *NEC Style Manual*.
426.51	**2533**	**288**	Create FR TG2-18 Editorial revisions were made to comply with section 3.2.5.3 of the *NEC Style Manual*.
Article 100	**3479**	**42**	**Create CI TG2-1** The CMP has reviewed public inputs 3479 and 4168 regarding conductive heated pavement systems and has decided to provide this committee input in order to solicit public review and comments. CMP17 solicits comments regarding if pavement heating systems warrant specific requirements and/or separate a Part in Art 426, and do the specific requirements originally proposed in public inputs 3479 and 4168 sufficiently address the safety concerns. Currently, CMP 17 has initial concerns such as, but not necessarily limited to: 1. The lack of a product listing standard or outline of investigation clarifying appropriate product performance and safety requirements. 2. GFCI and/or GFPE protection or other shock protection measures 3. Grounding & bonding

			4. Capacitive coupling 5. Scope of use 6. Accessible and acceptable contact voltages on or near the surface of the heated pavement, after damage or possible deterioration of the heated pavement such as wear, cracks, potholes, or penetrations into the heated pavement surface, such as signage, guard rails, benches, etc. 7. The use of a grounded or an ungrounded system 8. Limits on applied system voltage. After public comments are received, as well as progress of development of product safety standards, additional concerns may be presented for consideration. **Conductive Pavement Heating System**. A system in which heat is generated by passing current between electrodes embedded within the pavement material and through the pavement material. (426) (CMP-17) Informational Note: The pavement material may be primarily of concrete, asphalt, or the like, and is typically constructed as bridge structures, walks, steps, roads, or parking areas.
Article 426 (New) Part VII	**4168**	**153**	**Create CI TG2-2** ***Note to NFPA Staff: See separate document for CI text.** The CMP has reviewed public inputs 3479 and 4168 regarding conductive heated pavement systems and has decided to provide this committee input in order to solicit public review and comments. CMP17 solicits comments regarding if pavement heating systems warrant specific requirements and/or separate a Part in Art 426, and do the specific requirements originally proposed in public inputs 3479 and 4168 sufficiently address the safety concerns. Currently, CMP 17 has initial concerns such as, but not necessarily limited to:

			1. The lack of a product listing standard or outline of investigation clarifying appropriate product performance and safety requirements. 2. GFCI and/or GFPE protection or other shock protection measures 3. Grounding & bonding 4. Capacitive coupling 5. Scope of use 6. Accessible and acceptable contact voltages on or near the surface of the heated pavement, after damage or possible deterioration of the heated pavement such as wear, cracks, potholes, or penetrations into the heated pavement surface, such as signage, guard rails, benches, etc. 7. The use of a grounded or an ungrounded system 8. Limits on applied system voltage. After public comments are received, as well as progress of development of product safety standards, additional concerns may be presented for consideration.
427.1	**2204**	**290**	Create FR TG2-19 The title and scope of the article were revised to reflect installations of heat trace beyond those used for just pipelines and vessels. For example, installations of heat trace for doors of commercial freezers and similar applications.
427.3	**3743** **988**	**291** **292**	Create FR TG2-20 This section was deleted because reference to Article 422 is not needed as it applies regardless. The existing language also violated section 4.1.4 of the 2023 *NEC Style Manual*.
427.55(A)	**2534**	**293**	Create FR TG2-21

			Editorial revisions were made to comply with section 3.2.5 of the 2023 *NEC Style Manual*.
427.56(A)			Create FR TG2-22 Editorial revisions were made to comply with section 3.2.5.3 of the 2023 *NEC Style Manual*.
427.56(D)			Create FR TG2-23 Editorial revisions were made to comply with Section 3.2.5.3 of the *NEC Style Manual*.
424.22(C)			Create FR TG2-24 Informational Note No.1 has been deleted as it was redundant to Note 2 and not needed.
424.41(C)			Create FR TG2-25 The informational note was deleted because a reference to 424.41(F) within 424.41(C) is not needed.
425.22(C)			Create FR TG2-26 The permissive language of Informational Note 1 was supposed to be in the requirement of 425.22(C) and is now relocated to the correct location. This is consistent with the language of 424.22(C). The remainder of Informational Note No 1 was deleted as it was redundant to Informational Note No 2.
424.3			Create FR TG2-27 The requirements for reconditioned equipment were added here, in accordance with 2.2.1 of the 2023 *NEC Style Manual.* It is unlikely that equipment covered by 424.3(B) would be able to be acceptably reconditioned and installed. Additionally, CMP 17 is not aware of any options that

			exist today for listing or field evaluation of reconditioned equipment of this type.
426.3			Create FR TG2-28 The requirements for reconditioned equipment were added here, in accordance with 2.2.1 of the 2023 *NEC Style Manual.* It is unlikely that equipment covered by Article 426 would be able to be acceptably reconditioned and installed. Additionally, CMP 17 is not aware of any options that exist today for listing or field evaluation of reconditioned equipment of this type.
427.3			Create FR TG2-29 The requirements for reconditioned equipment were added here, in accordance with 2.2.1 of the 2023 *NEC Style Manual.* It is unlikely that equipment covered by Article 427 would be able to be acceptably reconditioned and installed. Additionally, CMP 17 is not aware of any options that exist today for listing or field evaluation of reconditioned equipment of this type.
100			**Note to NFPA Staff:** I Have this in a separate document for global 3099. Not sure if we do it there or do it here, so I've done both. Create FR TG2-30 The term "heating system" is only used in Articles 426, 427, and 100, all of which are under the purview of CMP 17.A first revision has been made to the definition to delete the reference to Article 426, in accordance with section 2.1.2.6.2 of the 2023 *NEC Style Manual*. Heating System. A complete system consisting of components such as heating elements, fastening devices, nonheating circuit wiring, leads, temperature controllers, safety signs,

			junction boxes, raceways, and fittings. (CMP-17)
GLOBAL REVIEW	**3085 3086 3099 4050 4287**	**1 2 3 5 6**	**As requested by NFPA staff, a separate document has been created for these global PIs.**
426.54			Create FR TG2-31 The requirements of 426.54 were relocated to 426.2 to comply with section 2.2.1 of the 2023 *NEC Style Manual*. Additionally, the listing requirements for this article have been expanded to cover all equipment within the article's scope, including cord-and-plug-connected equipment, to ensure the installation of the products used are in compliance with applicable product safety standards.
424.102			Create FR TG2-32 The requirements of 424.102 were relocated to 426.2 to comply with section 2.2.1 of the 2023 *NEC Style Manual*.

Global PI 3085
CMP 17 TG 2
11/29/2023

Task Group 2 of Code-Making Panel 17 has reviewed the Informational Notes in Articles 424, 425, 426, and 427. The Task Group has found that they comply with section 2.1.10.3 of the 2023 *NEC Style Manual*, and no further action is necessary.

Global PI 3086
CMP 17 TG 2
11/29/2023

Task Group 2 of Code-Making Panel 17 has reviewed Articles 424, 425, 426, and 427 for compliance with the parallel numbering requirements of section 2.2.1 of the 2023 *NEC Style Manual*. First revisions were made as a result of Public Inputs to the applicable sections, and compliance with the Style Manual has been verified.

Global PI 3099
CMP 17 TG 2
11/29/2023

Task Group 2 of Code-Making Panel 17 has reviewed the definitions in Article 100 and found that only one definition (heating system) was specific to Article 424, 425, 426, or 427. The term "heating system" is only used in Articles 426, 427, and 100, all of which are under the purview of CMP 17.A first revision has been made to the definition to delete the reference to Article 426, in accordance with section 2.1.2.6.2 of the 2023 *NEC Style Manual*.

Create FR TG2-30

Heating System.

A complete system consisting of components such as heating elements, fastening devices, nonheating circuit wiring, leads, temperature controllers, safety signs, junction boxes, raceways, and fittings. (CMP-17)

Global PI 4050
CMP 17 TG 2
11/29/2023

Task Group 2 of Code-Making Panel 17 has reviewed Articles 424, 425, 426, and 427 for consistent and appropriate use of terms relating to overcurrent protection, overcurrent protective devices and similar terms.
No action has been taken as the task group has found that the existing text appears to comply with the 2023 *NEC Style Manual* and uses the defined terms in Article 100.
The task group requests that future updates to the *NEC Style Manual* provide better guidance on these terms, as the glossary contains multiple variations of these terms (*overcurrent device* and *overcurrent protective device* are included, for example, but *overcurrent protection device* is not) without indicating any context in which they are to be used.

Global PI 4287
CMP 17 TG 2
11/29/2023

Task Group 2 of Code-Making Panel 17 has reviewed Articles 424, 425, 426, and 427 for usability and clarity as it relates to ac and dc systems and circuits. The task group finds that these articles are clear in this regard, despite some equipment only applying to ac systems. For example, provisions for transformers, skin-effect, and induction are obviously only applicable to ac, but the task group believes that adding a reference to indicate “ac only” is not necessary. Is Article 450 going to remind the code user that transformers are ac equipment in every section of Article 450? This would seem to fly in the face of the “untrained persons” intent in 90.2(A). While Public Input 4287 makes good sense in several instances of the *Code*, it does not seem to make sense in Articles 424, 425, 426, or 427.

Code-Making Panel 17 Task Group 2
Committee Inputs to Article 100 and Article 426

CI TG2-1

Article 100
Conductive Pavement Heating System. A system in which heat is generated by passing current between electrodes embedded within the pavement material and through the pavement material. (426) (CMP-17)
Informational Note: The pavement material may be primarily of concrete, asphalt, or the like, and is typically constructed as bridge structures, walks, steps, roads, or parking areas.

CI TG2-2

Article 426
Part I. General
426.1 Scope.
This article covers fixed outdoor electric deicing and snow-melting equipment and the installation of these systems.
(A) Embedded.
Embedded in driveways, walks, steps, roads, and other areas.
(B) Exposed.
Exposed on drainage systems, bridge structures, roofs, roads, and other structures.
Informational Note: See ANSI/IEEE 515.1-2012, *Standard for the Testing, Design, Installation and Maintenance of Electrical Resistance Trace Heating for Commercial Applications*, for further information. See IEEE 844/CSA 293 series of standards for fixed outdoor electric deicing and snow-melting equipment.
(C) Combination. Combinations of embedded and exposed equipment in driveways, walks, steps, roads, bridge structures, and similar locations.

426.2 Listing. A conductive pavement heating system shall be listed and installed in accordance with the installation instructions and conductive pavement mixture specifications.

Part VI Conductive Pavement Heating Systems
426.60 General. Except as modified in this Part, conductive pavement heating systems shall comply with Parts I, II and VII of Article 426 and the following additional requirements.

426.62 Engineered Design.

The engineering design shall comply with all the following.
(A) Site Specific Design. Conductive pavement heating systems shall be designed and specified for specific installation site applications within the limits of the listing and manufacturer's installation instructions.
(B) Professional Engineer Required. The engineer shall be a licensed professional electrical engineer retained by the system owner or installer.
(C) Documentation. Documentation of the engineered design of the conductive pavement heating system shall be stamped and provided to the Authority Having Jurisdiction. The installation instructions, mixture specifications, and required conductivity test reports shall be provided to the Authority Having Jurisdiction.
(D) Additional Design Information. Additional stamped independent engineering reports detailing compliance of the design with applicable electrical standards and industry practice shall be provided upon request of the Authority Having Jurisdiction.
(E) Conformance Documentation. Conformance documentation shall include details of conformance of the design with the applicable parts of Article 426, or other articles of this Code.

426.64 Installation Engineering Supervision. Conductive pavement heating systems shall be installed under engineering supervision and in accordance with the manufacturer's instructions. All documentation shall be provided to the Authority Having Jurisdiction.

426.66 Conductive Pavement Heating System
(A) Cover. Embedded electrodes shall be installed in accordance with the product listing and one of the following:
(1) On a substantial concrete, masonry, or asphalt base at least 100 mm (4 in.) thick and having at least 50 mm (2 in.) of conductive pavement applied under the electrodes and over the top of the electrodes,
(2) The electrodes shall be permitted to be installed over other identified structural bases and embedded within 150 mm (6 in.) of conductive pavement with not less than 50 mm (2 in.) under the electrodes and over the top of the electrodes,
(3) Equipment that has been listed for other forms of installation shall be installed only in the manner for which it has been identified.
(B) Secured. Electrodes and supply conductors shall be secured in place by frames or spreaders or other approved means while the conductive pavement is installed.
(C) Expansion and Contraction. Electrodes and supply conductors shall not be installed where they bridge expansion joints unless provision is made for expansion, contraction, or other movement.
(D) Overtemperature. The conductive pavement system shall be monitored for surface temperatures and have overtemperature protection installed set not greater than 15° C (60° F). An overtemperature condition shall cause the power to the electrodes to be deenergized.
(E) Flexural Capability. Where installed on flexible structures, the electrodes and associated equipment shall have a flexural capability that is compatible with the movement of the structure.

426.68- Installation of Nonheating Leads.
(A) Nonheating Leads. Power supply nonheating leads (cold leads) for connection to the electrodes shall be identified for the temperature encountered. Not less than 150 mm (6 in.) of nonheating leads shall be provided within junction boxes.

(B) Protection. Nonheating leads shall be enclosed in a rigid nonmetallic conduit or other approved means.

426.70 Electrical Connection.

(A) Electrode Connections. Electrical connections, other than factory connections of electrodes to nonheating leads, shall be made with insulated connectors identified for the use.

(B) Circuit Connections. Splices and terminations at the end of the nonheating leads, other than the electrode end, shall be installed in a box or fitting in accordance with 110.14 and 300.15.

426.72 Corrosion Protection. Ferrous and nonferrous metal raceways, boxes, fittings, supports, and support hardware shall be permitted to be installed in pavement or in direct contact with the earth, or in areas subject to severe corrosive influences, if made of material suitable for the condition, or if provided with corrosion protection identified as suitable for the condition.

426.76 Conductive Pavement Materials. The conductive pavement materials shall be mixed in accordance with the specifications from the installation instructions. The maximum and minimum limits for resistance or conductivity shall be in accordance with the listing and be provided in the installation instructions.

426.78 Conductivity Testing. The conductive pavement material mixture shall be tested for resistance or conductivity and the test report shall be provided to the AHJ. Final approval for the installation shall not be granted until all material test reports have been provided and reviewed.

426.80 Equipment Mounting. Structures or equipment mounted onto the conductive pavement surface shall be electrically bonded together and connected to the equipment grounding system.

426.82 Grounding and Bonding.

An 8 AWG bare copper ground ring shall be installed and connected to the equipment grounding conductors. The ground ring and associated connections shall comply with all the following:

(1) The conductors follow the contour of the perimeter surface.

(2) Only listed splicing devices suitable for direct burial or concrete encasement, or exothermic welding are used.

(3) The conductor(s) is 150 mm to 300 mm (6 in. to 12 in.) outside the perimeter of the conductive pavement heating system.

(4) The conductor(s) is under the perimeter surface 100 mm to 150 mm (4 in. to 6 in.) below finished grade.

2026 NEC® Public Input Task Group Report

CMP #	**17**		
TG#	**3**		
TG Chair	**Stephen Kuscsik**		
TG Members	**See excel sheet**		
Article/Section	**Public Input #**	**PI Report Page #**	**TG Recommendation & Statement**
All	3085	1	Global Input – Corr Comm. Style Manual 2.1.10 for Informational Notes. Vote: 10Y, 0 N. FR CMP17-TG3-47 FR CMP17-TG3-48 Substantiation: Task Group 3 of Code-Making Panel 17 has reviewed the Informational Notes in Article 680 for compliance with section 2.1.10.3 of the 2023 *NEC Style Manual* and recommends revisions to 680.12 and 680.26(A) informational notes.
All	3086	2	Global Input – Corr Comm. Style Manual 2.2 for Organization of sub sections/numbering. Vote 10 Y, 0 N. Response: Task Group 3 of Code-Making Panel 17 has reviewed Article 680 for compliance with the parallel numbering requirements of section 2.2.1 of the 2023 *NEC Style Manual*. First revisions were made as a result of Public Inputs to the applicable sections, and compliance with the Style Manual has been verified. Also see PI 2807 for action.

			Task Group Notes: 680.3 Reconditioned equipment is not being added at this time, as 110.20 already permits reconditioned equipment to be installed unless prohibited elsewhere, and we see no need to prohibit installation of reconditioned equipment in Art 680 at this time.
All	3099	3	Global Input Vote 10 Y, 0 N Response: Task Group 3 of Code-Making Panel 17 has discussed the Public Input and has decided not to make First Revisions at this time. This can be revisited at the Second Draft should CMP 15 act favorably on PI 3099.
All	4050	5	Global Input Overcurrent protection Terms. Vote: 10 Y, 0 N Response: Task Group 3 of Code-Making Panel 17 has reviewed Article 680 for consistent and appropriate use of terms relating to overcurrent protection, overcurrent protective devices, and similar terms. No action has been taken as the task group has found that the existing text appears to comply with the 2023 *NEC Style Manual* and uses the defined terms in Article 100. The task group requests that future updates to the *NEC Style Manual* provide better guidance on these terms, as the glossary contains multiple variations of these terms (*overcurrent device* and *overcurrent protective device* are included, for example, but *overcurrent protection device* is not) without indicating any context in which they are to be used.

All	4287	6	Global Input Which circuits do requirements apply to? Vote: 10 Y, No 0. Response: Task Group 3 of Code-Making Panel 17 has reviewed Article 680 for usability and clarity as it relates to ac and dc systems and circuits. The task group finds that Article 680 is clear regarding the use of ac and dc systems and circuits, as well as wye-or delta-connected systems, and single-phase or polyphase systems. There are multiple instances of Article 680 referring to transformers and power supplies. These have not been revised as recommended by the Public Input, because CMP 17 feels that the issue is already clear to those qualified to read the requirements.
680.26	1624	8	Global Input, TIA 23-9. See PDF. Vote: 11 Y, 0 N. Resolve: CMP17 reviewed TIA 23-9 and action was taken on PIs related to 680.26 which took into consideration the TIA. No further action is needed for PI 1624. See Action Taken regarding revisions made, and panel statement for proposed changes that were not made, for other related to Definitions and Section 680.26 PIs, including PI 211, 212, and 213.

Definition	1800, 3033	15	Equipotential Plane Per Jeff S NPFA staff 11-9-23, these two PIs have been reassigned from CMP 17 to CMP 7. No need for any action by CMP 17. RESOLVE Substantiation: The definition of Equipotential Plane is under purview of CMP7, not CMP17. CMP 17 is not at liberty to make a FR for this. VOTE: 9 Yes, 0 No.
Definition	3033, 1800	16	Equipotential Plane Combine definitions. See PI 1800 for Action Taken.
Definition	2350. See 4229.	17	Fixed (as applied to equipment). Proposal to change purview from 680 CMP17 to CMP1 See 4229
Definition	4229, 2350	18	FR TG3-1 Equipment that is fastened or otherwise secured at a specific location. ~~(680)~~ (CMP-17) Substantiation – The term Fixed is used in more Articles beyond Art 680, but still relates to CMP17 for many of its uses, therefore will remain under purview of CMP17, and not change to CMP 1. 14 Yes. 0 NO.
Definition	901	19	Low-Voltage Contact Limit. Remove reference to 680 but keep purview with CMP17. FR TG3-2 14 Yes. 0 NO. Substantiation:

			The term Low-Voltage Contact Limit is used in Articles beyond Art 680 but still relates to CMP17 for many of its uses. The reference to Art 680 is being removed, and will remain under purview of CMP17.
Definition	1678, 1712, 234, 2510, 3695	20	Pool, Permanently Installed Swimming, Wading…. FR TG3-3 See code text below. Substantiation: These changes are intended to clarify the pool types intended to be covered by this definition. Yes: 14 No: 0
Definition	1712 See 1678	22	Pool, Permanently Installed Swimming, Wading, I... See 1678
Definition	234 See 1678	23	Pool, Permanently Installed Swimming, Wading, I... See 1678
Definition	2510 See 1678	31	Pool, Permanently Installed Swimming, Wading, I... See 1678
Definition	3695 See 1678	32	Pool, Permanently Installed Swimming, Wading, I... See 1678
Definition	2205	33	Pool, Storable; used for Swimming, Wading, or I... FR TG3-4 Yes: 14 No: 0 Substantiation: The definition is being revised for clarity, without changing the meaning. New informational note was added to indicate that a pool with permanent deck is to be treated as a permanently installed pool.
Definition	3700	34	Pool, Storable; used for Swimming, Wading, or I... RESOLVE 12 Yes 0 No.

			Substantiation: The proposed revisions do not add clarity to what is considered a Storable Pool vs Permanent Pool, and may be considered requirements rather than terms. 2.2.1.5 of the NEC Style Manual requires that definitions shall not contain requirements or recommendations.
Definition	211, 2862, 295	35	Definition: Pool FR CMP17 TG3-5 Vote for FR: 12 YES, 0 NO, for the latest FR and the statement. Substantiation: To aid the user and provide further clarification, additional specific installation types are referenced in the definition, and excluded from the definition, as well as an Informational Note, regarding what is considered a Pool and what is not considered a Pool. Permanent and Semi-Permanent are removed from the definition as how long the pool is intended to remain is not relevant to the term Pool. Additionally, “man-made bodies of water” is revised to “artificially-made bodies of water” since this is a defined term.
Definition	2862 See 211	37	Pool FR See PI 211
Definition	295 See 211	38	Pool FR See PI 21
Definition	3994	39	Portable (as applied to equipment) RESOLVE 12 Y, 0 No.

			Substantiation: The terms Portable and Portable Equipment are used in many locations throughout the code. This instance as applied only to Art 680 serves the needs for Pool and Spa applications. We do not see a benefit of removing this Definition.
Definition	2351, 4228	40	Stationary (as applied to equipment) Proposal to change purview from 680 CMP17 to CMP1 FR CMP17 TG3-6 12 Y, 0 N. Substantiation: The term "Stationary (as applied to equipment)" is used in Art 680, and is also used in other Articles to make it applicable in a larger scope, the reference only to Art 680 is being removed. Since it is used extensively in Art 680, CMP17 reference is being retained.
Definition	4228, 2351	41	Stationary (as applied to equipment) See PI 2351
Definition (NEW)	3681	43	Pool, Semi-Permanent; used for Swimming, Wading, or Immersion RESOLVE Substantiation: The submitter's objectives have been addressed by the revisions of the definitions of permanently installed pools and storable pools. The type of pool suggested in the public input is now considered to be a storable pool unless a permanent deck is installed around all or part of the pool. Therefore, the term "Semi-Permanently Installed Pools" is not being added to the title of Part II.
New Article after 680	3620, 3774	294	Relocate Art 680 to a stand-alone Chapter XX for Bodies of Water

			See notes in PI 3774. Resolve. Vote: 11 Y, 0 N. Substantiation: Code-Making Panel 17 does not support the creation of a new NEC Chapter at this time. The NEC is likely to receive wholesale changes to the 2029 edition, including reorganization. Additionally, it is important to retain the knowledge and long-standing history of requirements in Art 680, which current CMP 17 members have.
680.2	2807, 2808	295	680.2 Listing Requirements……. FR CMP17 TG3-7 12 Y 0 N. Substantiation: To comply with the NEC style manual section 2.2.1, the requirement for Listing is being moved from 680.6 to 680.2.
680.6	2808, 2807	297	680.6 Listing Requirements…. Corr committee input. Relocate to 680.2 See PI 2807 for action.
680.5(B)	4500	296	GFCI requirements for 100 a circuits, 3 ph. FR CMP 17 TG3-12 8 Yes, 0 No. Substantiation: 680.5(B) currently stipulates a 60-ampere threshold for equipment requiring ground-fault circuit interrupter (GFCI) protection. Commercially available three-phase GFCI devices now offer ratings up to 100 amperes. This revision reflects the availability of higher-rated GFCI devices and

			harmonizes the code with existing provisions, such as Section 210.8(B). Additionally, 680.5(B was separated into a list (1) and (2) for improved usability.
680.8	1944, 2267, 1326	298	680.8 Cord and plug redundant language. FR CMP17-TG3-13 11 Y, 0 N Substantiation: Existing section 680.7(B) has existing grounding and bonding requirements for cord and plug connections. Redundant language in existing section 680.8(B) is deleted. Title for (A) was clarified to better reflect the requirements in this item. Section 680.8 first level subdivision (C) was clarified, and the title revised, and renumbered as (B). The words “maintenance or repair” were changed to “servicing” for clarification, as “servicing “ is a defined term and often encompasses maintenance and repair activities.
680.8(B)	2267	299	Equipment Grounding Conductor See PI 1944 for Action Taken.
680.8	1326	300	Fixed or stationary….. Repair – servicing. See PI 1944 for Action Taken.
680.9(A)	1151	301	Power cables overhead and nearby pool area. RESOLVE 11Y 0 N. Substantiation: The submitted input would expand the clearances of this table to 10' beyond any

			observation stand, diving board, or similar structure. Insufficient technical substantiation was provided to support this proposed change.
680.10	646	304	Pool water heaters. RESOLVE 10 Y, 1 No. Substantiation: For 2023 NEC, Section 680.10 title was revised, and heat pumps and chiller equipment were added to the article to address new technology that is being added to pool installations. Section 680.10 was also revised into subparts (A) and (B) for clarity. This new technology is still in its early stages of implementation, and addressing this in this section provides guidance.
680.10(A)	4464	305	Pool water heaters FR CMP17-TG3-14 10 Y, 0 N. Substantiation: 680.10(A) is being revised into a list item format to facilitate understanding for Code users, and in accordance with NFPA Style Manual section 3.5.1.2. Additionally, “ampere” was added for clarity.
680.10(B)	4465	306	Pool water heaters FR CMP17-TG3-15 8 Y 0 N Substantiation: 680.10(B) is being revised into a list item format to facilitate understanding for Code users, and in accordance with NFPA Style Manual section 3.5.1.2. Additionally, “ampere” was added for

			clarity.
680.12(B)	1459, 4467	307	Receptacles FR CMP17-TG3-16 Vote 13 Y, 0 N Substantiation: Commercially available three-phase GFCI devices now offer ratings up to 100 amperes, and single phase GFCI devices offer ratings up to 60 amperes. This revision also reflects the availability of higher-rated GFCI and SPGFCI devices up to 480V that can be applied to all receptacles within equipment room, vaults or pits, and harmonizes the code with existing provisions, such as Section 210.8(B). The text was also separated into two subsections in accordance with NFPA Style manual section 3.5.1.2.
680.12(B)	4467, 1459	308	Receptacles Breaks into two sections to be clearer. See PI 1459 for Action taken.
680.14(A)	2265	309	Wiring methods – add new option. FR CMP17-TG3-17 Vote: 12 Y, 0 N. Substantiation: Liquidtight flexible metal conduit (LFMC) is suitable for use in corrosive environments per UL 360. In addition, 680.21(A)(1) permits LFMC for flexible connections to pool motors.
680.14(B)	645	310	Other Equipment – corrosion - suitable/identified FR CMP17-TG3-18 Vote 12 Y 0 N. Substantiation:

			The word "suitable" is replaced with defined term “identified" for clarity, and editorial change to add “permitted” instead of ”considered suitable for use”.
680.20	3719	311	Adding “semi-permanently installed pools” RESOLVE Substantiation: The submitter’s objectives have been addressed by the revisions of the definitions of Permanently Installed Pools and Storable Pools. The type of pool suggested in the public input is now considered to be a storable pool unless a permanent deck is installed around all or part of the pool. Therefore, “semi-permanently installed pools” has not been added to the text in 680.20.
680.21(D)	1325	312	Pool pump motor – servicing and reconditioning FR CMP17-TG3-19 Vote: 11 Y, 0 N. Substantiation: The term “reconditioned” was added to the requirement, and the Title expanded, both for clarity. The word "where" was changed to "if" to comply with the NEC Style Manual. The language regarding "repair" was not changed to "servicing," because “servicing” is a broader term than "repairing."
680.22(A)(4)	1336	313	SPGFCI SEE PI 3814 for Action (Resolve)
680.22(A)(4)	2395	314	New exception for GFCI not required near shore power. Photo included? Coud not see. RESOLVE Substantiation: Existing requirements in

			680.22(A)(4) provide for protection against electric shock for receptacles that may be in the area of a pool, up to 20 ft away. Allowing an exemption for shore power or any other purpose, where the receptacles are not required to be protected by GFCI or SPGFCI, significantly increases the electric shock risk in the pool area.
680.22(A)(4)	2439, 4511	315	GFCI for circuits See PI 4511 for Action.
680.22(A)(4)	4511, 2439	316	GFCI 3 phase 100A FR CMP 17 TG3-11 8 Yes, 0 No. Substantiation: 680.22(A)(4) currently stipulates a 60-ampere threshold for equipment requiring ground-fault circuit interrupter (GFCI) protection. Commercially available three-phase GFCI devices now offer ratings up to 100 amperes. This revision reflects the availability of higher-rated GFCI devices and harmonizes the code with existing provisions, such as Section 210.8(B). Additionally, 680.22(A)(4) was separated into a list (A) and (B) for improved usability.
680.22(A)(5)	2241	317	Measurements power supply cord Remove doorways, windows, etc FR CMP17-TG3-20 Vote 10 Y 0 N Substantiation: “Power-” is added to “supply cord”, and “of an appliance” is deleted, to correlate with the existing defined term “power-supply cord” in Article 100. The existing requirements regarding doorways and window openings are unique to pool/spa applications, and are not being deleted. The

			proposed revision might, for example, encourage receptacles just inside of a door or window to be used as the required receptacle in 680.22(A) list item 1.
680.22(B)(1)	2394	318	Outdoor clearances – add festoon lighting Vote 10 Y, 0 N FR CMP17-TG3-21 Substantiation: Festoon lighting is installed above pools very frequently. This term is added to the title, and the text revision makes it clear that festoon lighting is also subject to this distance requirement, and it enhances electrical safety from shock hazards in the swimming pool area. The installation height is clarified to indicate that all parts must be above the minimum height. Additionally, “New” and “Installation” were removed from the title of 680.22(B)(1) to align the requirements with the remainder of this Section. 680.22(B)(4) is also revised to add festoon lighting to the requirement, to correlate with adding it to 680.22(B)(1).
680.22(B)(2)	1648	319	Indoor clearances – GFCI term FR CMP17-TG3-22 Vote 10 Y, 0 N Substantiation: Section 2.1.2.9 of the NEC Style Manual permits the use of acronyms. The acronym, GFCI, is currently used in Article 100 and Section 680.5. Editorial revision was made for clarification to provide reference to 680.22(B)(1) for outdoor area clearances.
680.22(B)(3)	1649	320	Existing installations – GFCI term

			FR CMP17-TG3-23 Vote 11- Y, 0 N Substantiation: Section 2.1.2.9 of the NEC Style Manual permits the use of acronyms. The acronym, GFCI, is currently used in Article 100 and Section 680.5.
680.22(B)(8)	4472	321	Measurements – power supply cord – imaginary. Also removes doors/windows. RESOLVE Vote 11 Y 0 N Substantiation: In the context of 680.22(B)(8), the term “imaginary cord” is used as a reference to determine required distances, so changing it to power supply cord is not being made. The existing requirements regarding doorways and window openings are unique to pool/spa applications, and are not being deleted.
680.22(D)	1441	322	Other Outlets. Informational note. RESOLVE Vote 11 Y, 0 N Substantiation: This informational note is not all-inclusive regarding outlet examples. Outlets are defined in Art 100 and include sources of power, including for hardwired utilization equipment.
680.22(E)	3210	323	Other Equipment. Change to Utilization. RESOLVE Vote: 10 Y 0 N Substantiation:

			The term "equipment" is defined in Art 100, and would include utilization equipment, appliances, and other equipment. Revising the term to "Utilization equipment and Appliances" instead of "Equipment" narrows the scope of equipment that is subject to these requirements, and reduces the level of safety.
680.23(A)(4)	1453, 2334	324	Underwater Luminaires – max voltage. RESOLVE Vote 10 Y, 0 N Substantiation: Existing 680.23(A) already provides for installation of pool lights at or below the low voltage contact limit, and also for GFCI protection for luminaries above this voltage level. Insufficient substantiation has been provided to show that shock related incidents are occurring with properly installed underwater luminaires.
680.23(A)(4)	2334, 1453	325	Underwater Luminaires – max voltage. See PI 1453 for Action taken.
680.23(A)(4)	573	326	Underwater Luminaires – max voltage. Editorial only. FR CMP17-TG3-24 Substantiation: This is an editorial revision made to provide consistency with other requirements in the Code.
680.23(B)(2)	1647	327	Nonmetallic conduit. GFCI term. FR CMP17-TG3-25 Vote 11 Y, 0 N

			Substantiation: Section 2.1.2.9 of the NEC Style Manual permits the use of acronyms. The acronym, GFCI, is currently used in Article 100 and Section 680.5.
680.23(B)(6)	2451	328	Servicing. Luminaire in spa for service. Move to Spa section. RESOLVE 11 Y. 0 N Substantiation: CMP 17 reaffirms that spas can be constructed as part of a permanently installed pool, or stand-alone. The existing requirement in Section 680.23(B)(6) addresses both types of constructions, due to Section 680.43(B)(2) referring back to Section 680.23. Therefore, moving the requirements from Section 680.23(B)(6) is not necessary.
680.23(F)(2)	2269	329	Equipment Grounding Conductor RESOLVE: Substantiation Adding the word “conductor” to the title of 680.23(F)(2) would not provide significant clarification and may cause confusion.
680.24(B)	1651	330	GFCI term. FR CMP17-TG3-26 Vote 11 Y, 0 N Substantiation Section 2.1.2.9 of the NEC Style Manual permits the use of acronyms. The acronym, GFCI, is currently used in Article 100 and Section 680.5.
680.24(D)	1652, 3211, 3212, 2082	331	GFCI term. FR CMP17-TG3-27 Vote 11 Y, 0 N

			Substantiation Title of 680.24 and text of 680.24(D) was revised. Section 2.1.2.9 of the NEC Style Manual permits the use of acronyms. The acronym, GFCI, is currently used in Article 100 and Section 680.5 The term ‘panelboard’ and ‘enclosed panelboard’ are defined terms. Adding the word ‘enclosed panelboard’ makes the text technically correct. Relocating 680.24(F) to 680.24(D)(2) to group these similar requirements together. Both 680.24(D) and (F) have requirements relating to grounding terminals, therefore this relocation will add clarity for Code users. Section 2.1.2.9 of the NEC Style Manual permits the use of acronyms. The acronym, GFCI, is currently used in Article 100 and Section 680.5
680.24(D)	3211, 3212, 2082, 1652	332	Grounding terminals. See PI 1652 for Action Taken (FR).
680.24(E)	1654	333	GFCI term. FR CMP17-TG3-28 Substantiation Vote 10 Y, 0 N Section 2.1.2.9 of the NEC Style Manual permits the use of acronyms. The acronym, GFCI, is currently used in Article 100 and Section 680.5 Also added “enclosure” after GFCI for clarity, as this section relates to strain reliefs for enclosures.
680.24(F)	2082. 3211, 3212	334	Grounding – “enclosed” panelboard. See PI 1652 for Action Taken (FR).

680.24(F)	3212 3211, 2082	335	Relocate to other section. See PI 1652 for Action Taken (FR).
680.26(A)	212, 3253	336	Informational Notes for Performance of Equipotential Bonding FR CMP17-TG3-49 Informational Note 2 was deleted as it did not add clarity to the requirements. Corrosive environments are already addressed in 680.14, and performance requirements are already addressed in 680.26(A). Therefore, this language is not needed.
680.26(A)	3253, 212	338	Informational Notes for Performance of Equipotential Bonding See PI 212 for Action Taken (FR).
680.26(B)(2)	1738, 213	343	Equipotential bonding of perimeter surfaces. See PI 213 for Action Taken (FR)
680.26(B)(2)	1916	354	Equipotential bonding of perimeter surfaces. FR CMP17-TG3-50 Substantiation: The requirements for listing in 680.26(B)(2)(a) were clarified and the effective date was extended to allow time for the preparation of safety standards that could be used for the different options in this requirement and for products listed to these requirements to become available.
680.26(B)(2)	213, 1738	366	Equipotential bonding of perimeter surfaces. FR CMP7-TG3-50 Substantiation:

			Multiple editorial changes were made to 680.26(B)(2) for clarification and readability; and redundant language, including 680.26(B)(2)(d), was eliminated. Changing the height parameter for the perimeter surface from 600 mm (2 ft) below maximum water level to 900 mm (3 ft) below maximum water level more accurately addresses the reach range for a person using the pool.
680.26(B)(2)	770	383	Equipotential bonding of perimeter surfaces. FR CMP7-TG3-52 Substantiation: 680.26(B)(5) “Metal Fittings” was expanded to include structures in order to address items such as bulkheads. Moveable bulkheads are common especially in large commercial and institutional pools. This clarifies that conductive bulkheads must be bonded. Exception 4 was added to provide relief for conductive components attached to nonconductive bulkheads. These are often constructed of nonconductive materials, with limited metal fittings and attachments such as handles or starting blocks. When isolated from the pool structure and other conductive parts, these present minimal increased risk of electric shock, and are not required to be bonded.
680.26(B)	1737, 2083	391	Equipotential bonding of perimeter surfaces. FR CMP17-TG3-53 Substantiation: The section 680.26(B)(1) was restructured as a list and clarifies that structural steel reinforcement may be used as a bonding conductor. The term “panelboard” was changed to “enclosed panelboard” to add clarity.
680.26(B)	2083, 1737	393	Enclosed panelboards See PI 1737 for Action Taken (FR).

680.26(B)	2018	392	Copper-clad steel as conductor option RESOLVE Vote 8 Y, 0 N. Substantiation: CMP 17 reaffirms that Sections 110.5 Conductors, 250.102(A) Grounded Conductor, Bonding Conductors, and Jumpers Material, and 310.3(B) Conductor Material do not recognize copper-clad steel as a conductor. Additionally, copper-clad steel conductor is not a defined term in Article 100 Definitions.
680.26(B)(1)	1125	339	Bonding of conductive pool shells RESOLVE Substantiation: The proposed language does not add clarification. Structural reinforcing steel is the more general term which includes, but is not limited to, steel rebar, and which makes it clear as to the nature of the material. Rebar, on the other hand, may include some reinforcing materials which are not steel and which are non-conductive and unsuitable for the bonding application (e.g., fiberglass rebar). The structural design of the pool shell is not within the scope of the NEC.
680.26(B)(1)	2019	340	Allowing copper-clad steel as a grid option RESOLVE Vote 5 Y, 2 N. Substantiation: CMP 17 reaffirms that Sections 110.5 Conductors, 250.102(A) Grounded Conductor, Bonding Conductors, and Jumpers Material, and 310.3(B) Conductor Material do not recognize copper-clad steel as a conductor. Additionally, copper-clad steel conductor is not a defined term in Article 100

			Definitions.
New Section after 680.26(B)(2)	1214	341	New Section after 680.26(B)(2) RESOLVE Substantiation: The proposed PI contains no enforceable code language. Section 680.26 presently requires equipotential bonding for area in proximity to a pool. Insufficient technical substantiation has been presented to support the proposed change.
New Section after 680.26(B)(2)	3460	342	New Section after 680.26(B)(2) RESOLVE Substantiation: Multiple varieties of corrosion-resistant structural reinforcing steel and rebar (e.g., stainless steel, galvanized) exist. Structural rebar has been an accepted method of perimeter bonding including not encased in concrete for many years with acceptable performance. Insufficient technical substantiation has been presented to support the proposed change.
680.26(B)(2)	2020	360	RESOLVE Vote 7 Y, 0 N. Substantiation: CMP 17 reaffirms that Sections 110.5 Conductors, 250.102(A) Grounded Conductor, Bonding Conductors, and Jumpers Material, and 310.3(B) Conductor Material do not recognize copper-clad steel as a conductor. Additionally, copper-clad steel conductor is not a defined term in Article 100 Definitions.
680.26(B)(2)	278	373	Bonding of perimeter surfaces RESOLVE

			Substantiation: The FR of 680.26(B)(2) satisfies the objectives of the submitter.
680.26(B)(2)	279	377	Bonding of perimeter surfaces RESOLVE Substantiation: The FR of 680.26(B)(2) satisfies the objectives of the submitter.
680.26(B)(7)	1215	389	New section – Metal Fence Bonding RESOLVE Substantiation: Section 680.26 presently requires equipotential bonding for area in proximity to a pool. Insufficient technical substantiation has been presented to support the proposed change.
680.26(B)(7)	3214	390	Add "..bonded metal part". RESOLVE Substantiation: Insufficient technical substantiation has been presented to support the proposed change. The proposal is impractical and would require bonding of all metal parts that are within 5 feet of each other (rather than within 5 feet of the pool), regardless of their function, creating in some foreseeable cases a "daisy chain" of now-required-to-be-bonded metal parts that could reach far from the pool and even off the property.
680.28	2468, 2467	394	New section 680.29 (after 680.28) for Portable Signs. Related also to PI 2467 for 680.57(C)(2). FR CMP17-TG3-29

			Substantiation: Currently, 680.57(C)(2) in Part V Fountains contains a pool specific requirement, regarding Portable Signs. This is being appropriately relocated to new 680.29 in Part II of Art. 680, and the requirement in 680.57(C)(2) is being modified to relate only to Fountains.
680.28	2489	395	New section 680.29 (after 680.28) for Electric Water Heaters. GFCI protection. FR CMP17-TG3-30 Vote 6 yes, 3 No Substantiation: Permanent swimming pools can and are heated using an electric water heaters. This revision provides for GFCI or SPGFCI protection similar to that which applies to gas-fired water heaters, as the hazards are similar.
680.28	2453	396	Gas-Fired Water Heaters Revise to remove spas, as these are covered elsewhere. RESOLVE Substantiation: Spas can be constructed as part of a permanently installed pool or stand-alone. This requirement is specific to a spa constructed as part of a permanently installed pool and is retained for clarity.
680.32	2440, 2441, 4518	397	GFCi and SPGFCI receptable ratings, remove 125/250 v limitation. See PI 4518 for Action Taken (FR).
680.32	2441, 2440, 4518	398	GFCI and SPGFCI – revise section to break into two parts, for clarity. See PI 4518 for Action Taken (FR).

680.32	2518	399	GFCI and SPGFCI 150V to ground Vote 8 Y, 0 N RESOLVE Substantiation: FR being made to this and other sections of Art 680 clarify the range of voltages associated with the receptacles requiring protection.
680.32	3814, 3815, 1336	400	GFCI and SPFGCI – remove SPGFCI as this section is for 150v to ground and SPGFCI is for greater than 150V to gnd. Vote: 7 Yes, 0 No. RESOLVE Substantiation: The existing code language is not in conflict with the definition of a SPGFCI, and the existing requirement is technically correct. Single- and three-phase receptacles rated 250-volts installed on 240-volt corner grounded delta systems or involving the high leg of a 120/240-volt 4-wire delta connected system have a voltage to ground greater than 150-volts and require SPGFCI (rather than GFCI) protection. These systems are discussed in the existing Informational Note to 680.5(B). Additional FR to this and other sections of Art 680 are being made to clarify that the range of voltages associated with SPGFCI includes 480V.
680.32	4518, 2441, 2440	401	GFCI and SPGFCI – expand to 100A 3 Ph, correlate with 210.8(B). FR CMP 17 TG3-10 8 Yes, 0 No. Substantiation: 680.32 currently stipulates a 60-ampere threshold for equipment requiring ground-fault circuit

			interrupter (GFCI) protection. Commercially available three-phase GFCI devices now offer ratings up to 100 amperes. This revision reflects the availability of higher-rated GFCI devices and harmonizes the code with existing provisions, such as Section 210.8(B). Additionally, 680.32 was separated into a list (A) and (B) for improved usability.
680.40	1286	402	General – editorial change from Corr Comm from last cycle. FR CMP17-TG3-31 Vote 13 Y, 0 N. Substantiation: The text is revised to comply with the NEC style manual Section 4.1.3.
680.439(A)(2)	2442, 4520	403	GFCI and SPGFCI – remove 125/250v limitation. See PI 4520 for Action Taken (FR).
680.43(A)(2)	3815	404	GFCI and SPGFCI – remove SPGFCI. See PI 3814 for Action (Resolve)
680.43(A)(2)	4520, 2442	405	GFCI and SPGFCI – expand to 100A. FR CMP 17 TG3-9 9 Yes, 0 No. Substantiation: 680.43(A)(2) currently stipulates a 60-ampere threshold for equipment requiring ground-fault circuit interrupter (GFCI) protection. Commercially available three-phase GFCI devices now offer ratings up to 100 amperes. This revision reflects the availability of higher-rated GFCI and SPGFCI devices up to 480V that can be applied to all receptacles within 3.0 m of inside walls of an indoor spa or hot tub, and harmonizes the code

			with existing provisions, such as Section 210.8(B). Additionally, 680.43(A)(2) was separated into a list (A) and (B) for improved usability.
680.43(A)(3)	4476	406	GFCI Protection for Spas. FR CMP17-TG3-32 Vote: 13 Y, 0 N. Substantiation: The word “Protection” was removed from title of 680.43(A)(3) to better align the title with the requirements in the text.
680.43(F)	2270	407	Grounding – revise title to better match text FR CMP17-TG3-33 Vote 14 Y, 0 N Substantiation: The Title of 680.43(F) was revised to add “Equipment” to be more descriptive and remain concise.
680.45(A)	1328	408	Cord and Plug Connection – change “repair” to “servicing”. I believe we accepted this in other PIs in other sections. FR CMP17-TG3-34 Vote: 14Y, 0 No. Substantiation: The text language regarding “..to facilitate….servicing” was removed. Deleting this text improves usability and does not change the requirement.
680.45(C)	1659	409	Heaters – proposed revisions for hard Wired and GFCI and cord connected. FR CMP17-TG3-38 Vote 11 Y, 0 N.

			Substantiation This section is restructured for clarity, usability and compliance with the 2023 NEC Style Manual, section 2.1.8.1 while making no technical changes to the requirements.
680.50	294, 293	412	General – add splash pads. RESOLVE: Vote: 14 Y, 0 N Substantiation: The term "splash pads" was not added to the text in 680.50, nor added to the Title of Part V, as the definition of Fountain already includes Splash Pads, and the definition of Splash Pad indicates that a Splash pad is a fountain.
680.50(A)	2927	413	Additional Requirements – editorial revisions for style manual. FR CMP17-TG3-35 Vote: 14 Y, 0 N Substantiation: Editorial revisions are made to comply with the NEC style manual.
680.54(A)	2084, 2272	414	Grounding – add "Enclosed" to panelboards. FR CMP17-TG3-36 Substantiation: The Title of 680.54(A) was revised to add "Equipment" to be more descriptive and remain concise. In 680.54(A)(3), the term 'panelboard' and 'enclosed panelboard' are defined terms. Adding the word 'enclosed panelboard' makes the text technically correct.

680.54(A)	2272, 2084	415	Grounding – modify title to better align with text. See PI 2084 for Action taken.
680.55	2273	416	Grounding – same change as 680.54(A) see PI above. FR CMP17-TG3-37 Vote: 14 Y, 0 N. Substantiation: The Title of 680.55 was revised to remove “Method” and add “Equipment” to be more descriptive and remain concise. Item (A) was editorially revised to improve usability.
680.56(D)	1327	417	Terminations – change “repair” to “servicing” FR CMP17-TG3-39 Vote 11 Y, 0 N. Substantiation: Editorial revisions were made to clarify that this section applies to any flexible cord-connected equipment, not just those that are cord-and-plug-connected. The terms "maintenance" and "repair" were changed to "servicing" to better incorporate defined terms.
680.57(C)(2)	2467, 2468	418	Portable – revise to remove pool. Aligns with PI 2468. See PI 2468 for Action Taken TG Notes: This PI proposes to remove the reference to a pool. Part V Fountains, per it's scope at 680.50, applies to all permanently installed fountains only. See companion PI 2468 that proposes to relocate the pool specific requirement to 680.29.

680.58	2443, 4527	419	GFCI and SPGFCI – remove 125/250 v rating. See PI 4527 for Action taken. FR.
680.58	4527, 2443	420	GFCI and SPGFCI – expand to 100A 3 PH FR CMP 17 TG3-8 9 Yes, 0 No. Substantiation: 680.58 currently stipulates a 60-ampere threshold for equipment requiring ground-fault circuit interrupter (GFCI) protection. Commercially available three-phase GFCI devices now offer ratings up to 100 amperes. This revision reflects the availability of higher-rated GFCI and SPGFCI devices up to 480V that can be applied to all receptacles within 6.0 m of fountain edge, and harmonizes the code with existing provisions, such as Section 210.8(B). Additionally, 680.58 was separated into a list (A) and (B) for improved usability.
680.60	2928	421	General – editorial revision for style manual. CC input. FR CMP17-TG3-40 Vote 11 Y, 0 N Substantiation: The text was revised to conform to the 2023 NEC Style Manual section 4.1.4.
680.62(A)(1)	1656	422	Listed Units – revised GFCi term to align with style manual. FR CMP17-TG3-41 Vote 12 Y, 0 N Substantiation: Section 2.1.2.9 of the 2023 NEC Style Manual permits the use of acronyms. The

			acronym, GFCI, is currently used in Article 100 and Section 680.5. GFCI is also a defined term.
680.62(A)(2)	1657	423	Other Units – revise GFCI term. See PI 1656 also. FR CMP17-TG3-42 Vote: 12 Y, 0 N Substantiation: Section 2.1.2.9 of the 2023 NEC Style Manual permits the use of acronyms. The acronym, GFCI, is currently used in Article 100 and Section 680.5. GFCI is also a defined term.
680.62(D)	2274	424	Grounding – change title to better match text. FR CMP17-TG3-43 Vote 11 Y, 0 N. Substantiation: The Title of 680.62(D) was revised to add “Equipment” to be more descriptive and remain concise.
680.71	2392, 2393	425	Protection – change title to better match text. FR CMP17-TG3-44 Vote 10 Y, 0 N. Substantiation: Section 680.71 was split into two separate sections, with 680.71 covering the requirement for an individual branch circuit and a new section 680.75 covering GFCI protection. New Section 680.75 was split into two subsections for clarity and ease of reading. These editorial revisions are non-technical in nature and are intended to satisfy section 3.5.1.2 of the 2023 NEC Style Manual.
680.71	2393, 2392	426	Protection – revise to make two subsections. See PI 2392 for Action Taken.
680.74(B)	2085	427	Bonding Conductor – add ”enclosed”

			FR CMP17-TG3-45 Vote: 10 Y, 0 N. Substantiation: The term 'panelboard' and 'enclosed panelboard' are defined terms. Adding the word 'enclosed panelboard' makes the text technically correct.
680.83	2086	428	Equipment Bonding – add "enclosed" FR CMP17-TG3-46 Vote 10 Y, 0 N Substantiation: The term 'panelboard' and 'enclosed panelboard' are defined terms. Adding the word 'enclosed panelboard' makes the text technically correct.
New Art after 682	3774, 3620	429	Relocate Art 682 to new stand-alone chapter XX for Bodies of Water See PI. 3620 for comments/action.
682.33(C)(1)	2415	430	Bonded Parts – connections shall be listed….. NO ACTION TAKEN BY CMP17. This should be sent to CMP 7 who now owns Art 682. This IS assigned to CMP 7. CMP 17 does not need to act.
680 Part II	3710	442	Part II Title – add Semi Permanent Pools Also see related PIs: 3681, 3695, 3700, 3719 RESOLVE Vote: 10 Y, 0 N Substantiation: The submitter's objectives have been addressed by the revisions of the definitions of permanently installed pools and storable pools. The type of pool suggested in the public input is now considered to

			be a storable pool unless a permanent deck is installed around all or part of the pool.
680 Part V	293, 294	443	Part V Title – revise to add Splash Pads See 294 for Action Taken

PI Categorization	Number of PIs	Number Completed	Number Still to Do
Globals	6	6	0
Definitions	19	18	1
680.26	18	0	18
680 other	40	23	17
TOTAL	83	41	42

680.26 Equipotential Bonding.

(A) Performance.

The equipotential bonding required by 680.26(B) and (C) to reduce voltage gradients in the pool area shall be installed for pools with or without associated electrical equipment related to the pool.

Informational Note No. 1: See ANSI C2, National Electrical Safety Code 2023 Edition, Rule 097D2, for measures that address voltage gradients originating on the utility side of the service point. Some causes of voltage gradients originate outside the premises wiring system and are not within the scope of the *NEC*. Measures identified in Rule 097D2 of ANSI C2, *National Electrical Safety Code*, can also serve to address voltage gradients originating on the utility side of the service point.

Informational Note No. 2: By its nature, equipotential bonding of swimming pools and perimeter surfaces involves contact between various metallic materials and the earth. This can, in some cases, expose various specific metals to a corrosive environment, depending on factors such as the type and chemical content of the soil and the specific metal. Corrosive environments are also addressed in 680.14.

(B) Bonded Parts.

The parts specified in 680.26(B)(1) through 680.26(B)(7) shall be bonded together using one or more of the following:

(1) solid copper conductors, insulated, covered, or bare, not smaller than 8 AWG, which shall not be required to be extended or attached to remote panelboard enclosures, service equipment, or electrodes. The conductor is permitted to encircle the pool to facilitate bonding connections to portions of the perimeter covered in 680.26(B)(2)(a) and 680.26(B)(2)(b) that are not contiguous.

(2) rigid metal conduit of brass or other identified corrosion-resistant metal.

(3) structural reinforcing steel.

(4) steel structural welded wire reinforcement (welded wire mesh, welded wire fabric).

The parts specified in 680.26(B)(1) through (B)(7) shall be bonded together using solid copper conductors, insulated, covered, or bare, not smaller than 8 AWG or with rigid metal conduit of brass or other identified corrosion-resistant metal. Connections to bonded parts shall be made in accordance with 250.8. An 8 AWG or larger solid copper bonding conductor provided to reduce voltage gradients in the pool

~~area shall not be required to be extended or attached to remote panelboards, service equipment, or electrodes.~~

(1) Conductive Pool Shells.

Bonding to conductive pool shells shall be provided as specified in 680.26(B)(1)(a) or (B)(1)(b). Cast-in-place concrete, pneumatically applied or sprayed concrete, and concrete block with painted or plastered coatings shall all be considered conductive materials due to water permeability and porosity. Reconstructed pool shells shall also meet the requirements of this section. Vinyl liners and fiberglass composite shells shall be considered to be nonconductive materials and not subject to these requirements.

(a) *Structural Reinforcing Steel.* Unencapsulated structural reinforcing steel shall be bonded together by steel tie wires or the equivalent. Where structural reinforcing steel is encapsulated in a nonconductive compound, a copper conductor grid shall be installed in accordance with 680.26(B)(1)(b).

(b) *Copper Conductor Grid.* A copper conductor grid shall be provided and shall comply with the following:

(1) Be constructed of minimum 8 AWG bare solid copper conductors bonded to each other at all points of crossing in accordance with 250.8 or other approved means

(2) Conform to the contour of the pool

(3) Be arranged in a 300 mm (12 in.) by 300 mm (12 in.) network of conductors in a uniformly spaced perpendicular grid pattern with a tolerance of 100 mm (4 in.)

(4) Be secured within or under the pool no more than 150 mm (6 in.) from the outer contour of the pool shell

(2) Perimeter Surfaces.

Bonding to perimeter surfaces shall be provided as specified in 680.26(B)(2)(a), 680.26(B)(2)(b), and 680.26(B)(2)(c). The perimeter surface shall include unpaved surfaces, concrete, masonry pavers and other types of paving. The perimeter surface to be bonded shall be considered to extend for 900 mm (3 ft) horizontally beyond the inside walls of the pool while also at a height between 900 mm (3 ft) above and 600 mm

(2 ft) below the maximum water level. ~~The perimeter surface shall include unpaved surfaces, concrete, and other types of paving.~~ Perimeter surfaces separated from the pool by a permanent wall or building 1.5 m (5 ft) in height or more shall require equipotential bonding only on the pool side of the permanent wall or building. ~~Bonding to perimeter surfaces shall be provided as specified in 680.26(B)(2)(a), (B)(2)(b), (B)(2)(c), and (B)(2)(d).~~

For conductive pool shells where bonding to perimeter surfaces is required, it shall be attached to the pool structural reinforcing steel or copper conductor grid at a minimum of four points uniformly spaced around the perimeter of the pool.~~, or if~~If the bonded perimeter surface does not surround the entire pool, it shall be attached to the pool structural reinforcing steel or copper conductor grid at a minimum of four uniformly spaced points along the bonded perimeter surface.

For nonconductive pool shells, where bonding to the perimeter surfaces is required, bonding at four points shall not be required. ~~, and t~~The perimeter bonding shall be attached to the 8 AWG copper equipotential bonding conductor and, if present, to any conductive support structure for the pool.

Informational Note: Because the perimeter surface can incorporate various types of materials at various locations and elevations above and below maximum water level, the perimeter surface required to be bonded might not surround the entire pool. The 8 AWG copper equipotential bonding conductor can encircle the entire pool to facilitate connection of bonded parts.

(a) *Conductive Paved Portions of Perimeter Surfaces.* Conductive paved portions of perimeter surfaces~~, including masonry pavers, if used,~~ shall be bonded with one or more of the following:

(1) ~~u~~Unencapsulated structural reinforcing steel in accordance with 680.26(B)(1)(a),

(2) A copper conductor grid,

(3) ~~or with u~~Unencapsulated steel structural welded wire reinforcement ~~(welded wire mesh, welded wire fabric),~~ bonded together by steel tie wires or the equivalent, ~~. Steel welded wire reinforcement shall be~~ and fully embedded within the pavement unless the pavement will not allow for embedding.

If ~~the~~ structural reinforcing steel is absent, or is encapsulated in a nonconductive compound, or embedding is not possible, unencapsulated welded wire steel reinforcement or a copper conductor grid shall be provided and shall be secured directly under the paving, and not more than 150 mm (6 in.) below finished grade.

Where ~~Unencapsulated steel welded wire reinforcement that is~~ not fully embedded in concrete, ~~and~~ copper conductor grid and unencapsulated steel structural welded wire used for equipotential bonding, ~~regardless of location, where used for equipotential bonding,~~ shall be listed for corrosion resistance and mechanical performance. This listing requirement shall become effective January 1, 2025. The copper conductor grid or unencapsulated steel structural welded wire reinforcement shall also meet the following:

(1) Copper conductor grid is constructed of 8 AWG solid bare copper and arranged in accordance with 680.26(B)(1)(b)(3).

(2) Structural ~~S~~steel welded wire reinforcement is minimum ASTM 6 × 6-W2.0 × W2.0 or minimum No. 3 rebar constructed in a 300 mm (12 in.) grid.

(3) Copper conductor grid and steel structural welded wire reinforcement shall follow the contour of the perimeter surface extending not less than 900 mm (3 ft) horizontally beyond the inside walls of the pool.

(4) Only listed splicing devices or exothermic welding are used.

Informational Note No. 1: Performance of the equipotential bonding system at the perimeter surface is improved as the distance between the bonding means and finished grade is minimized, either by embedding within, or by direct contact with the underside of, the finished pavement.

Informational Note No. 2: See ASTM A615/A615M, *Standard Specification for Deformed and Plain Carbon-Steel Bars for*

Concrete Reinforcement; A1064/A1064M, *Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete;* A1022/A1022M, *Standard Specification for Deformed and Plain Stainless Steel Wire and Welded Wire for Concrete Reinforcement;* A1060A/A1060M, *Standard Specification for Zinc-Coated (Galvanized) Steel Welded Wire Reinforcement, Plain and Deformed, for Concrete;* and ACI Standard ACI 318, *Building Code Requirements for Structural Concrete,* for examples of standards currently used in the listing of reinforcing steel bars and steel welded wire reinforcement.

(b) *Unpaved Portions of Perimeter Surfaces.* Unpaved portions of perimeter surfaces shall be bonded with any of the following methods:

(1) Copper conductor(s) shall meet the following:

a. At least one minimum 8 AWG bare solid copper conductor, including the 8 AWG copper equipotential bonding conductor if available.

b. The conductors follow the contour of the perimeter surface.

c. Only listed splicing devices or exothermic welding are used.

d. The conductor(s) is 450 mm to 600 mm (18 in. to 24 in.) from the inside walls of the pool.

e. The conductor(s) is under the unpaved portion of the perimeter surface 100 mm to 150 mm (4 in. to 6 in.) below finished grade.

f. Be installed only in perimeter surfaces not intended to have direct access to swimmers in the pool.

(2) Copper conductor grid or unencapsulated steel structural welded wire reinforcement used for equipotential bonding of unpaved portions of perimeter surfaces shall meet the following:

a. Be installed in accordance with 680.26(B)(2)(a).

b. Be located within unpaved surface(s) between 100 mm to 150 mm (4 in. to 6 in.) below finished grade.

(c) *Nonconductive Perimeter Surfaces.* Equipotential bonding shall not be required for nonconductive portions of perimeter surfaces that are separated from earth or raised on nonconducting supports.~~, and it~~ Equipotential bonding shall not be required for any perimeter surface that is electrically separated from the pool structure and raised on nonconductive supports above an equipotentially bonded surface.

Informational Note: Nonconductive materials include, but are not limited to, wood, plastic, wood-plastic composites, fiberglass, and fiberglass composites.

(d) *Interconnection of Bonded Portions of Perimeter Surfaces.* All surfaces where equipotential bonding is required shall be interconnected using listed splicing devices or exothermic welding. Where copper wire is used for this purpose, it shall be solid copper, not smaller than 8 AWG. The conductor shall be permitted to encircle the pool to facilitate bonding connections to portions of the perimeter covered in 680.26(B)(2)(a) and (B)(2)(b) that are not contiguous.

(3) Metallic Components.

All metallic parts of the pool structure, including reinforcing metal not addressed in 680.26(B)(1)(a), shall be bonded. Where reinforcing steel is encapsulated with a nonconductive compound, the reinforcing steel shall not be required to be bonded.

(4) Underwater Lighting.

All metal forming shells and mounting brackets of no-niche luminaires shall be bonded.

Exception: Listed low-voltage lighting systems with nonmetallic forming shells shall not require bonding.

(5) Metal Fittings.

All metal fittings within or attached to the pool structure shall be bonded.

Exception: The following shall not be required to be bonded:

(1) Isolated parts that are not over 100 mm (4 in.) in any dimension and do not penetrate into the pool structure more than 25 mm (1 in.)

(2) Metallic pool cover anchors intended for insertion in a concrete or masonry deck surface, 25 mm (1 in.) or less in any dimension and 51 mm (2 in.) or less in length

(3) Metallic pool cover anchors intended for insertion in a wood or composite deck surface, 51 mm (2 in.) or less in any flange dimension and 51 mm (2 in.) or less in length

(6) Electrical Equipment.

Metal parts of the following electrical equipment shall be bonded:

(1) Electrically powered pool cover(s)

(2) Pool water circulation, treatment, heating, cooling, or dehumidification equipment

(3) Unless separated from the pool by a permanent barrier that prevents contact by a person, any other electrical equipment within 1.5 m (5 ft) measured horizontally from the inside wall of the pool, or 3.7 m (12 ft) measured vertically above the maximum water level of the pool, or as measured vertically above any observation stands, towers, or platforms, or any diving structures

Exception: Metal parts of listed equipment incorporating an approved system of double insulation shall not be bonded.

(a) *Double-Insulated Water Pump Motors.* Where a double-insulated water pump motor is installed under the provisions of this rule, a solid 8 AWG copper conductor of sufficient length to make a bonding connection to a replacement motor shall be extended from the swimming pool equipotential bonding means to an accessible point in the vicinity of the pool pump motor. Where there is no connection between the swimming pool equipotential bonding means and the equipment grounding system for the premises, this bonding conductor shall be connected to the equipment grounding conductor of the motor circuit.

(b) *Pool Water Heaters.* For pool water heaters rated at more than 50 amperes and having specific instructions regarding bonding and grounding, only those parts designated to be bonded shall be bonded and only those parts designated to be grounded shall be grounded.

(7) Fixed Metal Parts.

All fixed metal parts, including, but not limited to, metal-sheathed cables and raceways, metal piping, metal awnings, metal fences, and metal door and window frames, shall be bonded where located no greater than either of the following:

(1) 1.5 m (5 ft) horizontally from the inside walls of the pool

(2) 3.7 m (12 ft) vertically above the maximum water level of the pool, observation stands, towers, or platforms, or any diving structures

Exception: Those separated from the pool by a permanent barrier that prevents contact by a person shall not be required to be bonded.

(C) Pool Water.

Where none of the bonded parts as specified in 680.26(B)(1) through (B)(7) are in direct connection with the pool water, the pool water shall be in direct contact with an approved corrosion-resistant conductive surface that exposes not less than 5800 mm^2 (9 in.^{2}) of surface area to the pool water at all times. The conductive surface shall be located where it is not exposed to physical damage or dislodgement during usual pool activities, and it shall be bonded in accordance with 680.26(B).

680.26 Equipotential Bonding.
(A) Performance.

The equipotential bonding required by 680.26(B) and (C) to reduce voltage gradients in the pool area shall be installed for pools with or without associated electrical equipment related to the pool.

Informational Note No. 1: Some causes of voltage gradients originate outside the premises wiring system and are not within the scope of the *NEC*. Measures identified in Rule 097D2 of ANSI C2, *National Electrical Safety Code*, can also serve to address voltage gradients originating on the utility side of the service point.

Informational Note No. 2: By its nature, equipotential bonding of swimming pools and perimeter surfaces involves contact between various metallic materials and the earth. This can, in some cases, expose various specific metals to a corrosive environment, depending on factors such as the type and chemical content of the soil and the specific metal. Corrosive environments are also addressed in 680.14.

(B) Bonded Parts.

The parts specified in 680.26(B)(1) through (B)(7) shall be bonded together using solid copper conductors, insulated, covered, or bare, not smaller than 8 AWG or with rigid metal conduit of brass or other identified corrosion-resistant metal. Connections to bonded parts shall be made in accordance with 250.8. An 8 AWG or larger solid copper bonding conductor provided to reduce voltage gradients in the pool area shall not be required to be extended or attached to remote panelboards, service equipment, or electrodes.

(1) Conductive Pool Shells.

Bonding to conductive pool shells shall be provided as specified in 680.26(B)(1)(a) or (B)(1)(b). Cast-in-place concrete, pneumatically applied or sprayed concrete, and concrete block with painted or plastered coatings shall all be considered conductive materials due to water permeability and porosity. Reconstructed pool shells shall also meet the requirements of this section. Vinyl liners and fiberglass composite shells shall be considered to be nonconductive materials and not subject to these requirements.

(a) *Structural Reinforcing Steel.* Unencapsulated structural reinforcing steel shall be bonded together by steel tie wires or the equivalent. Where structural reinforcing steel is encapsulated in a nonconductive compound, a copper conductor grid shall be installed in accordance with 680.26(B)(1)(b).

(b) *Copper Conductor Grid.* A copper conductor grid shall be provided and shall comply with the following:

(1) Be constructed of minimum 8 AWG bare solid copper conductors bonded to each other at all points of crossing in accordance with 250.8 or other approved means

(2) Conform to the contour of the pool

(3) Be arranged in a 300 mm (12 in.) by 300 mm (12 in.) network of conductors in a uniformly spaced perpendicular grid pattern with a tolerance of 100 mm (4 in.)

(4) Be secured within or under the pool no more than 150 mm (6 in.) from the outer contour of the pool shell

(2) Perimeter Surfaces.

The perimeter surface to be bonded shall be considered to extend for 900 mm (3 ft) horizontally beyond the inside walls of the pool while also at a height between 900 mm (3 ft) above and 600 mm (2 ft) below the maximum water level. The perimeter surface shall include unpaved surfaces, concrete, and other types of paving. Perimeter surfaces separated from the pool by a permanent wall or building 1.5 m (5 ft) in height or more shall require equipotential bonding only on the pool side of the permanent wall or building. Bonding to perimeter surfaces shall be provided as specified in 680.26(B)(2)(a), (B)(2)(b), (B)(2)(c), and (B)(2)(d). For conductive pool shells where bonding to perimeter surfaces is required, it shall be attached to the pool reinforcing steel or copper conductor grid at a minimum of four points uniformly spaced around the perimeter of the pool, or if the bonded perimeter surface does not surround the entire pool, it shall be attached to the pool reinforcing steel or copper conductor grid at a minimum of four uniformly spaced points along the bonded perimeter surface. For nonconductive pool shells, where bonding to the perimeter surfaces is required, bonding at four points shall not be required, and the perimeter bonding shall be attached to the 8 AWG copper equipotential bonding conductor and, if present, to any conductive support structure for the pool.

Informational Note: Because the perimeter surface can incorporate various types of materials at various locations and elevations above and below maximum water level, the perimeter surface required to be bonded might not surround the entire pool. The 8 AWG copper equipotential bonding conductor can encircle the entire pool to facilitate connection of bonded parts.

(a) *Conductive Paved Portions of Perimeter Surfaces.* Conductive paved portions of perimeter surfaces, including masonry pavers, if used, shall be bonded with unencapsulated structural reinforcing steel in accordance with 680.26(B)(1)(a), or with unencapsulated steel structural welded wire reinforcement (welded wire mesh, welded wire fabric), bonded together by steel tie wires or the equivalent. Steel welded wire reinforcement shall be fully embedded within the pavement unless the pavement will not allow for embedding. If the reinforcing steel is absent, or is encapsulated in a nonconductive compound, or embedding is not possible, unencapsulated welded wire steel reinforcement or a copper conductor grid shall be provided and shall be secured directly under the paving, and not more than 150 mm (6 in.) below finished grade.

Unencapsulated steel welded wire reinforcement that is not fully embedded in concrete, and copper grid regardless of location, where used for equipotential bonding, shall be listed for corrosion resistance and mechanical performance. This listing requirement shall become effective January 1, ~~2025~~2029. The copper grid or unencapsulated steel welded wire reinforcement shall also meet the following:

(1) Copper grid is constructed of 8 AWG solid bare copper and arranged in accordance with 680.26(B)(1)(b)(3).

(2) Steel welded wire reinforcement is minimum ASTM 6 × 6-W2.0 × W2.0 or minimum No. 3 rebar constructed in a 300 mm (12 in.) grid.

(3) Copper grid and steel welded wire reinforcement follow the contour of the perimeter surface extending not less than 900 mm (3 ft) horizontally beyond the inside walls of the pool.

(4) Only listed splicing devices or exothermic welding are used.

Informational Note No. 1: Performance of the equipotential bonding system at the perimeter surface is improved as the distance between the bonding means and finished grade is minimized, either by embedding within, or by direct contact with the underside of, the finished pavement.

Informational Note No. 2: See ASTM A615/A615M, *Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement;* A1064/A1064M, *Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete;* A1022/A1022M, *Standard Specification for Deformed and Plain Stainless Steel Wire and Welded Wire for Concrete Reinforcement;* A1060A/A1060M, *Standard Specification for Zinc-Coated (Galvanized) Steel Welded Wire Reinforcement, Plain and Deformed, for Concrete;* and ACI Standard ACI 318, *Building Code Requirements for Structural Concrete,* for examples of standards currently used in the listing of reinforcing steel bars and steel welded wire reinforcement.

(b) *Unpaved Portions of Perimeter Surfaces.* Unpaved portions of perimeter surfaces shall be bonded with any of the following methods:

(1) Copper conductor(s) shall meet the following:

a. At least one minimum 8 AWG bare solid copper conductor, including the 8 AWG copper equipotential bonding conductor if available.

b. The conductors follow the contour of the perimeter surface.

c. Only listed splicing devices or exothermic welding are used.

d. The conductor(s) is 450 mm to 600 mm (18 in. to 24 in.) from the inside walls of the pool.

e. The conductor(s) is under the unpaved portion of the perimeter surface 100 mm to 150 mm (4 in. to 6 in.) below finished grade.

f. Be installed only in perimeter surfaces not intended to have direct access to swimmers in the pool.

(2) Copper grid or unencapsulated steel welded wire reinforcement used for equipotential bonding of unpaved portions of perimeter surfaces shall meet the following:

a. Be installed in accordance with 680.26(B)(2)(a).

b. Be located within unpaved surface(s) between 100 mm to 150 mm (4 in. to 6 in.) below finished grade.

(c) *Nonconductive Perimeter Surfaces.* Equipotential bonding shall not be required for nonconductive portions of perimeter surfaces that are separated from earth or raised on nonconducting supports, and it shall not be required for any perimeter surface that is electrically separated from the pool structure and raised on nonconductive supports above an equipotentially bonded surface.
Informational Note: Nonconductive materials include, but are not limited to, wood, plastic, wood-plastic composites, fiberglass, and fiberglass composites.

(d) *Interconnection of Bonded Portions of Perimeter Surfaces.* All surfaces where equipotential bonding is required shall be interconnected using listed splicing devices or exothermic welding. Where copper wire is used for this purpose, it shall be solid copper, not smaller than 8 AWG. The conductor shall be permitted to encircle the pool to facilitate bonding connections to portions of the perimeter covered in 680.26(B)(2)(a) and (B)(2)(b) that are not contiguous.

(3) Metallic Components.

All metallic parts of the pool structure, including reinforcing metal not addressed in 680.26(B)(1)(a), shall be bonded. Where reinforcing steel is encapsulated with a nonconductive compound, the reinforcing steel shall not be required to be bonded.

(4) Underwater Lighting.

All metal forming shells and mounting brackets of no-niche luminaires shall be bonded.

Exception: Listed low-voltage lighting systems with nonmetallic forming shells shall not require bonding.

(5) Metal Fittings.

All metal fittings within or attached to the pool structure shall be bonded.

Exception: The following shall not be required to be bonded:

(1) Isolated parts that are not over 100 mm (4 in.) in any dimension and do not penetrate into the pool structure more than 25 mm (1 in.)

(2) Metallic pool cover anchors intended for insertion in a concrete or masonry deck surface, 25 mm (1 in.) or less in any dimension and 51 mm (2 in.) or less in length

(3) Metallic pool cover anchors intended for insertion in a wood or composite deck surface, 51 mm (2 in.) or less in any flange dimension and 51 mm (2 in.) or less in length

(6) Electrical Equipment.

Metal parts of the following electrical equipment shall be bonded:

(1) Electrically powered pool cover(s)

(2) Pool water circulation, treatment, heating, cooling, or dehumidification equipment

(3) Unless separated from the pool by a permanent barrier that prevents contact by a person, any other electrical equipment within 1.5 m (5 ft) measured horizontally from the inside wall of the pool, or 3.7 m (12 ft) measured vertically above the maximum water level of the pool, or as measured vertically above any observation stands, towers, or platforms, or any diving structures

Exception: Metal parts of listed equipment incorporating an approved system of double insulation shall not be bonded.

(a) *Double-Insulated Water Pump Motors.* Where a double-insulated water pump motor is installed under the provisions of this rule, a solid 8 AWG copper conductor of sufficient length to make a bonding connection to a replacement motor shall be extended from the swimming pool equipotential bonding means to an accessible point in the vicinity of the pool pump motor. Where there is no connection between the swimming pool equipotential bonding means and the equipment grounding system for the premises, this bonding conductor shall be connected to the equipment grounding conductor of the motor circuit.

(b) *Pool Water Heaters.* For pool water heaters rated at more than 50 amperes and having specific instructions regarding bonding and grounding, only those parts designated to be bonded shall be bonded and only those parts designated to be grounded shall be grounded.

(7) Fixed Metal Parts.

All fixed metal parts, including, but not limited to, metal-sheathed cables and raceways, metal piping, metal awnings, metal fences, and metal door and window frames, shall be bonded where located no greater than either of the following:

(1) 1.5 m (5 ft) horizontally from the inside walls of the pool

(2) 3.7 m (12 ft) vertically above the maximum water level of the pool, observation stands, towers, or platforms, or any diving structures

Exception: Those separated from the pool by a permanent barrier that prevents contact by a person shall not be required to be bonded.

(C) Pool Water.

Where none of the bonded parts as specified in 680.26(B)(1) through (B)(7) are in direct connection with the pool water, the pool water shall be in direct contact with an approved corrosion-resistant conductive surface that exposes not less than 5800 mm^2 (9 in.^{2}) of surface area to the pool water at all times. The conductive surface shall be located where it is not exposed to physical damage or dislodgement during usual pool activities, and it shall be bonded in accordance with 680.26(B).

680.26 Equipotential Bonding.
(A) Performance.

The equipotential bonding required by 680.26(B) and (C) to reduce voltage gradients in the pool area shall be installed for pools with or without associated electrical equipment related to the pool.

Informational Note No. 1: Some causes of voltage gradients originate outside the premises wiring system and are not within the scope of the *NEC*. Measures identified in Rule 097D2 of ANSI C2, *National Electrical Safety Code*, can also serve to address voltage gradients originating on the utility side of the service point.

Informational Note No. 2: By its nature, equipotential bonding of swimming pools and perimeter surfaces involves contact between various metallic materials and the earth. This can, in some cases, expose various specific metals to a corrosive environment, depending on factors such as the type and chemical content of the soil and the specific metal. Corrosive environments are also addressed in 680.14.

(B) Bonded Parts.

The parts specified in 680.26(B)(1) through (B)(7) shall be bonded together using solid copper conductors, insulated, covered, or bare, not smaller than 8 AWG or with rigid metal conduit of brass or other identified corrosion-resistant metal. Connections to bonded parts shall be made in accordance with 250.8. An 8 AWG or larger solid copper bonding conductor provided to reduce voltage gradients in the pool area shall not be required to be extended or attached to remote panelboards, service equipment, or electrodes.

(1) Conductive Pool Shells.

Bonding to conductive pool shells shall be provided as specified in 680.26(B)(1)(a) or (B)(1)(b). Cast-in-place concrete, pneumatically applied or sprayed concrete, and concrete block with painted or plastered coatings shall all be considered conductive materials due to water permeability and porosity. Reconstructed pool shells shall also meet the requirements of this section. Vinyl liners and fiberglass composite shells shall be considered to be nonconductive materials and not subject to these requirements.

(a) *Structural Reinforcing Steel.* Unencapsulated structural reinforcing steel shall be bonded together by steel tie wires or the equivalent. Where structural reinforcing steel is encapsulated in a nonconductive compound, a copper conductor grid shall be installed in accordance with 680.26(B)(1)(b).

(b) *Copper Conductor Grid.* A copper conductor grid shall be provided and shall comply with the following:

(1) Be constructed of minimum 8 AWG bare solid copper conductors bonded to each other at all points of crossing in accordance with 250.8 or other approved means

(2) Conform to the contour of the pool

(3) Be arranged in a 300 mm (12 in.) by 300 mm (12 in.) network of conductors in a uniformly spaced perpendicular grid pattern with a tolerance of 100 mm (4 in.)

(4) Be secured within or under the pool no more than 150 mm (6 in.) from the outer contour of the pool shell

(2) Perimeter Surfaces.

The perimeter surface to be bonded shall be considered to extend for 900 mm (3 ft) horizontally beyond the inside walls of the pool while also at a height between 900 mm (3 ft) above and ~~6~~900 mm (~~2~~3 ft) below the maximum water level. The perimeter surface shall include unpaved surfaces, concrete, and other types of paving. Perimeter surfaces separated from the pool by a permanent wall or building 1.5 m (5 ft) in height or more shall require equipotential bonding only on the pool side of the permanent wall or building. Bonding to perimeter surfaces shall be provided as specified in 680.26(B)(2)(a), (B)(2)(b), (B)(2)(c), and (B)(2)(d). For conductive pool shells where bonding to perimeter surfaces is required, it shall be attached to the pool reinforcing steel or copper conductor grid at a minimum of four points uniformly spaced around the perimeter of the pool, or if the bonded perimeter surface does not surround the entire pool, it shall be attached to the pool reinforcing steel or copper conductor grid at a minimum of four uniformly spaced points along the bonded perimeter surface. For nonconductive pool shells, where bonding to the perimeter surfaces is required, bonding at four points shall not be required, and the perimeter bonding shall be attached to the 8 AWG copper equipotential bonding conductor and, if present, to any conductive support structure for the pool.

Informational Note: Because the perimeter surface can incorporate various types of materials at various locations and elevations above and below maximum water level, the perimeter surface required to be bonded might not surround the entire pool. The 8 AWG copper equipotential bonding conductor can encircle the entire pool to facilitate connection of bonded parts.

(a) *Conductive Paved Portions of Perimeter Surfaces.* Conductive paved portions of perimeter surfaces, including masonry pavers, if used, shall be bonded with unencapsulated structural reinforcing steel in accordance with 680.26(B)(1)(a), or with unencapsulated steel structural welded wire reinforcement (welded wire mesh, welded wire fabric), bonded together by steel tie wires or the equivalent. Steel welded wire reinforcement shall be fully embedded within the pavement unless the pavement will not allow for embedding. If the reinforcing steel is absent, or is encapsulated in a nonconductive compound, or embedding is not possible, unencapsulated welded wire steel reinforcement or a copper conductor grid shall be provided and shall be secured directly under the paving, and not more than 150 mm (6 in.) below finished grade.

Unencapsulated steel welded wire reinforcement that is not fully embedded in concrete, and copper grid regardless of location, where used for equipotential bonding, shall be listed for corrosion resistance and mechanical performance. This listing requirement shall become effective January 1, 2025. The copper grid or unencapsulated steel welded wire reinforcement shall also meet the following:

(1) Copper grid is constructed of 8 AWG solid bare copper and arranged in accordance with 680.26(B)(1)(b)(3).

(2) Steel welded wire reinforcement is minimum ASTM 6 × 6-W2.0 × W2.0 or minimum No. 3 rebar constructed in a 300 mm (12 in.) grid.

(3) Copper grid and steel welded wire reinforcement follow the contour of the perimeter surface extending not less than 900 mm (3 ft) horizontally beyond the inside walls of the pool.

(4) Only listed splicing devices or exothermic welding are used.

Informational Note No. 1: Performance of the equipotential bonding system at the perimeter surface is improved as the distance between the bonding means and finished grade is minimized, either by embedding within, or by direct contact with the underside of, the finished pavement.

Informational Note No. 2: See ASTM A615/A615M, *Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement;* A1064/A1064M, *Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete;* A1022/A1022M, *Standard Specification for Deformed and Plain Stainless Steel Wire and Welded Wire for Concrete Reinforcement;* A1060A/A1060M, *Standard Specification for Zinc-Coated (Galvanized) Steel Welded Wire Reinforcement, Plain and Deformed, for Concrete;* and ACI Standard ACI 318, *Building Code Requirements for Structural Concrete,* for examples of standards currently used in the listing of reinforcing steel bars and steel welded wire reinforcement.

(b) *Unpaved Portions of Perimeter Surfaces.* Unpaved portions of perimeter surfaces shall be bonded with any of the following methods:

(1) Copper conductor(s) shall meet the following:

a. At least one minimum 8 AWG bare solid copper conductor, including the 8 AWG copper equipotential bonding conductor if available.

b. The conductors follow the contour of the perimeter surface.

c. Only listed splicing devices or exothermic welding are used.

d. The conductor(s) is 450 mm to 600 mm (18 in. to 24 in.) from the inside walls of the pool.

e. The conductor(s) is under the unpaved portion of the perimeter surface 100 mm to 150 mm (4 in. to 6 in.) below finished grade.

f. Be installed only in perimeter surfaces not intended to have direct access to swimmers in the pool.

(2) Copper grid or unencapsulated steel welded wire reinforcement used for equipotential bonding of unpaved portions of perimeter surfaces shall meet the following:

a. Be installed in accordance with 680.26(B)(2)(a).

b. Be located within unpaved surface(s) between 100 mm to 150 mm (4 in. to 6 in.) below finished grade.

(c) *Nonconductive Perimeter Surfaces.* Equipotential bonding shall not be required for nonconductive portions of perimeter surfaces that are separated from earth or raised on nonconducting supports, and it shall not be required for any perimeter surface that is electrically separated from the pool structure and raised on nonconductive supports above an equipotentially bonded surface.
Informational Note: Nonconductive materials include, but are not limited to, wood, plastic, wood-plastic composites, fiberglass, and fiberglass composites.

(d) *Interconnection of Bonded Portions of Perimeter Surfaces.* All surfaces where equipotential bonding is required shall be interconnected using listed splicing devices or exothermic welding. Where copper wire is used for this purpose, it shall be solid copper, not smaller than 8 AWG. The conductor shall be permitted to encircle the pool to facilitate bonding connections to portions of the perimeter covered in 680.26(B)(2)(a) and (B)(2)(b) that are not contiguous.

(3) Metallic Components.

All metallic parts of the pool structure, including reinforcing metal not addressed in 680.26(B)(1)(a), shall be bonded. Where reinforcing steel is encapsulated with a nonconductive compound, the reinforcing steel shall not be required to be bonded.

(4) Underwater Lighting.

All metal forming shells and mounting brackets of no-niche luminaires shall be bonded.

Exception: Listed low-voltage lighting systems with nonmetallic forming shells shall not require bonding.

(5) Metal Fittings.

All metal fittings within or attached to the pool structure shall be bonded.

Exception: The following shall not be required to be bonded:

(1) Isolated parts that are not over 100 mm (4 in.) in any dimension and do not penetrate into the pool structure more than 25 mm (1 in.)

(2) Metallic pool cover anchors intended for insertion in a concrete or masonry deck surface, 25 mm (1 in.) or less in any dimension and 51 mm (2 in.) or less in length

(3) Metallic pool cover anchors intended for insertion in a wood or composite deck surface, 51 mm (2 in.) or less in any flange dimension and 51 mm (2 in.) or less in length

(6) Electrical Equipment.

Metal parts of the following electrical equipment shall be bonded:

(1) Electrically powered pool cover(s)

(2) Pool water circulation, treatment, heating, cooling, or dehumidification equipment

(3) Unless separated from the pool by a permanent barrier that prevents contact by a person, any other electrical equipment within 1.5 m (5 ft) measured horizontally from the inside wall of the pool, or 3.7 m (12 ft) measured vertically above the maximum water level of the pool, or as measured vertically above any observation stands, towers, or platforms, or any diving structures

Exception: Metal parts of listed equipment incorporating an approved system of double insulation shall not be bonded.

(a) *Double-Insulated Water Pump Motors.* Where a double-insulated water pump motor is installed under the provisions of this rule, a solid 8 AWG copper conductor of sufficient length to make a bonding connection to a replacement motor shall be extended from the swimming pool equipotential bonding means to an accessible point in the vicinity of the pool pump motor. Where there is no connection between the swimming pool equipotential bonding means and the equipment grounding system for the premises, this bonding conductor shall be connected to the equipment grounding conductor of the motor circuit.

(b) *Pool Water Heaters.* For pool water heaters rated at more than 50 amperes and having specific instructions regarding bonding and grounding, only those parts designated to be bonded shall be bonded and only those parts designated to be grounded shall be grounded.

(7) Fixed Metal Parts.

All fixed metal parts, including, but not limited to, metal-sheathed cables and raceways, metal piping, metal awnings, metal fences, and metal door and window frames, shall be bonded where located no greater than either of the following:

(1) 1.5 m (5 ft) horizontally from the inside walls of the pool

(2) 3.7 m (12 ft) vertically above the maximum water level of the pool, observation stands, towers, or platforms, or any diving structures

Exception: Those separated from the pool by a permanent barrier that prevents contact by a person shall not be required to be bonded.

(C) Pool Water.

Where none of the bonded parts as specified in 680.26(B)(1) through (B)(7) are in direct connection with the pool water, the pool water shall be in direct contact with an approved corrosion-resistant conductive surface that exposes not less than 5800 mm^2 (9 $in.^2$) of surface area to the pool water at all times. The conductive surface shall be located where it is not exposed to physical damage or dislodgement during usual pool activities, and it shall be bonded in accordance with 680.26(B).

680.26 Equipotential Bonding.
(A) Performance.

The equipotential bonding required by 680.26(B) and (C) to reduce voltage gradients in the pool area shall be installed for pools with or without associated electrical equipment related to the pool.

Informational Note No. 1: Some causes of voltage gradients originate outside the premises wiring system and are not within the scope of the *NEC*. Measures identified in Rule 097D2 of ANSI C2, *National Electrical Safety Code*, can also serve to address voltage gradients originating on the utility side of the service point.

Informational Note No. 2: By its nature, equipotential bonding of swimming pools and perimeter surfaces involves contact between various metallic materials and the earth. This can, in some cases, expose various specific metals to a corrosive environment, depending on factors such as the type and chemical content of the soil and the specific metal. Corrosive environments are also addressed in 680.14.

(B) Bonded Parts.

The parts specified in 680.26(B)(1) through (B)(7) shall be bonded together using solid copper conductors, insulated, covered, or bare, not smaller than 8 AWG or with rigid metal conduit of brass or other identified corrosion-resistant metal. Connections to bonded parts shall be made in accordance with 250.8. An 8 AWG or larger solid copper bonding conductor provided to reduce voltage gradients in the pool area shall not be required to be extended or attached to remote panelboards, service equipment, or electrodes.

(1) Conductive Pool Shells.

Bonding to conductive pool shells shall be provided as specified in 680.26(B)(1)(a) or (B)(1)(b). Cast-in-place concrete, pneumatically applied or sprayed concrete, and concrete block with painted or plastered coatings shall all be considered conductive materials due to water permeability and porosity. Reconstructed pool shells shall also meet the requirements of this section. Vinyl liners and fiberglass composite shells shall be considered to be nonconductive materials and not subject to these requirements.

(a) *Structural Reinforcing Steel.* Unencapsulated structural reinforcing steel shall be bonded together by steel tie wires or the equivalent. Where structural reinforcing steel is encapsulated in a nonconductive compound, a copper conductor grid shall be installed in accordance with 680.26(B)(1)(b).

(b) *Copper Conductor Grid.* A copper conductor grid shall be provided and shall comply with the following:

(1) Be constructed of minimum 8 AWG bare solid copper conductors bonded to each other at all points of crossing in accordance with 250.8 or other approved means

(2) Conform to the contour of the pool

(3) Be arranged in a 300 mm (12 in.) by 300 mm (12 in.) network of conductors in a uniformly spaced perpendicular grid pattern with a tolerance of 100 mm (4 in.)

(4) Be secured within or under the pool no more than 150 mm (6 in.) from the outer contour of the pool shell

(2) Perimeter Surfaces.

The perimeter surface to be bonded shall be considered to extend for 900 mm (3 ft) horizontally beyond the inside walls of the pool while also at a height between 900 mm (3 ft) above and 600 mm (2 ft) below the maximum water level. The perimeter surface shall include unpaved surfaces, concrete, and other types of paving. Perimeter surfaces separated from the pool by a permanent wall or building 1.5 m (5 ft) in height or more shall require equipotential bonding only on the pool side of the permanent wall or building. Bonding to perimeter surfaces shall be provided as specified in 680.26(B)(2)(a), (B)(2)(b), (B)(2)(c), and (B)(2)(d). For conductive pool shells where bonding to perimeter surfaces is required, it shall be attached to the pool reinforcing steel or copper conductor grid at a minimum of four points uniformly spaced around the perimeter of the pool, or if the bonded perimeter surface does not surround the entire pool, it shall be attached to the pool reinforcing steel or copper conductor grid at a minimum of four uniformly spaced points along the bonded perimeter surface. For nonconductive pool shells, where bonding to the perimeter surfaces is required, bonding at four points shall not be required, and the perimeter bonding shall be attached to the 8 AWG copper equipotential bonding conductor and, if present, to any conductive support structure for the pool.

Informational Note: Because the perimeter surface can incorporate various types of materials at various locations and elevations above and below maximum water level, the perimeter surface required to be bonded might not surround the entire pool. The 8 AWG copper equipotential bonding conductor can encircle the entire pool to facilitate connection of bonded parts.

(a) *Conductive Paved Portions of Perimeter Surfaces.* Conductive paved portions of perimeter surfaces, including masonry pavers, if used, shall be bonded with unencapsulated structural reinforcing steel in accordance with 680.26(B)(1)(a), or with unencapsulated steel structural welded wire reinforcement (welded wire mesh, welded wire fabric), bonded together by steel tie wires or the equivalent. Steel welded wire reinforcement shall be fully embedded within the pavement unless the pavement will not allow for embedding. If the reinforcing steel is absent, or is encapsulated in a nonconductive compound, or embedding is not possible, unencapsulated welded wire steel reinforcement or a copper conductor grid shall be provided and shall be secured directly under the paving, and not more than 150 mm (6 in.) below finished grade.

Unencapsulated steel welded wire reinforcement that is not fully embedded in concrete, and copper grid regardless of location, where used for equipotential bonding, shall be listed for corrosion resistance and mechanical performance. This listing requirement shall become effective January 1, 2025. The copper grid or unencapsulated steel welded wire reinforcement shall also meet the following:

(1) Copper grid is constructed of 8 AWG solid bare copper and arranged in accordance with 680.26(B)(1)(b)(3).

(2) Steel welded wire reinforcement is minimum ASTM 6 × 6-W2.0 × W2.0 or minimum No. 3 rebar constructed in a 300 mm (12 in.) grid.

(3) Copper grid and steel welded wire reinforcement follow the contour of the perimeter surface extending not less than 900 mm (3 ft) horizontally beyond the inside walls of the pool.

~~(4) Only listed splicing devices or exothermic welding are used.~~

Informational Note No. 1: Performance of the equipotential bonding system at the perimeter surface is improved as the distance between the bonding means and finished grade is minimized, either by embedding within, or by direct contact with the underside of, the finished pavement.

Informational Note No. 2: See ASTM A615/A615M, *Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement;* A1064/A1064M, *Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete;* A1022/A1022M, *Standard Specification for Deformed and Plain Stainless Steel Wire and Welded Wire for Concrete Reinforcement;* A1060A/A1060M, *Standard Specification for Zinc-Coated (Galvanized) Steel Welded Wire Reinforcement, Plain and Deformed, for Concrete;* and ACI Standard ACI 318, *Building Code Requirements for Structural Concrete,* for examples of standards currently used in the listing of reinforcing steel bars and steel welded wire reinforcement.

(b) *Unpaved Portions of Perimeter Surfaces.* Unpaved portions of perimeter surfaces shall be bonded with any of the following methods:

(1) Copper conductor(s) shall meet the following:

a. At least one minimum 8 AWG bare solid copper conductor, including the 8 AWG copper equipotential bonding conductor if available.

b. The conductors follow the contour of the perimeter surface.

~~c. Only listed splicing devices or exothermic welding are used.~~

~~d~~c. The conductor(s) is 450 mm to 600 mm (18 in. to 24 in.) from the inside walls of the pool.

d~~e~~. The conductor(s) is under the unpaved portion of the perimeter surface 100 mm to 150 mm (4 in. to 6 in.) below finished grade.

e~~f~~. Be installed only in perimeter surfaces not intended to have direct access to swimmers in the pool.

(2) Copper grid or unencapsulated steel welded wire reinforcement used for equipotential bonding of unpaved portions of perimeter surfaces shall meet the following:

a. Be installed in accordance with 680.26(B)(2)(a).

b. Be located within unpaved surface(s) between 100 mm to 150 mm (4 in. to 6 in.) below finished grade.

(c) *Nonconductive Perimeter Surfaces.* Equipotential bonding shall not be required for nonconductive portions of perimeter surfaces that are separated from earth or raised on nonconducting supports, and it shall not be required for any perimeter surface that is electrically separated from the pool structure and raised on nonconductive supports above an equipotentially bonded surface.

Informational Note: Nonconductive materials include, but are not limited to, wood, plastic, wood-plastic composites, fiberglass, and fiberglass composites.

(d) *Interconnection of Bonded Portions of Perimeter Surfaces.* All surfaces where equipotential bonding is required shall be interconnected using listed splicing devices or exothermic welding. Where copper wire is used for this purpose, it shall be solid copper, not smaller than 8 AWG. The conductor shall be permitted to encircle the pool to facilitate bonding connections to portions of the perimeter covered in 680.26(B)(2)(a) and (B)(2)(b) that are not contiguous.

(3) Metallic Components.

All metallic parts of the pool structure, including reinforcing metal not addressed in 680.26(B)(1)(a), shall be bonded. Where reinforcing steel is encapsulated with a nonconductive compound, the reinforcing steel shall not be required to be bonded.

(4) Underwater Lighting.

All metal forming shells and mounting brackets of no-niche luminaires shall be bonded.

Exception: Listed low-voltage lighting systems with nonmetallic forming shells shall not require bonding.

(5) Metal Fittings.

All metal fittings within or attached to the pool structure shall be bonded.

Exception: The following shall not be required to be bonded:

(1) Isolated parts that are not over 100 mm (4 in.) in any dimension and do not penetrate into the pool structure more than 25 mm (1 in.)

(2) Metallic pool cover anchors intended for insertion in a concrete or masonry deck surface, 25 mm (1 in.) or less in any dimension and 51 mm (2 in.) or less in length

(3) Metallic pool cover anchors intended for insertion in a wood or composite deck surface, 51 mm (2 in.) or less in any flange dimension and 51 mm (2 in.) or less in length

(6) Electrical Equipment.

Metal parts of the following electrical equipment shall be bonded:

(1) Electrically powered pool cover(s)

(2) Pool water circulation, treatment, heating, cooling, or dehumidification equipment

(3) Unless separated from the pool by a permanent barrier that prevents contact by a person, any other electrical equipment within 1.5 m (5 ft) measured horizontally from the inside wall of the pool, or 3.7 m (12 ft) measured vertically above the maximum water level of the pool, or as measured vertically above any observation stands, towers, or platforms, or any diving structures

Exception: Metal parts of listed equipment incorporating an approved system of double insulation shall not be bonded.

(a) *Double-Insulated Water Pump Motors.* Where a double-insulated water pump motor is installed under the provisions of this rule, a solid 8 AWG copper conductor of sufficient length to make a bonding connection to a replacement motor shall be extended from the swimming pool equipotential bonding means to an accessible point in the vicinity of the pool pump motor. Where there is no connection between the swimming pool equipotential bonding means and the equipment grounding system for the premises, this bonding conductor shall be connected to the equipment grounding conductor of the motor circuit.

(b) *Pool Water Heaters.* For pool water heaters rated at more than 50 amperes and having specific instructions regarding bonding and grounding, only those parts designated to be bonded shall be bonded and only those parts designated to be grounded shall be grounded.

(7) Fixed Metal Parts.

All fixed metal parts, including, but not limited to, metal-sheathed cables and raceways, metal piping, metal awnings, metal fences, and metal door and window frames, shall be bonded where located no greater than either of the following:

(1) 1.5 m (5 ft) horizontally from the inside walls of the pool

(2) 3.7 m (12 ft) vertically above the maximum water level of the pool, observation stands, towers, or platforms, or any diving structures

Exception: Those separated from the pool by a permanent barrier that prevents contact by a person shall not be required to be bonded.

(C) Pool Water.

Where none of the bonded parts as specified in 680.26(B)(1) through (B)(7) are in direct connection with the pool water, the pool water shall be in direct contact with an approved corrosion-resistant conductive surface that exposes not less than 5800 mm^2 (9 $in.^2$) of surface area to the pool water at all times. The conductive surface shall be located where it is not exposed to physical damage or dislodgement during usual pool activities, and it shall be bonded in accordance with 680.26(B).

680.26 Equipotential Bonding.
(A) Performance.

The equipotential bonding required by 680.26(B) and (C) to reduce voltage gradients in the pool area shall be installed for pools with or without associated electrical equipment related to the pool.

Informational Note No. 1: Some causes of voltage gradients originate outside the premises wiring system and are not within the scope of the *NEC*. Measures identified in Rule 097D2 of ANSI C2, *National Electrical Safety Code*, can also serve to address voltage gradients originating on the utility side of the service point.

Informational Note No. 2: By its nature, equipotential bonding of swimming pools and perimeter surfaces involves contact between various metallic materials and the earth. This can, in some cases, expose various specific metals to a corrosive environment, depending on factors such as the type and chemical content of the soil and the specific metal. Corrosive environments are also addressed in 680.14.

(B) Bonded Parts.

The parts specified in 680.26(B)(1) through (B)(7) shall be bonded together using solid copper conductors, insulated, covered, or bare, not smaller than 8 AWG or with rigid metal conduit of brass or other identified corrosion-resistant metal. Connections to bonded parts shall be made in accordance with 250.8. An 8 AWG or larger solid copper bonding conductor provided to reduce voltage gradients in the pool area shall not be required to be extended or attached to remote panelboards, service equipment, or electrodes.

(1) Conductive Pool Shells.

Bonding to conductive pool shells shall be provided as specified in 680.26(B)(1)(a) or (B)(1)(b). Cast-in-place concrete, pneumatically applied or sprayed concrete, and concrete block with painted or plastered coatings shall all be considered conductive materials due to water permeability and porosity. Reconstructed pool shells shall also meet the requirements of this section. Vinyl liners and fiberglass composite shells shall be considered to be nonconductive materials and not subject to these requirements.

(a) *Structural Reinforcing Steel.* Unencapsulated structural reinforcing steel shall be bonded together by steel tie wires or the equivalent. Where structural reinforcing steel is encapsulated in a nonconductive compound, a copper conductor grid shall be installed in accordance with 680.26(B)(1)(b).

(b) *Copper Conductor Grid.* A copper conductor grid shall be provided and shall comply with the following:

(1) Be constructed of minimum 8 AWG bare solid copper conductors bonded to each other at all points of crossing in accordance with 250.8 or other approved means

(2) Conform to the contour of the pool

(3) Be arranged in a 300 mm (12 in.) by 300 mm (12 in.) network of conductors in a uniformly spaced perpendicular grid pattern with a tolerance of 100 mm (4 in.)

(4) Be secured within or under the pool no more than 150 mm (6 in.) from the outer contour of the pool shell

(2) Perimeter Surfaces.

The perimeter surface to be bonded shall be considered to extend for 900 mm (3 ft) horizontally beyond the inside walls of the pool while also at a height between 900 mm (3 ft) above and 600 mm (2 ft) below the maximum water level. The perimeter surface shall include unpaved surfaces, concrete, and other types of paving. Perimeter surfaces separated from the pool by a permanent wall or building 1.5 m (5 ft) in height or more shall require equipotential bonding only on the pool side of the permanent wall or building. Bonding to perimeter surfaces shall be provided as specified in 680.26(B)(2)(a), (B)(2)(b), (B)(2)(c), and (B)(2)(d). For conductive pool shells where bonding to perimeter surfaces is required, it shall be attached to the pool reinforcing steel or copper conductor grid at a minimum of four points uniformly spaced around the perimeter of the pool, or if the bonded perimeter surface does not surround the entire pool, it shall be attached to the pool reinforcing steel or copper conductor grid at a minimum of four uniformly spaced points along the bonded perimeter surface. For nonconductive pool shells, where bonding to the perimeter surfaces is required, bonding at four points shall not be required, and the perimeter bonding shall be attached to the 8 AWG copper equipotential bonding conductor and, if present, to any conductive support structure for the pool.

Informational Note: Because the perimeter surface can incorporate various types of materials at various locations and elevations above and below maximum water level, the perimeter surface required to be bonded might not surround the entire pool. The 8 AWG copper equipotential bonding conductor can encircle the entire pool to facilitate connection of bonded parts.

(a) *Conductive Paved Portions of Perimeter Surfaces.* Conductive paved portions of perimeter surfaces, including masonry pavers, if used, shall be bonded with unencapsulated structural reinforcing steel in accordance with 680.26(B)(1)(a), or with unencapsulated steel structural welded wire reinforcement (welded wire mesh, welded wire fabric), bonded together by steel tie wires or the equivalent. Steel welded wire reinforcement shall be fully embedded within the pavement unless the pavement will not allow for embedding. If the reinforcing steel is absent, or is encapsulated in a nonconductive compound, or embedding is not possible, unencapsulated welded wire steel reinforcement or a copper conductor grid shall be provided and shall be secured directly under the paving, and not more than 150 mm (6 in.) below finished grade.

Unencapsulated steel welded wire reinforcement that is not fully embedded in concrete, and copper grid regardless of location, where used for equipotential bonding, shall be listed for corrosion resistance and mechanical performance. This listing requirement shall become effective January 1, 2025. The copper grid or unencapsulated steel welded wire reinforcement shall also meet the following:

(1) Copper grid is constructed of 8 AWG solid bare copper and arranged in accordance with 680.26(B)(1)(b)(3).

(2) Steel welded wire reinforcement is minimum ASTM 6 × 6-W2.0 × W2.0 or minimum No. 3 rebar constructed in a 300 mm (12 in.) grid.

(3) Copper grid and steel welded wire reinforcement follow the contour of the perimeter surface extending not less than 900 mm (3 ft) horizontally beyond the inside walls of the pool.

(4) Only listed splicing devices or exothermic welding are used.

Informational Note No. 1: Performance of the equipotential bonding system at the perimeter surface is improved as the distance between the bonding means and finished grade is minimized, either by embedding within, or by direct contact with the underside of, the finished pavement.

Informational Note No. 2: See ASTM A615/A615M, *Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement;* A1064/A1064M, *Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete;* A1022/A1022M, *Standard Specification for Deformed and Plain Stainless Steel Wire and Welded Wire for Concrete Reinforcement;* A1060A/A1060M, *Standard Specification for Zinc-Coated (Galvanized) Steel Welded Wire Reinforcement, Plain and Deformed, for Concrete;* and ACI Standard ACI 318, *Building Code Requirements for Structural Concrete,* for examples of standards currently used in the listing of reinforcing steel bars and steel welded wire reinforcement.

(b) *Unpaved Portions of Perimeter Surfaces.* Unpaved portions of perimeter surfaces shall be bonded with any of the following methods:

(1) Copper conductor(s) shall meet the following:

a. At least one minimum 8 AWG bare solid copper conductor, including the 8 AWG copper equipotential bonding conductor if available.

b. The conductors follow the contour of the perimeter surface.

c. Only listed splicing devices or exothermic welding are used.

d. The conductor(s) is 450 mm to 600 mm (18 in. to 24 in.) from the inside walls of the pool.

e. The conductor(s) is under the unpaved portion of the perimeter surface 100 mm to 150 mm (4 in. to 6 in.) below finished grade.

f. Be installed only in perimeter surfaces not intended to have direct access to swimmers in the pool.

(2) Copper grid or unencapsulated steel welded wire reinforcement used for equipotential bonding of unpaved portions of perimeter surfaces shall meet the following:

a. Be installed in accordance with 680.26(B)(2)(a).

b. Be located within unpaved surface(s) between 100 mm to 150 mm (4 in. to 6 in.) below finished grade.

(c) *Nonconductive Perimeter Surfaces.* Equipotential bonding shall not be required for nonconductive portions of perimeter surfaces that are separated from earth or raised on nonconducting supports, and it shall not be required for any perimeter surface that is electrically separated from the pool structure and raised on nonconductive supports above an equipotentially bonded surface.
Informational Note: Nonconductive materials include, but are not limited to, wood, plastic, wood-plastic composites, fiberglass, and fiberglass composites.

~~(d) *Interconnection of Bonded Portions of Perimeter Surfaces.* All surfaces where equipotential bonding is required shall be interconnected using listed splicing devices or exothermic welding. Where copper wire is used for this purpose, it shall be solid copper, not smaller than 8 AWG. The conductor shall be permitted to encircle the pool to facilitate bonding connections to portions of the perimeter covered in 680.26(B)(2)(a) and (B)(2)(b) that are not contiguous.~~

(3) Metallic Components.

All metallic parts of the pool structure, including reinforcing metal not addressed in 680.26(B)(1)(a), shall be bonded. Where reinforcing steel is encapsulated with a nonconductive compound, the reinforcing steel shall not be required to be bonded.

(4) Underwater Lighting.

All metal forming shells and mounting brackets of no-niche luminaires shall be bonded.

Exception: Listed low-voltage lighting systems with nonmetallic forming shells shall not require bonding.

(5) Metal Fittings.

All metal fittings within or attached to the pool structure shall be bonded.

Exception: The following shall not be required to be bonded:

(1) Isolated parts that are not over 100 mm (4 in.) in any dimension and do not penetrate into the pool structure more than 25 mm (1 in.)

(2) Metallic pool cover anchors intended for insertion in a concrete or masonry deck surface, 25 mm (1 in.) or less in any dimension and 51 mm (2 in.) or less in length

(3) Metallic pool cover anchors intended for insertion in a wood or composite deck surface, 51 mm (2 in.) or less in any flange dimension and 51 mm (2 in.) or less in length

(6) Electrical Equipment.

Metal parts of the following electrical equipment shall be bonded:

(1) Electrically powered pool cover(s)

(2) Pool water circulation, treatment, heating, cooling, or dehumidification equipment

(3) Unless separated from the pool by a permanent barrier that prevents contact by a person, any other electrical equipment within 1.5 m (5 ft) measured horizontally from the inside wall of the pool, or 3.7 m (12 ft) measured vertically above the maximum water level of the pool, or as measured vertically above any observation stands, towers, or platforms, or any diving structures

Exception: Metal parts of listed equipment incorporating an approved system of double insulation shall not be bonded.

(a) *Double-Insulated Water Pump Motors.* Where a double-insulated water pump motor is installed under the provisions of this rule, a solid 8 AWG copper conductor of sufficient length to make a bonding connection to a replacement motor shall be extended from the swimming pool equipotential bonding means to an accessible point in the vicinity of the pool pump motor. Where there is no connection between the swimming pool equipotential bonding means and the equipment grounding system for the premises, this bonding conductor shall be connected to the equipment grounding conductor of the motor circuit.

(b) *Pool Water Heaters.* For pool water heaters rated at more than 50 amperes and having specific instructions regarding bonding and grounding, only those parts designated to be bonded shall be bonded and only those parts designated to be grounded shall be grounded.

(7) Fixed Metal Parts.

All fixed metal parts, including, but not limited to, metal-sheathed cables and raceways, metal piping, metal awnings, metal fences, and metal door and window frames, shall be bonded where located no greater than either of the following:

(1) 1.5 m (5 ft) horizontally from the inside walls of the pool

(2) 3.7 m (12 ft) vertically above the maximum water level of the pool, observation stands, towers, or platforms, or any diving structures

Exception: Those separated from the pool by a permanent barrier that prevents contact by a person shall not be required to be bonded.

(C) Pool Water.

Where none of the bonded parts as specified in 680.26(B)(1) through (B)(7) are in direct connection with the pool water, the pool water shall be in direct contact with an approved corrosion-resistant conductive surface that exposes not less than 5800 mm^2 (9 $in.^2$) of surface area to the pool water at all times. The conductive surface shall be located where it is not exposed to physical damage or dislodgement during usual pool activities, and it shall be bonded in accordance with 680.26(B).

680.26 Equipotential Bonding.
(A) Performance.

The equipotential bonding required by 680.26(B) and (C) to reduce voltage gradients in the pool area shall be installed for pools with or without associated electrical equipment related to the pool.

Informational Note No. 1: Some causes of voltage gradients originate outside the premises wiring system and are not within the scope of the *NEC*. Measures identified in Rule 097D2 of ANSI C2, *National Electrical Safety Code*, can also serve to address voltage gradients originating on the utility side of the service point.

Informational Note No. 2: By its nature, equipotential bonding of swimming pools and perimeter surfaces involves contact between various metallic materials and the earth. This can, in some cases, expose various specific metals to a corrosive environment, depending on factors such as the type and chemical content of the soil and the specific metal. Corrosive environments are also addressed in 680.14.

(B) Bonded Parts.

The parts specified in 680.26(B)(1) through (B)(7) shall be bonded together using solid copper conductors, insulated, covered, or bare, not smaller than 8 AWG or with rigid metal conduit of brass or other identified corrosion-resistant metal. Connections to bonded parts shall be made in accordance with 250.8. An 8 AWG or larger solid copper bonding conductor provided to reduce voltage gradients in the pool area shall not be required to be extended or attached to remote panelboards, service equipment, or electrodes.

(1) Conductive Pool Shells.

Bonding to conductive pool shells shall be provided as specified in 680.26(B)(1)(a) or (B)(1)(b). Cast-in-place concrete, pneumatically applied or sprayed concrete, and concrete block with painted or plastered coatings shall all be considered conductive materials due to water permeability and porosity. Reconstructed pool shells shall also meet the requirements of this section. Vinyl liners and fiberglass composite shells shall be considered to be nonconductive materials and not subject to these requirements.

(a) *Structural Reinforcing Steel.* Unencapsulated structural reinforcing steel shall be bonded together by steel tie wires or the equivalent. Where structural reinforcing steel is encapsulated in a nonconductive compound, a copper conductor grid shall be installed in accordance with 680.26(B)(1)(b).

(b) *Copper Conductor Grid.* A copper conductor grid shall be provided and shall comply with the following:

(1) Be constructed of minimum 8 AWG bare solid copper conductors bonded to each other at all points of crossing in accordance with 250.8 or other approved means

(2) Conform to the contour of the pool

(3) Be arranged in a 300 mm (12 in.) by 300 mm (12 in.) network of conductors in a uniformly spaced perpendicular grid pattern with a tolerance of 100 mm (4 in.)

(4) Be secured within or under the pool no more than 150 mm (6 in.) from the outer contour of the pool shell

(2) Perimeter Surfaces.

The perimeter surface to be bonded shall be considered to extend for 900 mm (3 ft) horizontally beyond the inside walls of the pool while also at a height between 900 mm (3 ft) above and 600 mm (2 ft) below the maximum water level. The perimeter surface shall include unpaved surfaces, concrete, and other types of paving. Perimeter surfaces separated from the pool by a permanent wall or building 1.5 m (5 ft) in height or more shall require equipotential bonding only on the pool side of the permanent wall or building. Bonding to perimeter surfaces shall be provided as specified in 680.26(B)(2)(a), (B)(2)(b), (B)(2)(c), and (B)(2)(d). For conductive pool shells where bonding to perimeter surfaces is required, it shall be attached to the pool reinforcing steel or copper conductor grid at a minimum of four points uniformly spaced around the perimeter of the pool, or if the bonded perimeter surface does not surround the entire pool, it shall be attached to the pool reinforcing steel or copper conductor grid at a minimum of four uniformly spaced points along the bonded perimeter surface. For nonconductive pool shells, where bonding to the perimeter surfaces is required, bonding at four points shall not be required, and the perimeter bonding shall be attached to the 8 AWG copper equipotential bonding conductor and, if present, to any conductive support structure for the pool.

Informational Note: Because the perimeter surface can incorporate various types of materials at various locations and elevations above and below maximum water level, the perimeter surface required to be bonded might not surround the entire pool. The 8 AWG copper equipotential bonding conductor can encircle the entire pool to facilitate connection of bonded parts.

(a) *Conductive Paved Portions of Perimeter Surfaces.* Conductive paved portions of perimeter surfaces, including masonry pavers, if used, shall be bonded with unencapsulated structural reinforcing steel in accordance with 680.26(B)(1)(a), or with unencapsulated steel structural welded wire reinforcement (welded wire mesh, welded wire fabric), bonded together by steel tie wires or the equivalent. Steel welded wire reinforcement shall be fully embedded within the pavement unless the pavement will not allow for embedding. If the reinforcing steel is absent, or is encapsulated in a nonconductive compound, or embedding is not possible, unencapsulated welded wire steel reinforcement or a copper conductor grid shall be provided and shall be secured directly under the paving, and not more than 150 mm (6 in.) below finished grade.

Unencapsulated steel welded wire reinforcement that is not fully embedded in concrete, and copper grid regardless of location, where used for equipotential bonding, shall be listed for corrosion resistance and mechanical performance. This listing requirement shall become effective January 1, 2025. The copper grid or unencapsulated steel welded wire reinforcement shall also meet the following:

(1) Copper grid is constructed of 8 AWG solid bare copper and arranged in accordance with 680.26(B)(1)(b)(3).

(2) Steel welded wire reinforcement is minimum ASTM 6 × 6-W2.0 × W2.0 or minimum No. 3 rebar constructed in a 300 mm (12 in.) grid.

(3) Copper grid and steel welded wire reinforcement follow the contour of the perimeter surface extending not less than 900 mm (3 ft) horizontally beyond the inside walls of the pool.

(4) Only listed splicing devices or exothermic welding are used.

Informational Note No. 1: Performance of the equipotential bonding system at the perimeter surface is improved as the distance between the bonding means and finished grade is minimized, either by embedding within, or by direct contact with the underside of, the finished pavement.

Informational Note No. 2: See ASTM A615/A615M, *Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement;* A1064/A1064M, *Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete;* A1022/A1022M, *Standard Specification for Deformed and Plain Stainless Steel Wire and Welded Wire for Concrete Reinforcement;* A1060A/A1060M, *Standard Specification for Zinc-Coated (Galvanized) Steel Welded Wire Reinforcement, Plain and Deformed, for Concrete;* and ACI Standard ACI 318, *Building Code Requirements for Structural Concrete,* for examples of standards currently used in the listing of reinforcing steel bars and steel welded wire reinforcement.

(b) *Unpaved Portions of Perimeter Surfaces.* Unpaved portions of perimeter surfaces shall be bonded with any of the following methods:

(1) Copper conductor(s) shall meet the following:

a. At least one minimum 8 AWG bare solid copper conductor, including the 8 AWG copper equipotential bonding conductor if available.

b. The conductors follow the contour of the perimeter surface.

c. Only listed splicing devices or exothermic welding are used.

d. The conductor(s) is 450 mm to 600 mm (18 in. to 24 in.) from the inside walls of the pool.

e. The conductor(s) is under the unpaved portion of the perimeter surface 100 mm to 150 mm (4 in. to 6 in.) below finished grade.

f. Be installed only in perimeter surfaces not intended to have direct access to swimmers in the pool.

(2) Copper grid or unencapsulated steel welded wire reinforcement used for equipotential bonding of unpaved portions of perimeter surfaces shall meet the following:

a. Be installed in accordance with 680.26(B)(2)(a).

b. Be located within unpaved surface(s) between 100 mm to 150 mm (4 in. to 6 in.) below finished grade.

(c) *Nonconductive Perimeter Surfaces.* Equipotential bonding shall not be required for nonconductive portions of perimeter surfaces that are separated from earth or raised on nonconducting supports, and it shall not be required for any perimeter surface that is electrically separated from the pool structure and raised on nonconductive supports above an equipotentially bonded surface.
Informational Note: Nonconductive materials include, but are not limited to, wood, plastic, wood-plastic composites, fiberglass, and fiberglass composites.

(d) *Interconnection of Bonded Portions of Perimeter Surfaces.* All surfaces where equipotential bonding is required shall be interconnected using listed splicing devices or exothermic welding. Where copper wire is used for this purpose, it shall be solid copper, not smaller than 8 AWG. The conductor shall be permitted to encircle the pool to facilitate bonding connections to portions of the perimeter covered in 680.26(B)(2)(a) and (B)(2)(b) that are not contiguous.

(3) Metallic Components.

All metallic parts of the pool structure, including reinforcing metal not addressed in 680.26(B)(1)(a), shall be bonded. Where reinforcing steel is encapsulated with a nonconductive compound, the reinforcing steel shall not be required to be bonded.

(4) Underwater Lighting.

All metal forming shells and mounting brackets of no-niche luminaires shall be bonded.

Exception: Listed low-voltage lighting systems with nonmetallic forming shells shall not require bonding.

(5) Metal Fittings and Metal Structures.

All metal fittings and metal structures within or attached to the pool ~~structure~~ or perimeter surface indicated in 680.26(B)(2) shall be bonded.

Exception: The following shall not be required to be bonded:

(1) Isolated parts that are not over 100 mm (4 in.) in any dimension and do not penetrate into the pool structure more than 25 mm (1 in.)

(2) Metallic pool cover anchors intended for insertion in a concrete or masonry deck surface, 25 mm (1 in.) or less in any dimension and 51 mm (2 in.) or less in length

(3) Metallic pool cover anchors intended for insertion in a wood or composite deck surface, 51 mm (2 in.) or less in any flange dimension and 51 mm (2 in.) or less in length

(4) Metal fittings and metal parts fixed to bulkheads constructed of nonconductive material within the pool, with no conductive connection to the pool or perimeter surface indicated in 680.26(B)(2) by the bulkhead and/or metal parts fixed to the bulkhead.

(6) Electrical Equipment.

Metal parts of the following electrical equipment shall be bonded:

(1) Electrically powered pool cover(s)

(2) Pool water circulation, treatment, heating, cooling, or dehumidification equipment

(3) Unless separated from the pool by a permanent barrier that prevents contact by a person, any other electrical equipment within 1.5 m (5 ft) measured horizontally from the inside wall of the pool, or 3.7 m (12 ft) measured vertically above the maximum water level of the pool, or as measured vertically above any observation stands, towers, or platforms, or any diving structures

Exception: Metal parts of listed equipment incorporating an approved system of double insulation shall not be bonded.

(a) *Double-Insulated Water Pump Motors.* Where a double-insulated water pump motor is installed under the provisions of this rule, a solid 8 AWG copper conductor of sufficient length to make a bonding connection to a replacement motor shall be extended from the swimming pool equipotential bonding means to an accessible point in the vicinity of the pool pump motor. Where there is no connection between the swimming pool equipotential bonding means and the equipment grounding system for the premises, this bonding conductor shall be connected to the equipment grounding conductor of the motor circuit.

(b) *Pool Water Heaters.* For pool water heaters rated at more than 50 amperes and having specific instructions regarding bonding and grounding, only those parts designated to be bonded shall be bonded and only those parts designated to be grounded shall be grounded.

(7) Fixed Metal Parts.

All fixed metal parts, including, but not limited to, metal-sheathed cables and raceways, metal piping, metal awnings, metal fences, and metal door and window frames, shall be bonded where located no greater than either of the following:

(1) 1.5 m (5 ft) horizontally from the inside walls of the pool

(2) 3.7 m (12 ft) vertically above the maximum water level of the pool, observation stands, towers, or platforms, or any diving structures

Exception: Those separated from the pool by a permanent barrier that prevents contact by a person shall not be required to be bonded.

(C) Pool Water.

Where none of the bonded parts as specified in 680.26(B)(1) through (B)(7) are in direct connection with the pool water, the pool water shall be in direct contact with an approved corrosion-resistant conductive surface that exposes not less than 5800 mm^2 (9 $in.^2$) of surface area to the pool water at all times. The conductive surface shall be located where it is not exposed to physical damage or dislodgement during usual pool activities, and it shall be bonded in accordance with 680.26(B).

PI’s 4486, 4500, 4511, 4518, 4520, 4527

NEC 2026 First Revision Meeting

Littelfuse®

Expertise Applied | Answers Delivered

PI 4486 and 4500

- Extend Class A GFCI protection on 3-phase equipment from 60 A up to 100 A
  - PI 4486 – Section 422.5(A) Appliances
  - PI 4500 – Section 680.5(B) Pools, Fountains, Spas

- Intent is to bring into alignment with other sections
  - 210.8(B) Other than Dwelling Units – since NEC 2017
  - 210.8(D) Specific Appliances – FR 2026

- Growing number of 3-phase devices rated 70, 80, 90 A

PI 4511, 4518, 4520, 4527

- Extend GFCI and SPGFCI protection on 3-phase equipment from 60 A up to 100 A
  - PI 4511 – Section 680.22(A)(4) Receptacles near permanent pool – 480V
  - PI 4518 – Section 680.32 Electrical equipment used near storable pools
  - PI 4520 – Section 680.43(A)(2) Receptacles near indoor spa
  - PI 4527 – Section 680.58 Receptacles near fountains

- Intent is to bring into alignment with other sections
  - 210.8(B) Other than Dwelling Units – since NEC 2017
  - 210.8(D) Specific Appliances – FR 2026

- Consideration for voltage ratings
  - Above sections mention circuits rated 125 V through 250 V
  - The intent for adding SPGFCI was to apply to circuits above 250 V

  - Two options given in inputs
    - Remove SPGFCI text >> rolls back SPGFCI protection added in 2023
    - Remove 125 through 250 Vac text >> matches language already used 680.59, 680.32

Conductive Pavement Heating Systems

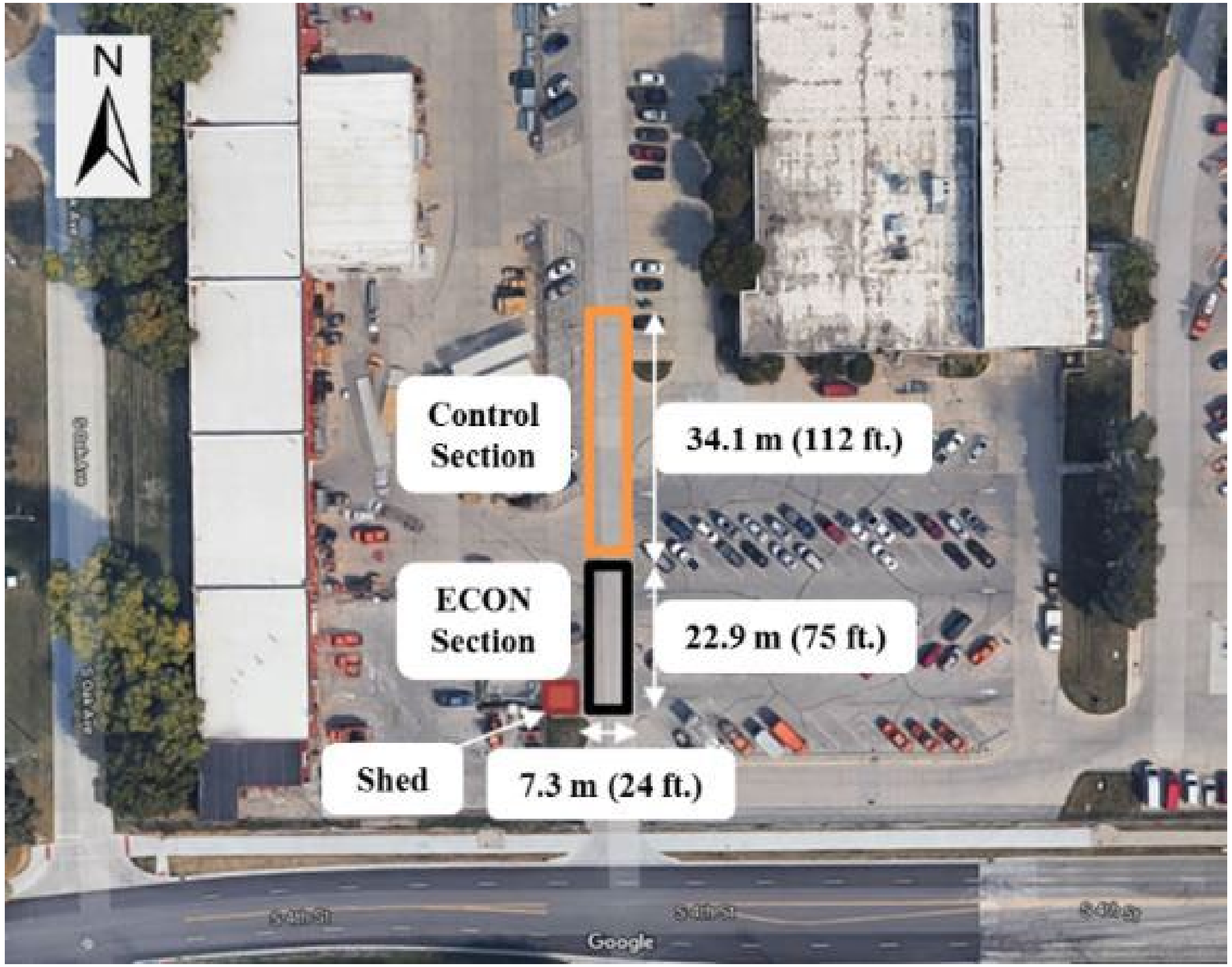
Presented by Chuck Mello
cdcmello Consulting LLC

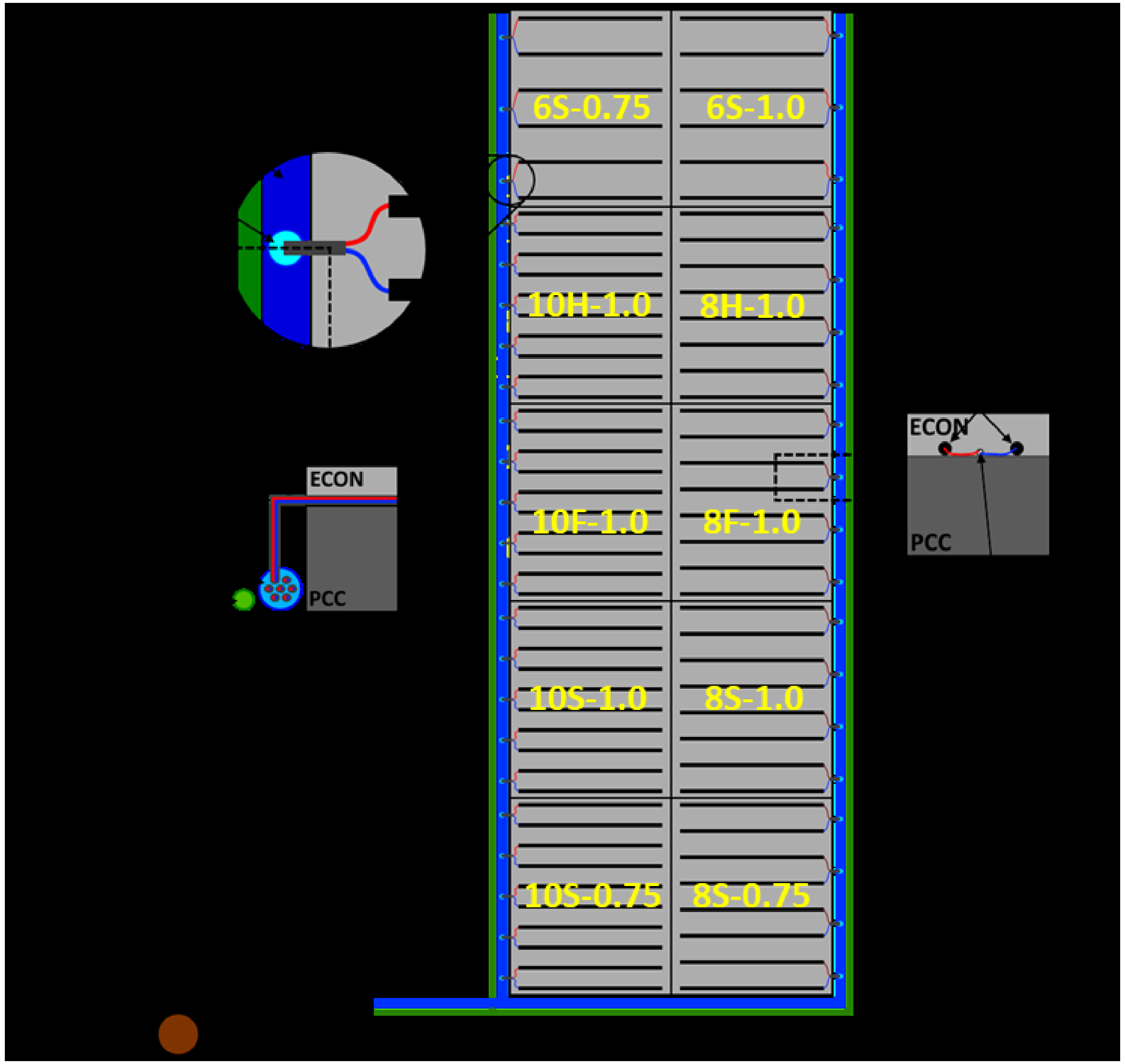
Background

- This technology has been researched since 2014 by a team at Iowa State University resulting in a published research report and doctorial dissertation.
- Full scale systems at the Des Moines airport and the State of Iowa DOT maintenance yard have been in place for ongoing research since 2016 and 2018 with multiple winters of operation.
- There has been previous research and pilot projects of similar technology for at least the last 20 years in Alaska and other locations.

Des Moines Airport

Iowa DOT Maintenance Yard





Safety Provisions

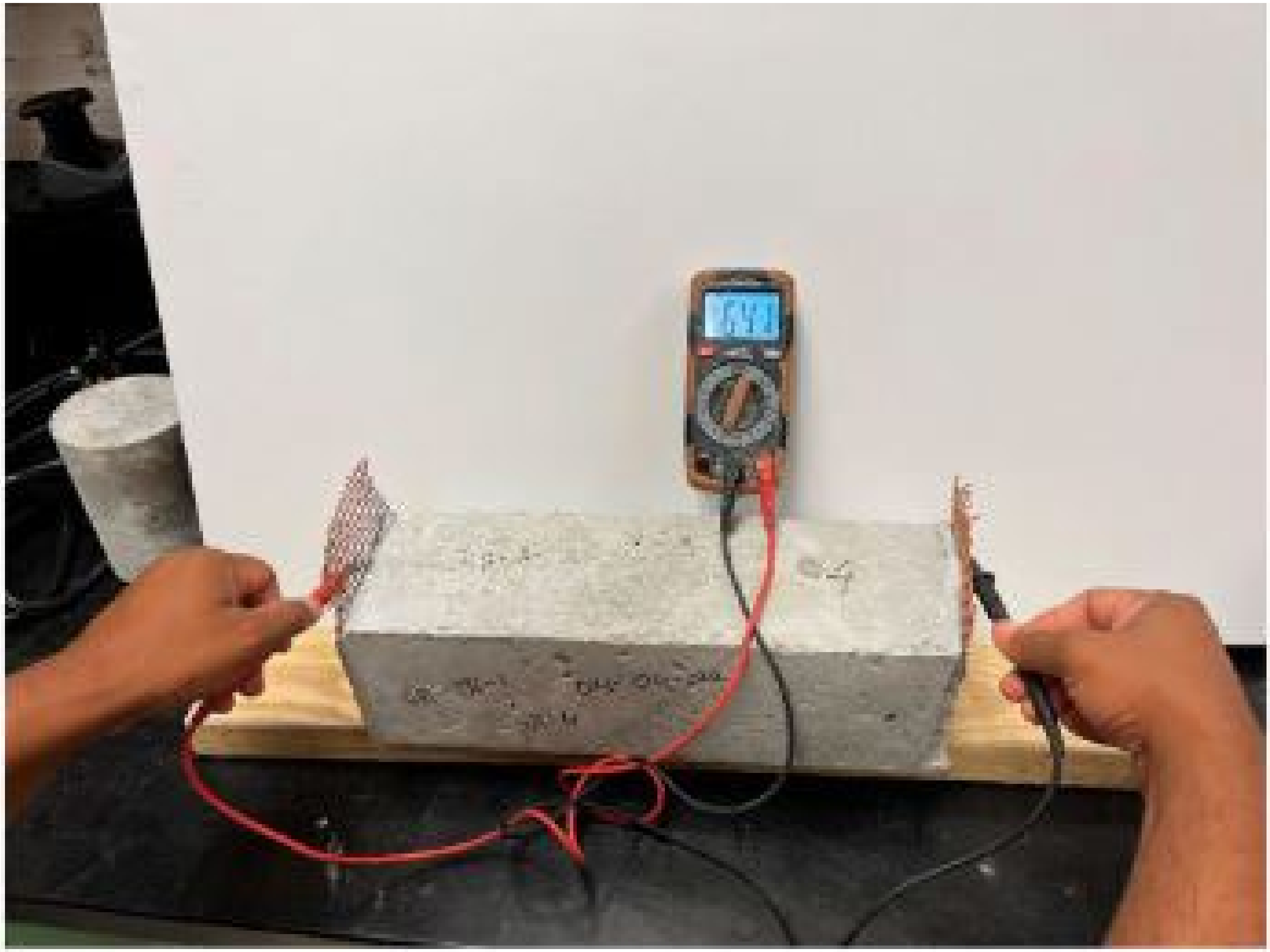
- The public input was to set the NEC requirements to install a listed and engineered conductive pavement heating system for snow melting and deicing.
- The system has to be listed
  - Controls and electrical components
  - Manufacturer’s instructions for:
    - concrete mix
    - Testing
    - Reporting
- Each system has to be engineered by a professional engineer and have engineering oversight for the entire installation.

Listing Required

- UL would need to develop a new or revise an existing standard for listing
- Contract has been let and preliminary investigation has commenced
- The development of the listing requirements needs to happen in parallel with NEC development so both operate in concert with one another.

“Stray” Currents

- Cured ECON resistivity approx. 1000 Ohm-cm when wet
  - Wet (uncured fresh poured) test approx. 100 Ohm-cm for beam to confirm proper mix
- Standard cured concrete (PCC) resistivity 100,000 Ohm-cm
- Rock base under slab or roadway >100,000 Ohm-cm
- At the reduced driving voltage of 120 or even 208 volts the system does not have the same “stray” current as occurs from medium voltage utility systems with driving voltage 50 to 100 times this voltage.



Voltage on **bare** concrete with 120 volts applied to Beam and to 24 x 24 slab

Voltage Test Results

	Surface voltage Without paint	Surface voltage with one layer of finish coat	Percent change with one layer of finish coat	Surface voltage with two layers of finish coat	Percent change with two layers of finish coat
Beam	8.9	1.8	-80%	0.1	-99%
Slab	2.8	0.5	-82%	0.9	-88%

Low voltage contact limit for swimming pools and immersed person is 15 volts RMS

Articles 100 & 426 New Text

- Added new definition in Article 100 under the purview of CMP-17
- Added to the scope a new item (C) to allow systems where there is a combination of exposed and embedded elements
- Added the listing item in accordance with Style Manual organization
- Added a new Part VI specific to the installation of this new technology
- The NEC is to assure a safe installation with coordinated requirements
- This is not a product someone will buy at the local distributor, or big box store to install.

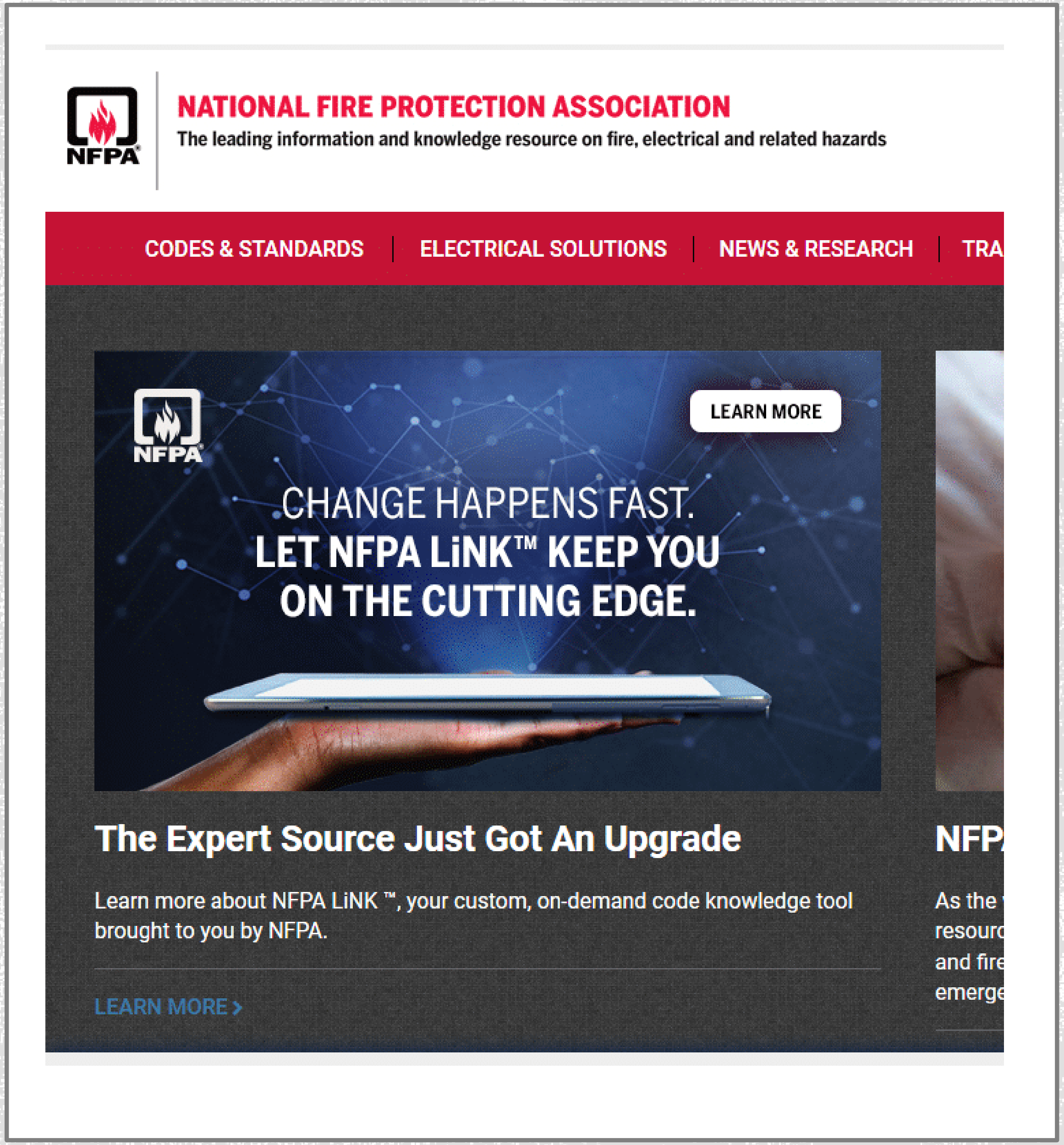
Article 426 New Part VI

- Brings in existing concepts from Article 426 for resistance heating that has not been previously required to be listed
- Each installation is unique requiring engineering design and oversight of the installation
- Required documentation for concrete mix testing to AHJ to confirm compliance with installation instructions that have the concrete specification range for resistance/conductivity
- Installation of non-heating leads from controller to the electrodes
- This is not a product someone will buy at the local distributor, or big box store to install.

Questions

- Thank you for your time and consideration


Founded to sell watches; evolved to sell everything
Founded to sell books; evolved to sell everything
1972
2017
sears
amazon
2 of every 3 Americans shopped in last 3 months
2 of every 3 Americans shopped in last 3 months
1987 Sales = 1% of GDP
2017 Sales = 1% of GDP
Merriam
Associates
Source: Chicago Tribune


NFPA
NATIONAL FIRE PROTECTION ASSOCIATION
The leading information and knowledge resource on fire, electrical and related hazards
CODES & STANDARDS
ELECTRICAL SOLUTIONS
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NFP
As the
resourc
and fire
emerge

March 2020

Chapter 1

General

Chapter 2

Wiring & Protection

Chapter 3

Wiring Methods & Materials

Chapter 4

Equipment for General Use

Chapter 5

Special Occupancies

Chapter 6

Special Equipment

Chapter 7

Special Conditions

Chapter 8

Communications Systems

1937-2023 (35 editions):

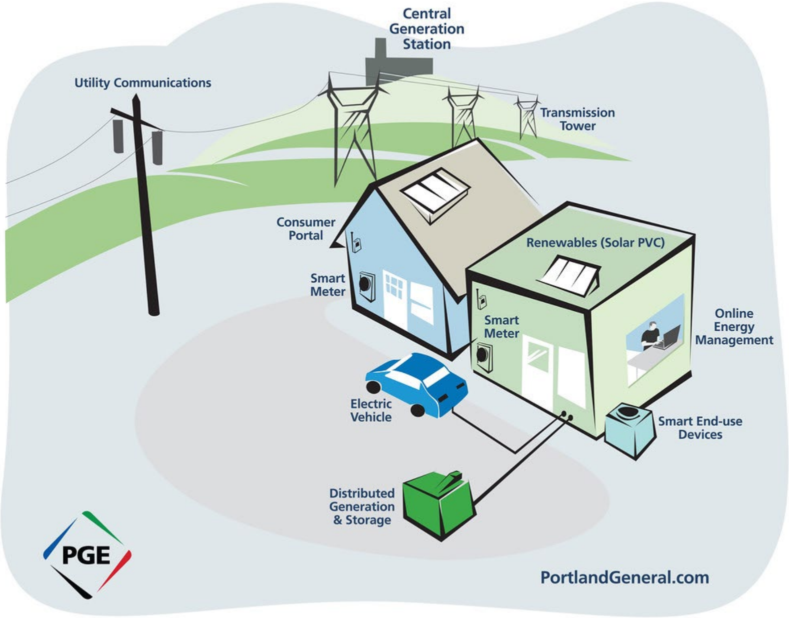
- Introduction (Identified as Article 90 starting in the 1959 edition)
- Chapter 1 – General
- Chapter 2 – Wiring Design and Protection
- Chapter 4 has grown from 10 articles in the 1937 edition to 22 articles in the 2023 edition
- Chapter 5 has grown from 5 articles in the 1937 edition to 27 articles in the 2023 edition
- Chapter 6 has grown from 7 articles in the 1937 edition to 27 articles in the 2023 edition
- Chapter 7 has grown from 4 articles in the 1937 edition to 15 articles in the 2023 edition
- Chapter 8 has grown from 2 articles in the 1937 edition to 6 articles in the 2023 edition

What Else is Coming Down the Pike?

By:National Renewable Labs

By: MTA Construction and Development

By: Portland General Electric



Where do we want to go?

- Remain relevant with the quickly evolving electrical industry
- Improve usability
  - Place content where it makes sense
  - Logical/parallel structure
    - Systems below 1000V
    - Limited Energy
    - Medium Voltage
  - Eliminate “Special Equipment”/ “Special Conditions”
  - Leverage the past to make the future even better
- Create a structure that looks to the future

National Electrical Code® Correlating Committee White Paper

Keeping the NEC® Relevant - Is Now the Time to Modernize?

The National Electrical Code® (NEC®) is the foundation of the electrical installation regulatory infrastructure for the United States, Mexico, and numerous other jurisdictions around the world. Growing demand for safe, reliable, resilient, and efficient use of electrical power to support society and the economy is aligning with technological advancement of power generation sources, electrical distribution, and new electrical power loads. It is critical the NEC be revised and implemented by the electrical community every three years to support the accelerating pace of change and technological advancement.

The structure of the NEC plays a critical role for personnel in learning, understanding, applying, and enforcing the requirements established within this regulatory code. While the current structure, first introduced in 1937, has provided tremendous success and stability and continues to be used by engineers, contractors, electricians and training programs, the ability to efficiently learn and quickly apply and inspect advancing technologies and uniquely configured electrical systems is a challenge for all electrical professionals. The existing NEC structure needs modernization to continue to support the advancing electrical infrastructure configurations and technological advancements. Therefore, it is imperative that the electrical industry actively pursue a revised NEC organizational structure to support ease of learning, understanding, and applying the NEC safety provisions in a rapidly advancing new energy landscape.

Keeping the NEC Relevant Now is the Time to Modernize

- Industry Trends
- Medium Voltage
- Limited Energy
- Multi-Directional Power Flow
- Digital Delivery of Content
- Future Vision
- Path Forward
- Feedback

Medium Voltage

A Starting Point for Considering a New Approach

- More difficult for AHJ’s when inspecting
- Less likely to have listed equipment since traditionally geared toward utility.
- More likely to have requirements that are antiquated
- Depth of knowledge of Technical Committees can be a challenge.
- Wiring methods in Chapter 3 for >1000 volt systems are difficult to determine
- With renewable energy and microgrids lines of distinction between NESC and NEC are blurred.

Limited Energy

Past

- Confusing
- No more Ma Bell
- Independence Chapter 8 vs Dependence Chapter 1-7
- Cat 5/6 Cable Article 725 and 805
- POE is Article 725 and 840
- How do we maintain relevance?

Future

- Improve usability.
- Improve Terminology
- Create structure that is technology agnostic.
- Eliminate redundancy.
- Parallel Structure
- Everything communicates

Short-Term Goals (2026)

MV /Limited Energy

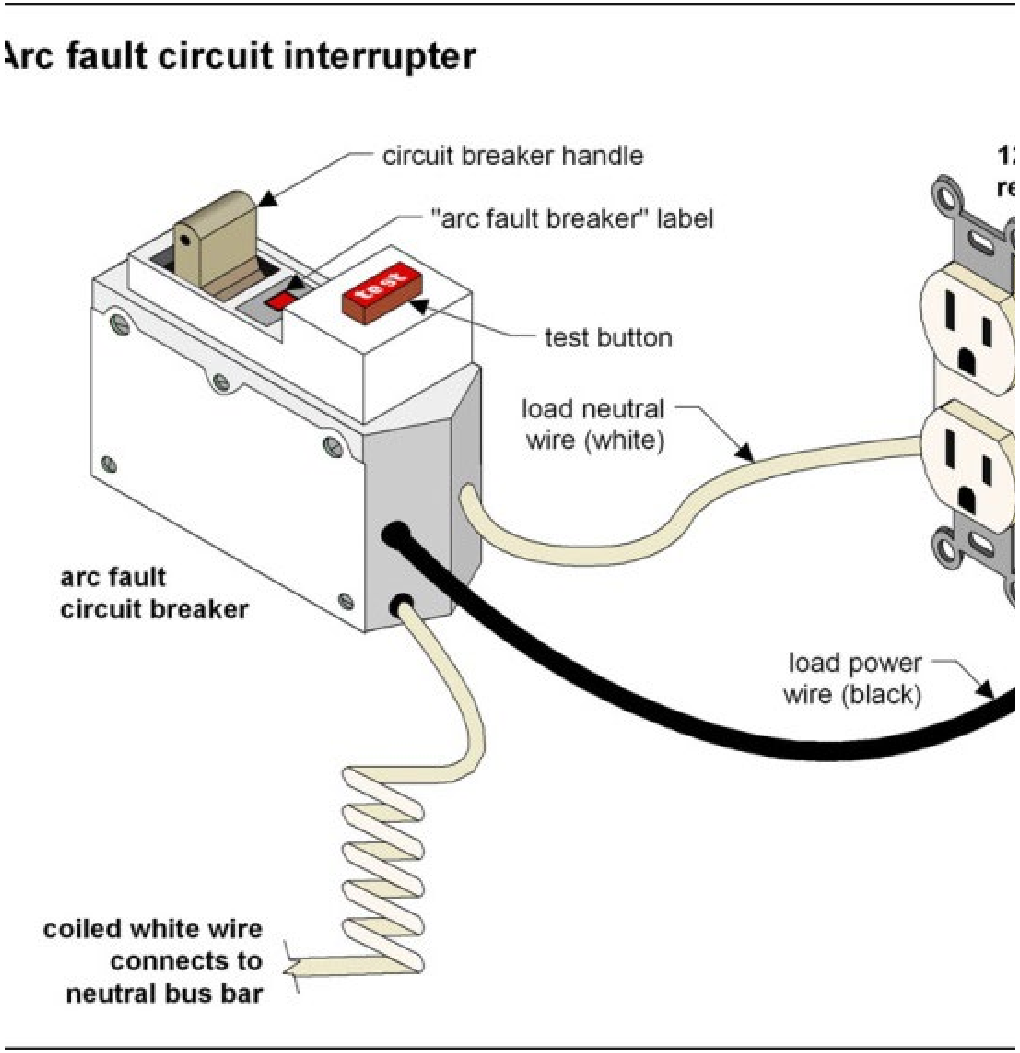
- Move from Medium voltage structure to Medium Voltage Technical changes
- Work on Limited Energy

Create parallel structure for Limited Energy

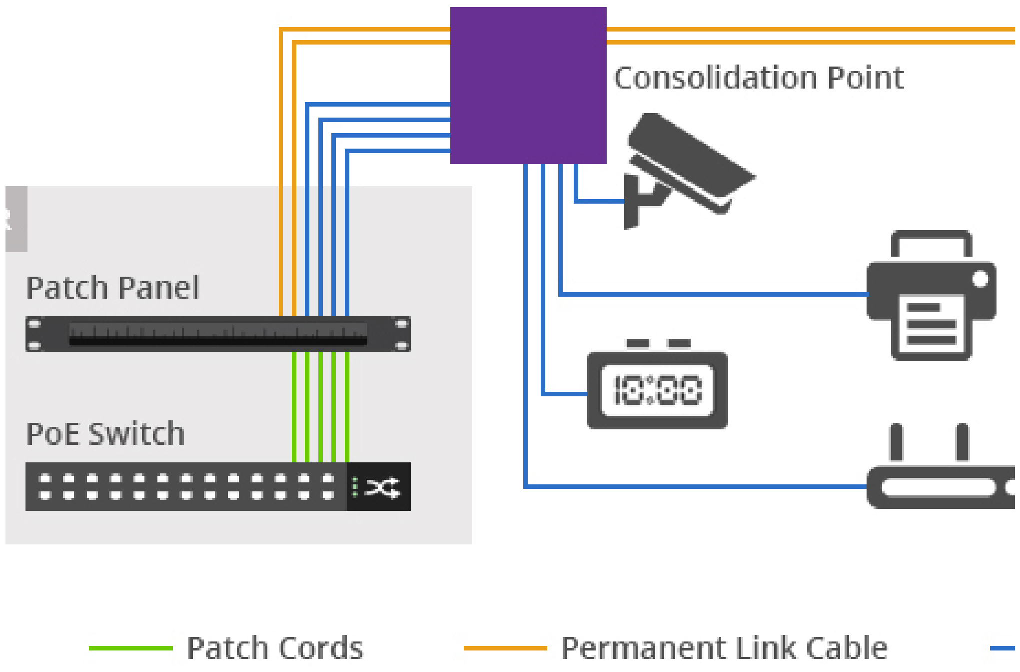
- Make it look like the front of the book.
- (Protection scheme, wire and a load)

Begin Implementation

- Move certain articles for long-term road map implementation



Arc fault circuit interrupter
circuit breaker handle
"arc fault breaker" label
test
test button
load neutral wire (white)
arc fault circuit breaker
load power wire (black)
coiled white wire connects to neutral bus bar



Consolidation Point
Patch Panel
PoE Switch
10:00
Patch Cords
Permanent Link Cable

90.3 -2023 NEC

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Definitions and General Requirements
Chapter 1

Wiring and Protection
Chapter 2

Wiring Methods and Materials
Chapter 3

Equipment for General Wiring
Chapter 4

Special Occupancies
Chapter 5

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Chapter 9

Informative Annex A through Informative Annex K

(Light Blue) Applies generally to electrical installations

(Brown) Supplemental or Amendatory requirements

Applicable as referenced

Informative Only

PROPOSED 90.3 -2029 NEC

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Wiring and Protection for Systems 1000 VAC, 1500 VDC and Below
Chapter 2

Wiring and Protection for Systems Over 1000 VAC, 1500 VDC
Chapter 3

Wiring and Protection for Limited Energy Systems
Chapter 4

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Chapters 5 - 10

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Chapter 11 - 14

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Chapters 15 – 17

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Chapters 18

Life Safety and Emergency Systems
Chapter 19

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Chapter 20

Informative Annex A through Informative Annex K

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120	Load Calculations	220	2	2
130	Energy Management Systems	750	13	13
140	Temporary Installations	590	3	3
Chapter 2 Wiring and Protection for Systems 1000 VAC, 1500 VDC and Below				
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205	Conductors	310	6	6
206	Use and Identification of Grounded Conductors	200	5	5
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215	Feeders	215	10	10
225	Outside Branch Circuits and Feeders	225	10	10
230	Services	230	10	10
240	Overcurrent Protection	240	10	10
242	Overvoltage Protection (Part I and II)	242	10	10
250	Grounding and Bonding	250	5	5

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Chapter 3 Wiring and Protection for Systems Over 1000 VAC, 1500 VDC				
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305	Conductors and Cables	315	9	9
306	Use and Identification of Grounded Conductors	205	5	9
310	Branch Circuits	235	9	9
315	Feeders	235	9	9
325	Outside Branch Circuits and Feeders	235	9	9
330	Services	235	9	9
342	Overvoltage Protection	242 (Part III)	10	9
350	Grounding and Bonding	250 (Part X)	5	5

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406	Use and Identification of Conductors		3	3
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435	Exterior Cabling Systems (Outside Plant) Part I- Communication Circuits Part II- Antenna Systems Part III- CATV Part IV- Networked-Powered Broadband Communication Systems Part V- Premises-Powered Broadband Communication Systems		16	16
440	Overcurrent Protection Part I- Class 1 Power-Limited Circuits Part II- Class 2 and Class 3 Part III- Class 4	724, 725, 726	3	3
442	Overvoltage Protection		3	3
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706	Liquidtight Flexible Metal Conduit: Type LFMC	350	8	8
708	Rigid Polyvinyl Chloride Conduit: Type PVC	352	8	8
710	High Density Polyethylene Conduit: Type HDPE Conduit	353	8	8
712	Nonmetallic Underground Conduit with Conductors: Type NUCC	354	8	8
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718	Electrical Metallic Tubing: Type EMT	358	8	8
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1202	Low-Voltage Lighting	411	18	18
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1208	Cranes and Hoists	610	12	12
1210	Elevators, Dumbwaiters, Escalators, Moving Walks, Platform Lifts, and Stairway Chairlifts	620	12	12
1212	Electrically Driven or Controlled Irrigation Machines	675	7	7
1214	Appliances	422	17	17
1216	Fixed Electric Space Heating Equipment	424	17	17
1218	Fixed Resistance and Electrode Industrial Process Heating Equipment	425	17	17
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1224	Air-Conditioning and Refrigeration Equipment	440	11	11
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1408	Motors, Motor Circuits, and Controllers	430 (Part XI)	11	9
1410	Capacitors	460 (Part III)	11	9
1412	Resistors and Reactors	470 (Part III)	11	9

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1512	Cannabis Oil Equipment and Cannabis Oil Systems Using Flammable or Combustible Materials	512	14	14
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1608	Carnivals, Circuses, Fairs, and Similar Events	525	15	15
1610	Motion Picture and Television Studios and Similar Locations	530	15	15
1612	Motion Picture Projection Rooms	540	15	15
1614	Manufactured Buildings and Relocatable Structures	545	7	7
1616	Agricultural Buildings	547	7	7
1618	Mobile Homes, Manufactured Homes, and Mobile Home Parks	550	7	7
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Chapter 17 Installations Associated with Bodies of Water				
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1702	Natural and Artificially Made Bodies of Water	682	7	7
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1806	Solar Photovoltaic (PV) Systems	690	4	4
1808	Large-Scale Photovoltaic (PV) Electric Supply Stations	691	4	4
1810	Fuel Cell Systems	692	4	4
1812	Wind Electric Systems	694	4	4
1814	Energy Storage Systems	706	13	13
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Introduction

Definitions and General Requirements
Chapter 1

Wiring and Protection
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2026 NEC STRUCTURE

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Chapter 1 Definitions and General Requirements		
100	Definitions	100
110	Requirements for Electrical Installations	110
120	Load Calculations	220
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140	Temporary Installations	590

Takeaways

- Feedback to Jeff Sargent
- Proposed structure is fluid and will continue to evolve as we receive input
- Intent to print proposed structure in Annex for 2026 NEC edition.
- Structure is not intended to impact technical, only the organization and correlation of the technical content
- Intent is to move articles once

Public Comment No. 1657-NFPA 70-2024 [Global Input]

This Global Public Comment is for CMP-17 to review the use of the terms "overcurrent", "overcurrent protective devices" and "overcurrent protection".

Additional Proposed Changes

File Name	Description	Approved
CMP-17_OCPD_TG-4_CMP-10.pdf	CMP-17_OCPD_TG-4 CMP-10	
All_CMP_Comments_Files_from_CMP-10_TG-4.pdf	All CMP Comments Files from CMP-10 TG-4	

Statement of Problem and Substantiation for Public Comment

This Public Comment is submitted on behalf of a Task Group formed under the purview of Code Making Panel 10 consisting of Randy Dollar, Thomas Domitrovich, Jason Doty, Diane Lynch, Alan Manche, Nathan Philips, David Williams, and Danish Zia. This Public Comment, along with other Public Comments, was developed with the goal of improving usability and accuracy on requirements associated with overcurrent protective devices.

The Task Group reviewed all instances of the term "overcurrent", "overcurrent protective devices" and "overcurrent protection" and provided recommended changes to align proposed and current defined terms.

For consistency, the task group chose to use the full defined term "overcurrent protective device" in the title of all sections or subdivisions and the acronym "OCPD" or "OCPDs" when used in the body of each code section.

The term overcurrent protection applies to the application of an overcurrent protective device OCPD, to protect conductors and equipment.

Two documents are attached: One for your specific code panel and the other is a comprehensive document illustrating all of the code-wide comments made by this task group.

The current term "Overcurrent Protective Device, Branch-Circuit" is being deleted and the new defined term "Overcurrent Protective Device (OCPD)" will be used instead.

The following are the proposed terms being submitted to CMP-10.

PC 1639 Overcurrent Protection.
Automatic interruption of an overcurrent

PC 1636 Overcurrent Protective Device (OCPD).
A device capable of providing protection over the full range of overcurrent between its rated current and its interrupting rating. (CMP-10)

Informational Note 1: Prior editions of NFPA 70 included the defined term "branch circuit overcurrent protective device" for overcurrent protective devices suitable for providing protection for service, feeder and branch circuits. This term has been revised to a generalized term of "overcurrent protective device" (OCPD). The specific requirements using this term may include modifiers (such as branch OCPD, feeder OCPD, service OCPD) to specify location or application of the OCPD, or to specify variations (such as supplementary OCPD).

Informational Note 2: See 240.7 for a list of overcurrent protective devices suitable for providing protection for service, feeder, branch circuits and equipment.

Related Item

- Global PI 4050 • PC 1636 • PC 1639

Submitter Information Verification

Submitter Full Name: David Williams
Organization: Delta Charter Township
Street Address:

City:	
State:	
Zip:	
Submittal Date:	Sun Aug 25 21:56:59 EDT 2024
Committee:	NEC-P17

CMP-10 TG-4 Review of Overcurrent Language for the Articles undeer the purview of CMP-17			
CMP	**NEC Section (using First Draft of 2026 NEC)**	**Current Language**	**"New" Language**
17	**Article 422**		
	422.5(C)	Branch-circuit overcurrent protective device	Branch-Circuit OCPD
	422.11. Title	Overcurrent Protection	Fine as is
	422.11	protected against overcurrent	shall be provided with overcurrent protection
	422.11(A)	Overcurrent Protection	Fine as is
	422.11(A)	Branch-circuit overcurrent protective device	Branch-Circuit OCPD
	422.11(B)	Overcurrent Protection	OCPDs
	422.11(C)	Overcurrent Protection	OCPDs
	422.11(D)	Overcurrent protective devices	OCPDs
	422.11(E)	Overcurrent Protection	Fine as is
	422.11(E)(1)	Overcurrent Protection	Fine as is
	422.11(E)(2)	Overcurrent Protection	Fine as is
	422.11(E)(3)	Overcurrent Protection	OCPD
	422.11(E)(3)	Overcurrent Device	OCPD
	422.11(F)(1)	Supplementary Overcurrent Protective Devices	Supplementary OCPDs
	422.11(F)(1)	Overcurrent Protective Devices	OCPDs
	422.11(G)	Overcurrent Protective Devices	OCPDs
	422.13	Overcurrent Protection	Fine as is
	422.31(A)	Branch-circuit overcurrent protective device	Branch-Circuit OCPD
	422.60(A)	Overcurrent Protection	Fine as is
	422.62(B)(1). (X2)	Overcurrent protective device	OCPD
17	**Article 424**		
	424.19	Supplementary Overcurrent Protective Devices	Supplementary OCPDs
	424.19(A)	Supplementary Overcurrent Protection	Fine as is
	424.19(A)	Supplementary Overcurrent Protection	Fine as is
	424.19(A)	Supplementary Overcurrent Protective Device(s)	Supplementary OCPDs
	424.19(B)	Supplementary Overcurrent Protection	Fine as is
	424.22	Overcurrent Protection	Fine as is
	424.22(A)	Overcurrent Protection	Fine as is
	424.22(A)	protected against overcurrent	"..shall be permitted to have overcurrent protection.."
	424.22(B)	Supplementary Overcurrent Protective Device	Supplementary OCPD
	424.22(C). Title	Overcurrent Protective Devices	Fine as is
	424.22(C)	Supplementary Overcurrent Protective Devices	Supplementary OCPDs

	424.22(C)	Overcurrent Protection	Fine as is
	424.22(C)	Supplementary Overcurrent Protection	Fine as is
	424.22(D) (X2)	Supplementary Overcurrent Protective Devices	Supplementary OCPDs
	424.22(E). (X3)	Supplementary Overcurrent Protective Devices	Supplementary OCPDs
	424.72	Overcurrent Protection	Fine as is
	424.72(A)	Overcurrent protective device	OCPD
	424.72(B)	Overcurrent protective device	OCPD
	424.72(C). Title	Supplementary Overcurrent Protective Devices	Fine as is
	424.72(C)	Supplementary Overcurrent Protective Devices	Supplementary OCPDs
	424.72(C)	Overcurrent Protection	Fine as is
	424.72(D). Title	Supplementary Overcurrent Protective Devices	Fine as is
	424.72(D).	Supplementary Overcurrent Protective Devices	Supplementary OCPDs
	424.72(D)	Overcurrent protective device	OCPD
	424.72(E)	Supplementary Overcurrent Protective Devices. (X3)	Supplementary OCPDs
	424.82	Overcurrent protective devices	OCPDs
17	**Article 425**		
	425.19	Supplementary Overcurrent Protective Devices	Supplementary OCPDs
	425.19(A). (X2)	Supplementary Overcurrent Protection	Fine as is
	425.19(A)	Supplementary Overcurrent Protective Devices	Supplementary OCPDs
	425.19(B)	Supplementary Overcurrent Protection	Fine as is
	425.22. Title	Overcurrent Protection	Fine as is
	425.22(A)	Overcurrent Protection	Fine as is
	425.22(A)	protected against overcurrent	"..shall be permitted to have overcurrent protection.."
	425.22(B)	Supplementary Overcurrent Protective Device	Supplementary OCPD
	425.22(C). Title	Overcurrent Protective Devices	Fine as is
	425.22(C)	Supplementary Overcurrent Protective Devices	Supplementary OCPDs
	425.22(C). (X2)	Supplementary Overcurrent Protection	Fine as is
	425.22(D). Title	Supplementary Overcurrent Protective Devices	Fine as is
	425.22(D). (X2)	Supplementary Overcurrent Protective Devices	Supplementary OCPDs
	425.22(E) (X3)	Supplementary Overcurrent Protective Devices	Supplementary OCPDs
	425.72	Overcurrent Protection	Fine as is
	425.72(A)	Overcurrent protective device	OCPD
	425.72(B)	Overcurrent protective device	OCPD
	425.72(C). Title	Supplementary Overcurrent Protective Devices	Fine as is
	425.72(C)	Supplementary Overcurrent Protective Devices	Supplementary OCPDs

	425.72(C)	Overcurrent Protection	Fine as is
	425.72(D)	Overcurrent protection	Fine as is
	425.72(E). Title	Supplementary Overcurrent Protective Devices	Fine as is
	425.72(E)	Supplementary Overcurrent Protective Devices	Supplementary OCPDs
	425.72(E)	Overcurrent Protective Devices	OCPD
	425.72(F). (X3)	Supplementary Overcurrent Protective Devices	Supplementary OCPDs
	425.82	Overcurrent protective devices	OCPDs
17	**Article 427**		
	427.57	Overcurrent Protection	Fine as is
	427.57	considered protected against Overcurrent	considered to have overcurrent protection
17	**Article 680**		
	680.10.(A)& (B)(2)	Overcurrent protective devices	OCPDs
	680.23(F)(2)	Overcurrent Protection	Fine as is

CMP-10 TG-4 Review of Overcurrent Language for the Articles undeer the purview of CMP-1			
CMP	**NEC Section (using First Draft of 2026 NEC)**	**Current Language**	**"New" Language**
1	**Article 110**		
	110.10.	overcurrent protective devices	OCPDs
	110.10.	circuit protective devices	Fine as is
	110.26(C)(2)	overcurrent devices	OCPD
	110.26(C)(3)	overcurrent devices	OCPD
	110.52	Overcurrent protection	Fine as is
	110.52	Overcurrent	Motor-operated Equipment shall be provided with overcurrent protection
	110.52	Overcurrent	Transformers shall be provided with overcurrent protection

CMP-10 TG-4 Review of Overcurrent Language for the Articles undeer the purview of CMP-2			
CMP	**NEC Section (using First Draft of 2026 NEC)**	**Current Language**	**"New" Language**
2	**Article 100**		
	Branch Circuit (Branch-Circuit)	overcurrent device	overcurrent protective device (OCPD)
2	**Article 120**		
	120.5(E)	overcurrent device	OCPD
	120.7(B)	overcurrent protective device	OCPD
	120.87(3)	Overcurrent protection	Fine as is
2	**Article 210**		
	210.4(A)	branch-circuit overcurrent protective device, OCPD	Fine as is
	210.4(C)	branch-circuit OCPD	Fine as is
	210.11(B)	branch-circuit OCPD	Fine as is
	210.12(A)	branch-circuit OCPD (X-8)	Fine as is
	210.18	~~overcurrent device~~ OCPD (X-2)	Fine as is
	210.19(A)(1)EX	branch-circuit OCPD	Fine as is
	210.20.	Overcurrent protection	Fine as is
	210.20.	branch-circuit OCPD	Fine as is
	210.20(A)	branch-circuit OCPD	Fine as is
	210.20(C)	branch-circuit OCPD	Fine as is
	T-210.24	Overcurrent protection	Fine as is
2	**Annex D**		
	D3. (X2)	Overcurrent Protection	CMP-2 To review references to OCPD and the revised terms.
	D3a. (X8)	Branch-Circuit OCPD	CMP-2 to Review
	D3a.	Overcurrent Protection	CMP-2 to Review
	D3a. (X2)	Branch-Circuit OCPD	CMP-2 to Review

CMP-10 TG-4 Review of Overcurrent Language for the Articles undeer the purview of CMP-3			
CMP	**NEC Section (using First Draft of 2026 NEC)**	**Current Language**	**"New" Language**
3	**Article 100**		
	Fault Managed Power.	Overcurrent protection	Fine as is
	Fire Alarm Circuit	Overcurrent device	overcurrent protective device (OCPD)
3	**Article 300**		
	300.5-T	Overcurrent Protection	Fine as is
	300.17(I)	Overcurrent Device	OCPD
	300.28(C)(3). (X5)	Overcurrent Protection	Fine as is
3	**Article 590**		
	590.6(A)	Overcurrent Protection	Fine as is
	590.6(B)	be protected from Overcurrent	shall be provided with overcurrent protection
	590.9. Title	Overcurrent protective device	Fine as is
	590.9(A)	Overcurrent protective devices	OCPDs
	590.9(B) Title	Service Overcurrent protective devices	Fine as is
	590.9(B)	Overcurrent protective devices	OCPDs
3	**Article 721**		
	721.50(A)	Overcurrent	Fine as is
3	**Article 722**		
	722.1	Overcurrent Protection	Fine as is
3	**Article 724**	Class 1	
	724.40(B). (X3)	Overcurrent Devices	OCPDs
	724.40(B). (X2)	Overcurrent Device	OCPD
	724.40(B). (X2)	Overcurrent Protection	Fine as is
	724.43. (X4)	Overcurrent Protection	Fine as is
	724.45	Overcurrent Device	OCPD
	724.45. (X3)	Overcurrent Devices	OCPDs
	724.45(A)	Overcurrent Devices	OCPDs
	724.45(B)	Overcurrent Protection	Fine as is
	724.45(B)	Overcurrent Device	OCPD
	724.45(C). (X2)	Overcurrent protective devices	OCPDs
	724.45(D)	Overcurrent Protection	Fine as is
	724.45(E)	Overcurrent Protection	Fine as is
3	**Article 725**		
	725.1 In	Overcurrent Protection	Fine as is

	725.127	Overcurrent Device	OCPD
3	**Article 760**		
	760.41(B)	Overcurrent protective device	OCPD
	760.41(B)	Overcurrent protection devices	OCPDs
	760.43. (X3)	Overcurrent Protection	Fine as is
	760.45. Title	Overcurrent device	Overcurrent protective device
	760.45	Overcurrent protection devices	OCPDs
	760.45 Ex 1 & 2	Overcurrent Protection	Fine as is
	760.121(B)	Branch-Circuit Overcurrent protective device	OCPD
	760.121(B)	Overcurrent protection devices	OCPDs
	760.127	Overcurrent Protection	Fine as is
	760.127	Overcurrent Device	OCPD
3	**Article 794**		
	794.1	Overcurrent Protection	Fine as is

CMP-10 TG-4 Review of Overcurrent Language for the Articles undeer the purview of CMP-4			
CMP	**NEC Section (using First Draft of 2026 NEC)**	**Current Language**	**"New" Language**
4	**Article 690**		
	690.2	PV dc Overcurrent protective devices	PV dc OCPDs
	690.8	Overcurrent Device	OCPD and OCPDs
	690.9. Title	Overcurrent Protection	Fine as is
	690.9(A). (X2)	be protected from Overcurrent	shall be provided with overcurrent protection
	690.9(A)(1). Title	Overcurrent Protection	Fine as is
	690.9(A)(1).	Overcurrent protective devices	OCPDs
	690.9(A)(2). Title	Overcurrent Protection	Fine as is
	690.9(A) (2)	be protected from Overcurrent	shall be provided with overcurrent protection
	690.9(A) (2) In	Overcurrent protection	Fine as is
	690.9(A) (2) In	Overcurrent device	OCPD
	690.9(A)(3)	Overcurrent	Fine as is
	690.9(B)	shall be permitted to prevent overcurrent of conductors	Fine as is
	690.9(B)	Overcurrent device	OCPD and OCPDs
	690.9(C)	Overcurrent protective device and Devices	OCPD and OCPDs
	690.31(E)	Overcurrent protective devices	OCPDs
	690.45	Overcurrent protective device	OCPD
	690.45	Overcurrent Device	OCPD
4	**Article 692**		
	692.8. Title	Overcurrent Device	Overcurrent Protective Devices
	692.8	Overcurrent protective device	OCPDs
	692.9	Overcurrent Protection	Fine as is
	692.9	Overcurrent Devices	OCPDs
4	**Article 694**		
	694.7(D)	Overcurrent Device	OCPD
	694.12(B). Title	Overcurrent Device	Overcurrent Protective Device
	694.12(B)(2). Title	Overcurrent Devices	Overcurrent Protective Devices
	694.12(B)(2)	Overcurrent Devices	OCPDs
	694.15	Overcurrent Protection	Fine as is
	694.15	Overcurrent Devices	OCPDs
	694.15 In	Overcurrent Protection	Fine as is
	694.15(B)(1)	Overcurrent Protection	Fine as is
	694.15(C)	Overcurrent Devices	OCPDs

4	**Article 705**		
	705.11(C). Title	Overcurrent Protection	Fine as is
	705.11(C)	be protected from overcurrent	have overcurrent protection
	705.11(C)(1). (1) (2) (3)	Overcurrent protective device	OCPD
	705.11(C)(2)	Overcurrent protection devices	OCPDs
	705.12(A)(2). (X4)	Overcurrent Device	OCPD
	705.12(A)(3)	Overcurrent Devices	OCPDs
	705.12(B)	(Multiple) Overcurrent Device and (s)	OCPD. And OCPDs
	705.12(B)	(Warning labels) Overcurrent Device and (s)	Overcurrent Protective Device and Devices
	705.28(B)Ex.1	Overcurrent Devices	OCPDs
	705.28(B)Ex.3	Overcurrent Device	OCPD
	705.30. Title	Overcurrent Protection	Fine as is
	705.30(A). (X2)	Overcurrent Protection	Fine as is
	705.30(A)	Overcurrent Devices	OCPDs
	705.30.(C)	Overcurrent Devices	OCPDs
	705.30.(F)	Overcurrent Protection	Fine as is
	705.70.	Overcurrent Devices	OCPDs
	705.70.	Overcurrent Protection	Fine as is

CMP-10 TG-4 Review of Overcurrent Language for the Articles undeer the purview of CMP-5			
CMP	**NEC Section (using First Draft of 2026 NEC)**	**Current Language**	**"New" Language**
5	**Article 100**		
	Ground-Fault Current Path, Effective	overcurrent protective device	overcurrent protective device (OCPD)
	Ground-Fault Protection of Equipment	overcurrent device	overcurrent protective device (OCPD)
5	**Article 200**		
	200.10(E)	overcurrent device	OCPD
5	**Article 250**		
	250.4(A)(5). Title	Overcurrent protective Device	Fine as is
	250.4(A)(5)	Overcurrent Device	OCPD
	250.4(B)(4)	Overcurrent Devices	OCPDs
	250.30(A)(1)	Overcurrent Device	OCPD
	250.30(A)(1)	Overcurrent Devices	OCPDs
	250.32(B)(2). (X4)	Overcurrent Protection	Fine as is
	250.32(C)(2). (X4)	Overcurrent Protection	Fine as is
	250.35(B)	Overcurrent Protection	Fine as is
	250.36(D)	Overcurrent Device	Fine as is
	250.36(E)(1)	Overcurrent Device	OCPD
	250.102(B)(2)	Overcurrent Protection	Fine as is
	250.102(D). (X3)	Overcurrent Devices	OCPDs
	250.118(A)(5)	Overcurrent Devices	OCPDs
	250.118(A)(6)	Overcurrent Devices	OCPDs
	250.118(A)(7)	Overcurrent Devices	OCPDs
	250.122(C)	Overcurrent Device	OCPD
	250.122(F)(1). (X3)	Overcurrent protective device	OCPD
	250.122(G)	Overcurrent Device	OCPD
	250.142. (X2)	Overcurrent Device	OCPD
	250.148	Overcurrent Device	OCPD
	250.164	Overcurrent Device	OCPD
	250.166	Overcurrent Protection	Fine as is
	250.169	Overcurrent Devices	OCPD
5	**Article 270**		
	270.4(A)(5)	Overcurrent Device	OCPD
	270.4(B)(4)	Overcurrent Devices	OCPDs
	270.30(A)(1)	Overcurrent Devices	OCPDs

	270.32(B)(2). (X4)	Overcurrent Protection	Fine as is
	270.32(C)(2). (X4)	Overcurrent Protection	Fine as is
	270.35(B)	Overcurrent Protection	Fine as is
	270.35(B)	Overcurrent protective device	OCPD
	270.36(D)	Overcurrent Device	OCPD
	270.36(E)	Overcurrent Devices	OCPDs
	270.102(C)(2)	Overcurrent Protection	Fine as is
	270.102(D)	Overcurrent Device	OCPDs
	270.114(C)(3)	Overcurrent setting	CMP to review Language based on new terms
	270.118	Overcurrent Devices	OCPDs
	270.142	Overcurrent Devices	OCPDs
	270.148(B)	Overcurrent Device	OCPD
	270.164(B)	Overcurrent Device	OCPD
	270.166(A)	Overcurrent Protection	Fine as is
	270.169	Overcurrent Devices	OCPDs

CMP-10 TG-4 Review of Overcurrent Language for the Articles undeer the purview of CMP-6			
CMP	NEC Section (using First Draft of 2026 NEC)	Current Language	"New" Language
6	**Article 310**		
	310.10(G).	Overcurrent Protection	Fine as is
	310.15(A)	Overcurrent Protection	Fine as is
	310.16-T	Overcurrent Protection	Fine as is
	310.17-T	Overcurrent Protection	Fine as is
6	**Article 335**		
	335.90.	Overcurrent Protection	Fine as is
6	**Article 382**		
	382.4	Supplementary Overcurrent Protection	Supplementary Overcurrent Protective Device
6	**Article 400**		
	400.16	Overcurrent Protection	Fine as is
	400.16	protected against Overcurrent	shall be provided with overcurrent protection
6	**Article 402**		
	402.14 (X2)	Overcurrent Protection	Fine as is

CMP-10 TG-4 Review of Overcurrent Language for the Articles undeer the purview of CMP-7			
CMP	**NEC Section (using First Draft of 2026 NEC)**	**Current Language**	**"New" Language**
7	**Article 100**		
	Service Equipment, Mobile Home	overcurrent protective devices	overcurrent protective devices (OCPDs)
7	**Article 545**		
	545.24	Branch-circuit overcurrent protective device	Branch-circuit OCPD
	545.24(B) Title	Branch Circuit Overcurrent Protection Device	Overcurrent protective devices
	545.24(B)	a Branch Circuit Overcurrent Protective Device	an OCPD
7	**Article 547**		
	547.41(A)(6). (X2)	Overcurrent Protection	Fine as is
	547.41(B)	Overcurrent Protection	Fine as is
	547.42	Overcurrent Protection	Fine as is
7	**Article 550**		
	550.11(B). Title	Branch-Circuit protective equipment	Branch-Circuit Overcurrent Protection
	550.11(B)	Overcurrent Protection	Fine as is
	550.11(B)	Branch-Circuit Overcurrent Devices	OCPDs
	550.11(B)	Overcurrent protection size	OCPD rating
	550.15(E)	Branch-circuit overcurrent protective device	OCPD
	550.32	Overcurrent Protection	Fine as is
7	**Article 551**		
	551.31(A)	Overcurrent protective device	OCPD
	551.31(C)	Overcurrent protective device	OCPD
	551.31(D)	Overcurrent Protection	Fine as is
	551.42	Overcurrent Protection	Fine as is
	551.43. Title	Branch-Circuit protection	Branch-Circuit Overcurrent Protection
	551.43(A)	Branch Circuit Overcurrent Devices	Branch-Circuit OCPDs
	551.43(A)(3)	Overcurrent Protection	Fine as is
	551.45(C)	Overcurrent protective device	OCPD
	551.47(Q)	Overcurrent protective device	OCPD
	551.47(R)	Overcurrent Protection	Fine as is
	551.47(S)	Overcurrent Protection	Fine as is
	551.74	Overcurrent Protection	Fine as is
7	**Article 552**		
	552.10.(E) Title	Overcurrent Protection	Fine as is
	552.10(E)(1)	Overcurrent protective devices	OCPDs

	T-552.10(E)(1)	Overcurrent Protection	Fine as is
	552.10(E)(4). (X2)	Overcurrent protective device	OCPD
	552.42(A)	Branch Circuit Overcurrent Devices	OCPDs
	552.42(A)	Overcurrent Protection	Fine as is
	552.45(C)	Overcurrent protective device	OCPD
	552.46(A) IN	Overcurrent Protection	Fine as is
	552.47(P)	Overcurrent protective device	OCPD
	552.47(Q)	Overcurrent Protection	Fine as is
7	**Article 555**		
	555.53	Overcurrent protective device	OCPD
7	**Article 675**		
	675.6	Branch Circuit Overcurrent Protective Device	OCPD
	675.7	Branch Circuit Overcurrent Protective Devices	OCPDs
	675.8	Overcurrent Protection	Fine as is
7	**Article 682**		
	682.15(B)	Feeder Overcurrent protective device	Feeder OCPD

CMP-10 TG-4 Review of Overcurrent Language for the Articles undeer the purview of CMP-8			
CMP	**NEC Section (using First Draft of 2026 NEC)**	**Current Language**	**"New" Language**
8	**Article 312**		
	312.11. Title	Overcurrent Devices	Overcurrent Protective Device
	312.11	Overcurrent Devices	OCPDs
	312.11(A). (X3)	Overcurrent Device	OCPDs
	312.11(B)	Overcurrent Devices	OCPDs
	312.11(B)(1)	Overcurrent Device	OCPD
8	**Article 366**		
	366.12	Overcurrent Devices	OCPDs
	366.56(D)	Overcurrent Protection	Fine as is
8	**Article 368**		
	368.17(A). Title	Overcurrent Protection	Fine as is
	368.17	Overcurrent Protection	Fine as is
	368.17(A)	Protected against Overcurrent	shall be provided with overcurrent protection
	368.17(B). (X2)	Overcurrent Protection	Fine as is
	368.17(B)	Overcurrent Device	OCPD
	368.17(C)	Overcurrent Devices	OCPDs
	368.17(C)Ex.2	Branch-Circuit Overcurrent Device	Branch-Circuit OCPD
	368.17(C)Ex.3	Overcurrent Device	OCPD
	368.17(C)Ex.4	Branch-Circuit overcurrent plug-in device	CMP to review Language based on new terms
	368.17(D). Title	Overcurrent Protection	Fine as is
	368.17(D)	Protected against Overcurrent	shall be provided with overcurrent protection
8	**Article 370**		
	370.23. Title	Overcurrent Protection	Fine as is
	370.23	Protected against Overcurrent	shall be provided with overcurrent protection
8	**Article 371**		
	371.17. Title	Overcurrent Protection	Fine as is
	371.17	Overcurrent Protection	Fine as is
	371.17 (A)-(C). Titles	Overcurrent Protection	Fine as is
	371.17(A)-(C)	Protected against Overcurrent	shall be provided with overcurrent protection
	371.17(D)	Protected against Overcurrent	shall be provided with overcurrent protection
	371.17(F)	Overcurrent	shall be provided with overcurrent protection
	371.17(G)	Overcurrent Protection	
	371.17(G)Ex	Overcurrent Protection	Fine as is
	371.17(G)Ex	Overcurrent Device	OCPD

CMP-10 TG-4 Review of Overcurrent Language for the Articles undeer the purview of CMP-9			
CMP	**NEC Section (using First Draft of 2026 NEC)**	**Current Language**	**"New" Language**
9	**Article 265**		
	265.18	Overcurrent Device	OCPD
	265.20.	Overcurrent Protection	Fine as is
	265.20.	Overcurrent protective devices	OCPDs
	265.20.	Overcurrent Devices	OCPDs
9	**Article 266**		
	266.1	Overcurrent Protection	Fine as is
	266.5	Overcurrent Protection	Fine as is
	266.5	Protected against overcurrent	shall be provided with overcurrent protection
	266.5	Overcurrent Device	OCPD
9	**Article 268**		
	268.2. (X2)	Overcurrent Protection	Fine as is
	268.70(F)	Overcurrent Devices	OCPDs
	268.82. (X4)	Overcurrent Protection	Fine as is
	Art. 268 Part VII	Overcurrent Protection	Fine as is
	268.90.	Overcurrent Device	OCPD
	268.90.	Overcurrent Devices	OCPDs
	268.91	Overcurrent Device	OCPD
	268.92	Overcurrent Devices	OCPDs
	268.93	Overcurrent Device	OCPD
9	**Article 450**		
	450.5 (previously 450.3). (X3)	overcurrent protection	Fine As Is
	450.5(A) and Table. (X3)	overcurrent protection	Fine As Is
	Table 450.5(A) Footnote 2. (X4)	overcurrent device	OCPD
	450.5(B)	overcurrent protection	Fine As Is
	Table 450.5(B) and Table (X2)	overcurrent protection	OCPD
	Table 450.5(B) Footnote 2. (X3)	overcurrent device	OCPD
	Table 450.5(B) Footnote 3	overcurrent protection	OCPD
	450.6(A) Title	overcurrent protection	Fine As Is
	450.6(A) (X3)	overcurrent device	OCPD
	450.6(A) Exception	overcurrent device	OCPD
	450.7(A)(1). (X2)	overcurrent protection	OCPD
	450.7(A)(2). Title	overcurrent protection	Fine As Is

	450.7(A)(2)	overcurrent sensing device	Fine As Is
		overcurrent protection	OCPD
		overcurrent device	OCPD
		branch or feeder protective devices	branch or feeder OCPDs
	450.7(A)(3)	overcurrent device	OCPD
	450.7(B)(2)	overcurrent protection	Fine As Is
	450.7(B)(2)(a)	overcurrent protective device	OCPD
	450.7(B)(2)(b)	overcurrent protection	OCPD
	450.7(B)(2)(b)	overcurrents	Fine As Is
	450.7(B)(2)(b) Exception	overcurrent device	OCPD
	450.8(A). (X2)	overcurrent protection	Fine As Is
	450.8(A)(1)	overcurrent protection	Fine As Is
	450.8(A)(2)	overcurrent protection	Fine As Is
	450.8(A)(3)	protective device	OCPD
	450.8(A)(4)(a)	protective device	OCPD
	450.8(B). Title	Overcurrent Protection	Fine As Is
	450.8(B)	overcurrent device	OCPD
	450.9	overcurrent protection	Fine As Is
	450.9	protective devices (2x)	OCPDs
	450.23(A)(1)(d) Informational Note	overcurrent protection	OCPD
	450.23(B)(1) Informational Note 2	overcurrent protection	OCPD
9	**Article 495**		
	495.62. Title	Overcurrent Protection	Fine As Is
	495.72	Overcurrent Relay	Fine As Is

CMP-10 TG-4 Review of Overcurrent Language for the Articles undeer the purview of CMP-10			
CMP	**NEC Section (using First Draft of 2026 NEC)**	**Current Language**	**"New" Language**
10	**Article 100**		
	Circuit Breaker	Overcurrent	Fine as is
	Coordination, Selective. (Selective Coordination)	Overcurrent condition	Fine as is
	Coordination, Selective. (Selective Coordination)	overcurrent protective devices	overcurrent protective devices (OCPDs)
	Coordination, Selective. (Selective Coordination)	overcurrents	Fine as is
	Coordination, Selective. (Selective Coordination)	overcurrent protective device	overcurrent protective device (OCPD)
	Current Limiting (as applied to overcurrent protection devices)	overcurrent protection devices	overcurrent protective devices (OCPDs)
	Feeder	final branch-circuit overcurrent protective device	overcurrent protective device (OCPD)
	Fuse	overcurrent protective device	overcurrent protective device (OCPD)
	Fuse	overcurrent	Fine as is
	Fuse, Electronically Actuated	overcurrent protective device	overcurrent protective device (OCPD)
	Fuse, Electronically Actuated	overcurrent	Fine as is
	Overcurrent	Overcurrent protection	Fine as is
	Overcurrent Protective Device, Branch-Circuit	Revise with the term Overcurrent Protective Device. (OCPD)	
	Overcurrent **Protective** Device, Supplementary (need to Revise term with acronym)	overcurrent protective device	overcurrent protective device (OCPD)
	Panelboard	overcurrent devices	overcurrent protective devices (OCPDs)
	Surge-Protective Device (SPD). (X2)	overcurrent device. (X2)	overcurrent protective device (OCPD)
	Switchboard	overcurrent	overcurrent protective devices (OCPDs)
	Tap Conductor	Overcurrent protection	Fine as is
10	**Article 215**		
	215.1	Overcurrent protection	Fine as is
	215.4(A)(1)Ex.1	overcurrent devices protecting the feeders	feeder OCPD
	215.4(A)(1)Ex.3	overcurrent device	OCPD
	215.5 Title	Overcurrent protection	Fine as is
	215.5	Feeders shall be protected against overcurrent	Feeders shall be provided with overcurrent protection in accordance with Article 240, Parts I
	215.5	overcurrent device	OCPD
	215.5Ex	overcurrent device protecting the feeders	feeder OCPDs
	215.5Ex	overcurrent device	OCPD

	215.18(B)	branch circuit overcurrent devices	OCPDs
10	**Article 225**		
	225.40. Title	Overcurrent protective devices	Fine as is
	225.40.	feeder overcurrent device (x2)	feeder OCPD
	225.40.	branch circuit overcurrent devices	Branch circuit OCPDs
	225.42(B)	branch circuit overcurrent devices	OCPDs
10	**Article 230**		
	230.7 Ex.2	Overcurrent protection	Fine as is
	230.42(A)(1)	overcurrent device (X3)	OCPD
	230.82(6)	Overcurrent protection	Fine as is
	230.82(7)	Overcurrent protection	Fine as is
	230.82(8)	Overcurrent protection	Fine as is
	230.82(9)	Overcurrent protection	Fine as is
	230.82(10)	Overcurrent protection	Fine as is
	230 Part VII	Overcurrent protection	Fine as is
	230.90(A)	overcurrent device	OCPD
	230.90(A)Ex.3	overcurrent device	OCPD
	230.90(B)	overcurrent device	OCPD
	230.91	overcurrent device (X2)	OCPD
	230.92	overcurrent device (X4)	OCPDs and OCPD
	230.93	overcurrent device	OCPD
	230.94	overcurrent device (X3)	OCPD
	230.94	Overcurrent protection (X2)	Fine as is
	230.95(A)	overcurrent device	OCPD
	230.95(B)	overcurrent device	OCPD
10	**Article 240**		
	240	Overcurrent Protection	Fine as is
	240.1 (X3)	Overcurrent protection	Fine as is
	240.2	branch-circuit Overcurrent protective devices	~~branch-circuit~~ Overcurrent protective devices
	240.4. Title	Protection of Conductors	Overcurrent Protection of Conductors
	240.4	Protected against overcurrent	shall be provided with overcurrent protection in accordance with
	240.4(B). Title	Overcurrent devices	Overcurrent protective Devices
	240.4(B)	Overcurrent device	OCPD
	240.4(B)	Overcurrent protective device	OCPD

	240.4(C). Title	Overcurrent devices	Overcurrent protective Devices
	240.4(C). (X2)	Overcurrent device.	OCPD
	240.4(D)	Overcurrent Protection	Fine as is
	240.4(D)(1)	Overcurrent protection	Fine as is
	240.4(D)(1)(2)		(a) OCPDs in accordance with 240.7 shall be marked for use with 18 AWG copper conductor (b) Delete (c) change to (b)
	240.4(D)(2)	Overcurrent protection	Fine as is
	240.4(D)(2)(2)		(a) OCPDs in accordance with 240.7 shall be marked for use with 16 AWG copper conductor (b) Delete (c) change to (b)
	240.4(D)(3)	Overcurrent protection	Fine as is
	240.4(D)(3)(2)		~~(a) Fuses and circuit breakers in accordance with 240.7 marked for use with 14 AWG copper-clad aluminum conductor~~ ~~(b) Delete~~
	240.4(D)(3)(2)		OCPDs in accordance with 240.7 shall be marked for use with 14 AWG copper-clad aluminum conductor
	240.4(E)	Protected against overcurrent	shall be permitted to have overcurrent protection in accordance with the following
	240.4(F)	Overcurrent protection	Fine as is
	240.4(F)	Overcurrent protective device	OCPD
	240.4(G). (X2)	Overcurrent protection	Fine as is
	240.4(H)	Protected against overcurrent	shall be provided with overcurrent protection in accordance with
	240.5	Protected against overcurrent	shall be provided with overcurrent protection in accordance with
	240.5(A)	Overcurrent device	OCPD
	240.5(A)	Protected against overcurrent	Fixture wires shall be provided with overcurrent protection in accordance with
	240.5(A)	Supplementary overcurrent protection	Fine as is
	240.5(B) Title	Branch-circuit overcurrent device.	Branch-Circuit Overcurrent protective Devices

	240.9	Protection of conductors against overcurrent	Fine as is
	240.10. Title	Supplementary Overcurrent protection	Fine as is
	240.10.	Supplementary overcurrent protection	Fine as is
	240.10.	Branch-Circuit overcurrent devices	OCPDs
	240.10.	Supplementary overcurrent devices	Supplementary OCPDs
	240.11. (X2)	Feeder overcurrent protective devices.	Feeder OCPDs
	240.11. (X2)	Service overcurrent protective device.	Service OCPD
	240.15(A). Title	Overcurrent device	Overcurrent protective device required
	240.15(A)	Overcurrent device	OCPD
	240.15(A)	Overcurrent trip. Overcurrent relay	Fine as is
	240.15(B) Title	Overcurrent device	Circuit breaker as Overcurrent protective device
	240.16	Branch circuit overcurrent protective devices	OCPDs
	240.21	Overcurrent Protection	Fine as is
	240.21	overcurrent protective device	OCPD
	240.21 (A)	Overcurrent Protection	Fine as is
	240.21 (B)	Overcurrent Protection	Fine as is
	240.21 (B) (1) (1) (b)	Overcurrent device(s)	OCPDs
	240.21 (B) (1) (1) (b)	overcurrent protective device	OCPD
	240.21 (B)(1) (1) (4)	Overcurrent device	OCPD
	240.21 (B) (1)(1) (4) In	Overcurrent Protection	Fine as is
	240.21 (B) (2) (1)	Overcurrent device	OCPD
	240.21 (B) (2) (2)	Overcurrent devices	OCPDs
	240.21 (B) (3) (1)	Overcurrent device	OCPD
	240.21 (B) (3) (2)	Overcurrent device	OCPD
	240.21 (B) (4) (3)	Overcurrent device	OCPD
	240.21 (B) (4) (4)	Overcurrent device	OCPD
	240.21 (B) (4) (4)	Overcurrent devices	OCPDs
	240.21 (B) (5) (2)	Overcurrent device	OCPD
	240.21 (B) (5) (2)	Overcurrent devices	OCPDs
	240.21 (B) (5) (3)	Overcurrent device	OCPD
	240.21 (C). (X2)	Overcurrent Protection	Fine As Is
	240.21 (C) (1). Title	Title change	Overcurrent Protective Device
	240.21 (C) (1)	"...protected by overcurrent protection..."	Fine As Is
	240.21 (C) (1)	Overcurrent protective device	OCPD
	240.21 (C) (2) (1) (b)	Overcurrent device(s)	OCPDs

	240.21 (C) (2) (1) (b)	Overcurrent device	OCPD
	240.21 (C) (2) (4)	Overcurrent device	OCPD
	240.21 (C) (2) (4)	Overcurrent device	OCPD
	240.21 (C) (2) (4)	Overcurrent protection	Fine as is
	240.21 (C) (3) (2)	Overcurrent devices	OCPDs
	240.21 (C) (3) (3)	Overcurrent devices	OCPDs
	240.21 (C) (4) (2)	Overcurrent device	OCPD
	240.21 (C) (4) (2)	Overcurrent devices	OCPDs
	240.21 (C) (4) (3)	Overcurrent device	OCPD
	240.21 (C) (5)	Overcurrent Protection	Fine As Is
	240.21 (C) (6) (1)	Overcurrent device	OCPD
	240.21 (D)	Overcurrent devices	OCPDs
	240.21 (E)	.shall be permitted to be protected against overcurrent.	"..shall be permitted to have overcurrent protection.."
	240.21 (F)	.shall be permitted to be protected against overcurrent.	"..shall be permitted to have overcurrent protection.."
	240.21 (H). (X2)	Overcurrent Protection	Fine As Is
	240.22. (X2)	Overcurrent device	OCPD
	240.24(A)	Supplementary overcurrent protection	Fine as is
	240.24(A). (X4)	Overcurrent protective devices	OCPDs
	240.24(B)	Overcurrent devices	OCPDs
	240.24(B)(1). Title	Feeder overcurrent protective devices	Feeder OCPDs
	240.24(B)(1)	Service overcurrent protective devices	Service OCPDs
	240.24(B)(2). TITLE	Branch-circuit overcurrent protective device	Fine as is
	240.24(B)(2).	Branch-circuit overcurrent protective device	Branch-Circuit OCPD
	240.24(C)	Overcurrent protective devices	OCPDs
	240.24(D)	Overcurrent protective devices	OCPDs
	240.24(E)	Overcurrent protective devices	OCPDs
	240.24(E)	Supplementary overcurrent protection	Fine as is
	240.24(E) (X2)	Overcurrent protective devices	OCPDs
	240.24(F)	Overcurrent protective devices	OCPDs
	240.30(A)	Overcurrent devices	OCPDs
	240.32	Overcurrent devices	OCPDs
	240.33	Overcurrent devices	OCPDs
	240.86	Overcurrent device	OCPD
	240.86(B)	Overcurrent device	OCPD
	240.86(C)	Overcurrent device	OCPD

	240.87	Overcurrent device	OCPD
	240.90.	Overcurrent protection	Fine as is
	240.91(B). (X2)	Overcurrent device	OCPD
	240.92	Overcurrent device	OCPD
	240.92(A)	~~be protected~~	shall be provided with overcurrent protection
	240.92(C)	Overcurrent protection	Fine as is
	240.92(C)(1)(1)	Overcurrent device	OCPD
	240.92(C)(1)(2)	protective devices	Fine as is
	240.92(C)(1)(3)	Overcurrent devices	OCPDs
	240.92(C)(2)(1)	Overcurrent device	OCPD
	240.92(C)(2)(2) (X3)	Overcurrent devices	OCPDs
	240.92(C)(2)(3)	Overcurrent relaying	Fine as is
	240.92(C)(2)(4)	Overcurrent device	OCPD
	240.92(D)	Overcurrent protection	Fine as is
	240.92(D)(2). (X3)	Overcurrent devices	OCPDs
	240.92(D)(4)	Overcurrent device	OCPD
	240.92(E)	Overcurrent device	OCPD
	240.92(E)	Overcurrent protection	Fine as is
10	**Article 242**		
	242.14(ABC)	Overcurrent device	OCPD
	242.16	Overcurrent protection	Branch-circuit OCPD
10	**Article 404**		
	404.5	Overcurrent Devices	OCPDs
10	**Article 408**		
	408.4(A)	Overcurrent device	OCPD
	408.6 (X2)	Overcurrent protection devices	OCPDs
	408.36. Title	Overcurrent protection	Fine as is
	408.36. (X2)	Overcurrent protective device	OCPD
	408.36. (X3)	Overcurrent devices	OCPDs
	408.36(A)	Overcurrent protection	Fine as is
	408.36(B)	Overcurrent protection	Fine as is
	408.36(C)	Overcurrent device	OCPD
	408.36(D)	Overcurrent protection devices	OCPDs
	408.52	Overcurrent devices	OCPDs
	408.54	Overcurrent devices	OCPDs

	408.55	Overcurrent devices	OCPDs

CMP-10 TG-4 Review of Overcurrent Language for the Articles undeer the purview of CMP-11			
CMP	NEC Section (using First Draft of 2026 NEC)	Current Language	"New" Language
11	Article 409		
	409.21. TITLE	Overcurrent Protection	Fine as is
	409.21(A)	Overcurrent Protection	Fine as is
	409.21(B)	Protection	Overcurrent protection
	409.21(B)	overcurrent protective device	OCPD
	409.21(B)	Overcurrent Protection	Fine as is
	409.21(C). (X2)	overcurrent protective device	OCPD
	409.104	Overcurrent Devices	OCPDs
11	Article 430		
	430.10(A) In.	Overcurrent Device	OCPD
	430.22(G)(1)(1)	Overcurrent Protection	Fine as is
	430.22(G)(1)(2)	Overcurrent Protection	Fine as is
	430.22(G)(2)(1)	Overcurrent Protection	Fine as is
	430.22(G)(2)(2)	Overcurrent Protection	Fine as is
	430.28	Branc-Circuit protective device	OCPD
	430.28	Overcurrent Device	OCPD
	430.51	Overcurrent	Fine as is
	430.53(C)(5)	Overcurrent Protection	Fine as is
	430.55	Overcurrent Protection	Fine as is
	430.61	Overcurrents	Fine as is
	430.62(A)Ex.2	Feeder Overcurrent protective device	Feeder OCDP
	430.62(A)Ex.2	Overcurrent Protection	Fine as is
	430.62(B)	Feeder Overcurrent protective device	Feeder OCDP
	430.63Ex.	Feeder Overcurrent device	Feeder OCDP
	430.63Ex.	Overcurrent Protection	Fine as is
	430.72. Title	Overcurrent Protection	Fine as is
	430.72(A)	protected against overcurrent	shall be provided with overcurrent protection in accordance with
	430.72(A)	Branch-circuit overcurrent protective devices	OCPDs
	430.72(A)	protected against overcurrent	shall be provided with overcurrent protection in accordance with
	430.72(B). (X2)	Overcurrent Protection	Fine as is
	430.72(B)	Overcurrent Device	OCPD

	430.72(B)	Overcurrent Protection	Fine as is
	430.72(B)(1) (X3)	Overcurrent Protection	Fine as is
	430.72(B)(2) Title	Branch-circuit overcurrent protective device	Fine as is
	430.72(B)(2) (X2)	protective devices	OCPDs
	430.72(C)Ex.	Overcurrent Protection	Fine as is
	430.72(C)(3)	Overcurrent Devices	OCPDs
	430.72(C)(4)	Overcurrent Device	OCPD
	430.72(C)(5)	Protection	Overcurrent protection
	430.87	Overcurrent Device	OCPD
	430.94. (X2)	Overcurrent Protection	Fine as is
	430.94. (X3)	Overcurrent protective device	OCPD
	430.109(A)(7)	Overcurrent protection	Fine as is
	430.109(B)	Branch-circuit overcurrent device	branch-circuit OCPD
	430.111(A). (X2)	Overcurrent Device	Fine as is
	430.112 Ex.	Branch circuit protective device	Suggest CMP to Review
	430.206. Title	Overcurrent protection	Fine as is
	430.206(B)(2)	considered to have Overcurrent	Overload
	430.206(C)	Fault-Current protection	Suggest CMP to Review
	430.207	Overcurrent (overload)Relays	Fine as is
	430.207	Overcurrent Relays	Fine as is
11	**Article 440**		
	440.21	Overcurrent	Fine as is
	440.21	Overcurrent Protection	Fine as is
	440.22(B)(2)Ex.	Overcurrent device	OCPD
	440.52(B)	Overcurrent	shall be provided with overcurrent protection
11	**Article 460**		
	460.9. Title	Overcurrent Protection	Fine As Is
	460.9. (X3)	Overcurrent Device	OCPD
	460.25	Overcurrent Protection	Fine As Is
	460.28(B)	Overcurrent Device	OCPD

CMP-10 TG-4 Review of Overcurrent Language for the Articles undeer the purview of CMP-12			
CMP	NEC Section (using First Draft of 2026 NEC)	Current Language	"New" Language
12	Article 610		
	610. Part V	Overcurrent Protection	Fine as is
	610.41(A)	Overcurrent Devices	OCPDs
	610.43(A)(1)	Branch Circuit Overcurrent Device	OCPD
	610.53 Title	Overcurrent Protection	Fine as is
	610.53	be protected from Overcurrent	shall be provided with overcurrent protection
	610.53	Overcurrent Devices	OCPDs
	610.53(B)	Branch Circuit Overcurrent Devices	OCPDs
12	Article 620		
	620.12(A)(4)	Overcurrent Protection	Fine as is
	620.22(A)(2) Title	Overcurrent protective device	Fine as is
	620.22(A)(2)	Overcurrent Device protecting	branch-circuit OCPD
	620.22(A)(2)	Overcurrent Device	OCPD
	620.22(B)	Overcurrent Device protecting	branch-circuit OCPD
	620.22(B)	Overcurrent Device	OCPD
	620.25 Title	Overcurrent Devices	Overcurrent Protective Devices
	620.25. (X2)	Overcurrent Devices	OCPDs
	620.53	Overcurrent protective device	OCPD
	620.54	Overcurrent protective device	OCPD
	620.55	Overcurrent protective device	OCPD
	Art 620 Part VII	Overcurrent Protection	Fine as is
	620.61	Overcurrent Protection	Fine as is
	620.61(A). (X2)	be protected against Overcurrent	shall be provided with overcurrent protection
	620.62(A)	Overcurrent protective devices, (OCPD)	OCPDs
	620.62(B)	OCPDs	Fine as is
	620.62(C)	OCPDs. And. Overcurrent Devices	Fine as is. And. OCPDs
	620.62	Overcurrent protective devices	OCPDs
	620.65. (X3)	Overcurrent Devices	OCPDs
12	Article 625		
	625.60(C). (X4)	Overcurrent Protection	Fine as is
12	Article 627		
	627.41	Overcurrent Protection	Fine as is
	627.41(A)	Overcurrent Protection	Fine as is

	627.41(B)	Overcurrent Devices	OCPDs
12	**Article 630**		
	630.12	Overcurrent Protection	Fine as is
	630.12	Overcurrent Device	OCPD
	630.12(A). (X2)	Overcurrent Protection	Fine as is
	630.12(A). (X5)	Overcurrent Device	OCPD
	630.13	Overcurrent Protection	Fine as is
	630.32	Overcurrent Protection	Fine as is
	630.32	Overcurrent Device	OCPD
12	**Article 640**		
	640.9(C)	Overcurrent Protection	Fine as is
	640.22	Overcurrent protection devices	OCPDs
	640.22	Overcurrent Devices	OCPDs
	640.43	Overcurrent protection devices	OCPDs
12	**Article 645**		
	645.27	Overcurrent protective devices, (OCPD)	OCPDs
	645.27	Overcurrent protective devices	OCPDs
12	**Article 646**		
	646.7. (X11)	Overcurrent Protection	Fine as is
12	**Article 647**		
	647.5	Overcurrent Protection	Fine as is
12	**Article 650**		
	650.9	Overcurrent Protection	Fine as is
	650.9	Overcurrent Device	OCPD
12	**Article 660**		
	660.7	Overcurrent Protection	Fine as is
	660.7(A)	Overcurrent protective devices	OCPDs
	660.7(B)	Overcurrent Devices	OCPDs
	660.7(B)	Overcurrent Protection	Fine as is
	660.9	Overcurrent Devices	OCPDs
12	**Article 665**		
	665.24	Overcurrent Protection	Fine as is
12	**Article 668**		
	668.4(C)(2)	Overcurrent Protection	Fine as is
	668.21	Overcurrent Protection	Fine as is

	668.21	Overcurrent Device	OCPD
12	**Article 669**		
	669.9	Overcurrent Protection	Fine as is
	669.9	be protected from Overcurrent	shall be provided with overcurrent protection
12	**Article 670**		
	670.1	Overcurrent Protection	Fine as is
	670.4(B). (X3)	Overcurrent Protection	Fine as is
	670.5. (X4)	Overcurrent Protection	Fine as is
	670.5(C). (X2)	Overcurrent protective device	OCPD
12	**Article 685**		
	685.10.	Overcurrent Devices	OCPDs

CMP-10 TG-4 Review of Overcurrent Language for the Articles undeer the purview of CMP-13			
CMP	**NEC Section (using First Draft of 2026 NEC)**	**Current Language**	**"New" Language**
13	**Article 100**		
	Emerg.Power Supply Systems (EPSS)	overcurrent protection devices	overcurrent protective devices (OCPDs)
	Transfer-Switch B-C Emerg. Ltg.	branch-circuit overcurrent device	branch-circuit overcurrent protective device (OCPD)
13	**Article 130**		
	130.80(C)	overcurrent devices	OCPDs
	130.80(C)	branch-circuit overcurrent device	OCPD
13	**Article 445**		
	445.11	Overcurrent protective Relay	Fine as is
	445.12. Title	Overcurrent Protection	Fine as is
	445.12(A)	Overcurrent protective means	Overcurrent protection means
	445.12(B)	Overcurrent Protection	Fine as is
	445.12(B) (X2)	Overcurrent Device	OCPD
	445.12(C)	Overcurrent Device	OCPD
	445.12(D)	Overcurrent Devices	OCPDs
	445.12(E). (X3)	Overcurrent Devices	OCPDs
	445.13(A). (X2)	Overcurrent Protection	Fine as is
	445.13(B). Title	Overcurrent protection	Fine as is
	445.13(B).	Overcurrent protective device	OCPD
	445.13(B)	Overcurrent Relay	Fine as is
13	**Article 455**		
	455.7	Overcurrent Protection	Fine As Is
	455.7	protected from Overcurrent	shall be provided with overcurrent protection in accordance with
	455.7(A)	Overcurrent Protection	Fine As Is
	455.7(B)	Overcurrent Protection	Fine As Is
13	**Article 480**		
	480.4(B) IN.2	Overcurrent Protection	Fine As Is
	480.6. (X2)	Overcurrent Protection	Fine As Is
	480.7	Overcurrent Device	OCPD
13	**Article 695**		
	695.4(C)	Overcurrent protective devices	OCPDs
	695.4(H). Title	Overcurrent Device Selection	Overcurrent Protective Device Selection
	695.4(H)	Overcurrent Devices	OCPDs

	695.5	Overcurrent Device	OCPD
	695.5	Overcurrent protective devices	OCPDs
	695.5	Overcurrent Protection	Fine as is
	695.6	Overcurrent protective devices	OCPDs
	695.6	Overcurrent Devices	OCPD
	695.6	Overcurrent Protection	Fine as is
	695.7(A)(2)	Overcurrent Devices	OCPDs
	695.7	Overcurrent Protection	Fine as is
13	**Article 700**		
	700.4(F)(8)	Overcurrent protective devices, (OCPD)	OCPDs
	700.6(E)	Overcurrent protective device	OCPD
	700.10(B). (X6)	Overcurrent Protection	Fine as is
	700.10(B)(6)(b)(ii)	Overcurrent protective device	OCPD
	700.10(B)(6)(e)	Overcurrent protective devices	OCPDs
	Art. 700 Part VI	Overcurrent Protection	Fine as is
	700.30.	Branch-circuit overcurrent devices	OCPDs
	700.32(A)	Overcurrent protective devices, (OCPDs)	OCPDs
	700.32(A) In	Overcurrent Protection	Fine as is
	700.32(C)	Overcurrent Devices	OCPDs
13	**Article 701**		
	701.6(C)	Overcurrent protective device	OCPD
	701.10(B)(1). (X5)	Overcurrent Protection	Fine as is
	701.10(B)(1)	Overcurrent protective device	OCPD
	Art. 701. Part IV	Overcurrent Protection	OCPDs
	701.30.	Branch-Circuit Overcurrent devices	Branch-Circuit OCPDs
	701.32(A). (X2)	Overcurrent protective devices, OCPDs	OCPDs
	701.32(B). (X3)	OCPDs	Fine as is
	701.32(C). (X2)	OCPDs	Fine as is
	701.32(C)Ex	Overcurrent Devices	OCPDs
	701.32(C) In 2	OCPD and OCPDs	Fine as is
13	**Article 702**		
	702.5(C)	Overcurrent protective device	OCPD
13	**Article 706**		
	706.15(E)(1)	Overcurrent Device	OCPD
	706.30(B)	Overcurrent Devices	OCPDs

	706.31 Title	Overcurrent Protection	Fine as is
	706.31(A)	shall be protected at the source from overcurrent.	shall be provided with overcurrent protection at the source
	706.31(A)	shall be protected from overcurrent.	shall be provided with overcurrent protection
	706.31(A) In	Overcurrent Device	OCPD
	706.31(B). Title	Overcurrent Device	Overcurrent Protective Device
	706.31(B)	Overcurrent protective devices	OCPDs
	706.31(B)	Overcurrent devices	OCPDs
	706.31(C)	Overcurrent protective devices	OCPDs
	706.31(E)	Overcurrent Protection	Fine as is
	706.33(B)(2)	Overcurrent Device	OCPD
13	**Article 708**		
	708.10(B)	Overcurrent Protection	Fine as is
	708.24(E)	Overcurrent protective device	OCPD
	Art. 708. Part IV	Overcurrent Protection	Fine as is
	708.50.	Feeder- and Branch-circuit overcurrent devices	Feeder- and Branch-circuit OCPDs
	708.52(B)	Overcurrent Devices	OCPDs
	708.54(A)	Overcurrent protective devices, (OCPD)	OCPDs
	708.54(A). (B). (C)	OCPDs	Fine as is
	708.54	Overcurrent Devices	OCPDs

CMP-10 TG-4 Review of Overcurrent Language for the Articles undeer the purview of CMP-14			
CMP	**NEC Section (using First Draft of 2026 NEC)**	**Current Language**	**"New" Language**
14	**Article 500**		
	500.30(A)(2)	Branch Circuit Overcurrent Protection	OCPD
	500.30.	Overcurrent Protection	Fine as is
14	**Article 501**		
	501.105(B)(5)	Overcurrent Protection	Fine as is
	501.125(B)(2)	Motor Overcurrent	Fine as is
14	**Article 502**		
	502.120(A)	Overcurrent Devices	OCPDs
	502.120(B)(1)	Overcurrent Devices	OCPDs
	502.125	Motor Overcurrent	Fine as is
14	**Article 505**		
	505.30(A)(2)	Branch Circuit Overcurrent Protection	OCPD
	505.30.	Overcurrent Protection	Fine as is
14	**Article 506**		
	506.30.	Branch Circuit Overcurrent Protection	OCPD
	506.30.	Overcurrent Protection	Fine as is

CMP-10 TG-4 Review of Overcurrent Language for the Articles undeer the purview of CMP-15			
CMP	**NEC Section (using First Draft of 2026 NEC)**	**Current Language**	**"New" Language**
15	**Article 100**		
	Bull Switch	Overcurrent protection	Fine as is
15	**Article 517**		
	517.17(B)	Overcurrent protective devices	OCPDs
	517.31(G). (X5)	Overcurrent protective devices	OCPDs
	517.31(G)	Overcurrent	Fine as is
	517.33((C). (X5)	Overcurrent protective devices	OCPDs
	517.42(F)	Overcurrent protective devices	OCPDs
	517.42(F)	Overcurrent	Fine as is
	517.73	Overcurrent Protection	Fine as is
	517.73(A)	Overcurrent protective devices	OCPDs
	517.73(B)	Overcurrent protective devices	OCPDs
	517.73(B)	Overcurrent Protection	Fine as is
	517.74(B)	Overcurrent protective devices	OCPDs
	517.160(A)(2)	Overcurrent Protection	Fine as is
	517.160(A)(2)	Overcurrent protective device	OCPD
	517.160(A)(2)	be protected against Overcurrent	be provided with overcurrent protection
	517.160(A)(3)	Overcurrent protective devices	OCPDs
	517.160(B)(1)	Overcurrent protective devices	OCPDs
15	**Article 518**		
	518.7(A)(1)	Overcurrent Protection	Fine as is
	518.17(A)(1) and (2)	Overcurrent Devices	OCPDs
15	**Article 520**		
	520.9	Branch Circuit Overcurrent Device	OCPD
	520.21	Overcurrent protective devices	OCPDs
	520.25. (X3)	Overcurrent Protection	Fine as is
	520.26	Overcurrent protective devices	OCPD
	520.26. (X3)	Overcurrent Protection	Fine as is
	520.27. (X2)	Overcurrent Device	OCPD
	520.44-T	Overcurrent Devices	OCPD
	520.50(C)	Overcurrent Protection	Fine as is
	520.50.	Branch-circuit overcurrent protective device	OCPDs
	520.52	Overcurrent Protection	Fine as is

	520.53(A)	Overcurrent protective devices	OCPDs
	520.53(D)	Overcurrent Protection	Fine as is
	520.54	Overcurrent Devices	OCPDs
	520.54(D)	Overcurrent Device	OCPD
	520.54(D)(1) and (2)	Overcurrent protective devices	OCPD
	520.54(E)	Overcurrent protective device	OCPD
	520.54(E). (X4)	Overcurrent protection device	OCPD
	520.54(E)	Overcurrent Devices	OCPDs
	520.54(K)	Overcurrent Device	OCPD
	520.68	Overcurrent protective device	OCPD
	520.68(3)	Overcurrent Device	OCPD
	520.68(4)	Overcurrent protective device	OCPD
	520.68(6)	Overcurrent Devices	OCPDs
	520.68(C)	Overcurrent Protection	Fine as is
15	**Article 522**		
	522.10(A)(2). (X3)	Overcurrent Devices	OCPDs
	522.10(A)(2	Overcurrent protective device	OCPD
	522.10(B). (X4)	Overcurrent Devices	OCPDs
	522.23. (X3)	Overcurrent Protection	Fine as is
15	**Article 525**		
	525.12	Overcurrent Device	OCPD
	525.23(B)	Overcurrent Device	OCPD
	525.23(C). (X2)	Overcurrent Protection	Fine as is
15	**Article 530**		
	530.9(A)	Branch-circuit overcurrent device	Branch-circuit OCPD
	530.10(C)	Overcurrent Protection	Fine as is
	530.23 and (A)	Overcurrent Protection	Fine as is
	530.23(B)	Overcurrent protective devices	OCPDs
	530.23(D)	Overcurrent Protection	Fine as is
	530.42	Overcurrent Protection	Fine as is
15	**Article 540**		
	540.11(B)	Overcurrent Devices	OCPDs

CMP-10 TG-4 Review of Overcurrent Language for the Articles undeer the purview of CMP-16			
CMP	**NEC Section (using First Draft of 2026 NEC)**	**Current Language**	**"New" Language**
16	**Article 830**		
	830.15. (X4)	Overcurrent Protection	Fine as is

CMP-10 TG-4 Review of Overcurrent Language for the Articles undeer the purview of CMP-17			
CMP	**NEC Section (using First Draft of 2026 NEC)**	**Current Language**	**"New" Language**
17	**Article 422**		
	422.5(C)	Branch-circuit overcurrent protective device	Branch-Circuit OCPD
	422.11. Title	Overcurrent Protection	Fine as is
	422.11	protected against overcurrent	shall be provided with overcurrent protection
	422.11(A)	Overcurrent Protection	Fine as is
	422.11(A)	Branch-circuit overcurrent protective device	Branch-Circuit OCPD
	422.11(B)	Overcurrent Protection	OCPDs
	422.11(C)	Overcurrent Protection	OCPDs
	422.11(D)	Overcurrent protective devices	OCPDs
	422.11(E)	Overcurrent Protection	Fine as is
	422.11(E)(1)	Overcurrent Protection	Fine as is
	422.11(E)(2)	Overcurrent Protection	Fine as is
	422.11(E)(3)	Overcurrent Protection	OCPD
	422.11(E)(3)	Overcurrent Device	OCPD
	422.11(F)(1)	Supplementary Overcurrent Protective Devices	Supplementary OCPDs
	422.11(F)(1)	Overcurrent Protective Devices	OCPDs
	422.11(G)	Overcurrent Protective Devices	OCPDs
	422.13	Overcurrent Protection	Fine as is
	422.31(A)	Branch-circuit overcurrent protective device	Branch-Circuit OCPD
	422.60(A)	Overcurrent Protection	Fine as is
	422.62(B)(1). (X2)	Overcurrent protective device	OCPD
17	**Article 424**		
	424.19	Supplementary Overcurrent Protective Devices	Supplementary OCPDs
	424.19(A)	Supplementary Overcurrent Protection	Fine as is
	424.19(A)	Supplementary Overcurrent Protection	Fine as is
	424.19(A)	Supplementary Overcurrent Protective Device(s)	Supplementary OCPDs
	424.19(B)	Supplementary Overcurrent Protection	Fine as is
	424.22	Overcurrent Protection	Fine as is
	424.22(A)	Overcurrent Protection	Fine as is
	424.22(A)	protected against overcurrent	"..shall be permitted to have overcurrent protection.."
	424.22(B)	Supplementary Overcurrent Protective Device	Supplementary OCPD
	424.22(C). Title	Overcurrent Protective Devices	Fine as is
	424.22(C)	Supplementary Overcurrent Protective Devices	Supplementary OCPDs

	424.22(C)	Overcurrent Protection	Fine as is
	424.22(C)	Supplementary Overcurrent Protection	Fine as is
	424.22(D) (X2)	Supplementary Overcurrent Protective Devices	Supplementary OCPDs
	424.22(E). (X3)	Supplementary Overcurrent Protective Devices	Supplementary OCPDs
	424.72	Overcurrent Protection	Fine as is
	424.72(A)	Overcurrent protective device	OCPD
	424.72(B)	Overcurrent protective device	OCPD
	424.72(C). Title	Supplementary Overcurrent Protective Devices	Fine as is
	424.72(C)	Supplementary Overcurrent Protective Devices	Supplementary OCPDs
	424.72(C)	Overcurrent Protection	Fine as is
	424.72(D). Title	Supplementary Overcurrent Protective Devices	Fine as is
	424.72(D).	Supplementary Overcurrent Protective Devices	Supplementary OCPDs
	424.72(D)	Overcurrent protective device	OCPD
	424.72(E)	Supplementary Overcurrent Protective Devices. (X3)	Supplementary OCPDs
	424.82	Overcurrent protective devices	OCPDs
17	**Article 425**		
	425.19	Supplementary Overcurrent Protective Devices	Supplementary OCPDs
	425.19(A). (X2)	Supplementary Overcurrent Protection	Fine as is
	425.19(A)	Supplementary Overcurrent Protective Devices	Supplementary OCPDs
	425.19(B)	Supplementary Overcurrent Protection	Fine as is
	425.22. Title	Overcurrent Protection	Fine as is
	425.22(A)	Overcurrent Protection	Fine as is
	425.22(A)	protected against overcurrent	"..shall be permitted to have overcurrent protection.."
	425.22(B)	Supplementary Overcurrent Protective Device	Supplementary OCPD
	425.22(C). Title	Overcurrent Protective Devices	Fine as is
	425.22(C)	Supplementary Overcurrent Protective Devices	Supplementary OCPDs
	425.22(C). (X2)	Supplementary Overcurrent Protection	Fine as is
	425.22(D). Title	Supplementary Overcurrent Protective Devices	Fine as is
	425.22(D). (X2)	Supplementary Overcurrent Protective Devices	Supplementary OCPDs
	425.22(E) (X3)	Supplementary Overcurrent Protective Devices	Supplementary OCPDs
	425.72	Overcurrent Protection	Fine as is
	425.72(A)	Overcurrent protective device	OCPD
	425.72(B)	Overcurrent protective device	OCPD
	425.72(C). Title	Supplementary Overcurrent Protective Devices	Fine as is
	425.72(C)	Supplementary Overcurrent Protective Devices	Supplementary OCPDs

	425.72(C)	Overcurrent Protection	Fine as is
	425.72(D)	Overcurrent protection	Fine as is
	425.72(E). Title	Supplementary Overcurrent Protective Devices	Fine as is
	425.72(E)	Supplementary Overcurrent Protective Devices	Supplementary OCPDs
	425.72(E)	Overcurrent Protective Devices	OCPD
	425.72(F). (X3)	Supplementary Overcurrent Protective Devices	Supplementary OCPDs
	425.82	Overcurrent protective devices	OCPDs
17	**Article 427**		
	427.57	Overcurrent Protection	Fine as is
	427.57	considered protected against Overcurrent	considered to have overcurrent protection
17	**Article 680**		
	680.10.(A)& (B)(2)	Overcurrent protective devices	OCPDs
	680.23(F)(2)	Overcurrent Protection	Fine as is

CMP-10 TG-4 Review of Overcurrent Language for the Articles undeer the purview of CMP-18			
CMP	**NEC Section (using First Draft of 2026 NEC)**	**Current Language**	**"New" Language**
18	**Article 393**		
	393.45. Title	Overcurrent ...... Protection	Overcurrent Protection ....
	393.45(A)	Overcurrent Protection	Fine as is
18	**Article 406**		
	406.46(F)	Overcurrent Device	OCPD
18	**Article 410**		
	410.59(A)	Branch-circuit overcurrent devices	Branch-Circuit OCPD
	410.153	Overcurrent Protection	Fine as is
18	**Article 600**		
	600.41	Overcurrent	CMP to Review

Public Comment No. 1990-NFPA 70-2024 [Global Input]

Make the Definition of Portable (as applied to equipment) applicable through the Code, assign to CMP-1, and revise definition as follows:

Portable (as applied to equipment)

Equipment that is moved from one place to another in normal use. (CMP-1)

Statement of Problem and Substantiation for Public Comment

This comment is in support of the Correlating Committee Note No. 145 which directed CMP-17 to consider revising the definition "Portable (as applied to equipment)" to be applicable throughout the Code. The text of the definition is revised to be general, yet specific enough to address one particular concern: equipment with wheels attached. Just because equipment has wheels does not mean it should be considered portable by default. Wheels may be used solely for positioning, or manufacturers may add wheels to list equipment to UL standards for portable equipment, while the equipment is not truly meant to be portable nor do the installations instructions allow actual portability. This may create an illusion for enforcement that code requirements should not apply, for example Article 480 Stationary Batteries. Attaching wheels to a 1500lb battery and inverter stack which is hardwired into premises wiring doesn't make that equipment truly portable (even if listed to UL 2743 as a portable power pack).

FCR-155 stated that the term “stationary” is a commonly used adjective and can be applied in requirements without the need for a unique definition in Article 100 - and has thus been deleted. That makes it even more important to define portable adequately and correctly for equipment. This comment is made globally to draw attention to the question of whether Article-specific definitions of portable and/or stationary might be needed for additional clarity.

Related Item

- FCR 155, CN145

Submitter Information Verification

Submitter Full Name: Rebekah Hren
Organization: IPPNC LLC
Street Address:
City:
State:
Zip:

Submittal Date: Wed Aug 28 14:23:55 EDT 2024
Committee: NEC-P17

Public Comment No. 479-NFPA 70-2024 [Definition: Appliance.]

Appliance.

Utilization equipment, generally other than industrial, that is normally built in a standardized size or type and is installed or connected as a unit to perform one or more functions such as clothes washing, air-conditioning, food mixing, and deep frying. (CMP-17)

Additional Proposed Changes

File Name	Description	Approved
CN_126.pdf		

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 126 appeared in the First Draft Report on First Revision No. 8854.

The Correlating Committee directs CMP-17 to review the definition “appliance” and consider placing the examples in an informational note to comply with the NEC Style Manual 2.1.2.5.

Related Item

- First Revision No. 8854

Submitter Information Verification

Submitter Full Name: CC Notes

Organization: NEC Correlating Committee

Street Address:

City:

State:

Zip:

Submittal Date: Tue Jul 30 19:34:59 EDT 2024

Committee: NEC-P17

Correlating Committee Note No. 126-NFPA 70-2024 [Definition: Appliance.]

Submitter Information Verification

Committee: NEC-AAC

Submittal Date: Wed May 08 15:00:12 EDT 2024

Committee Statement

Committee Statement: The Correlating Committee directs CMP-17 to review the definition "appliance" and consider placing the examples in an informational note to comply with the NEC Style Manual 2.1.2.5.

First Revision No. 8854-NFPA 70-2024 [Definition: Appliance.]

Ballot Results

✔ **This item has passed ballot**

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

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.
Bowmer, Trevor N.
Hickman, Palmer L.
Holub, Richard A.
Jackson, Peter D.
Kendall, David H.
Manche, Alan
Osborne, Robert D.
Porter, Christine T.
Schultheis, Timothy James
Williams, David A.

Public Comment No. 5-NFPA 70-2024 [Definition: Appliance.]

Appliance.

Utilization equipment, generally other than industrial, that is normally built in a standardized size or type and is installed or connected as a unit to perform one or more functions such as, but not limited to, clothes washing, air-conditioning, food mixing, and deep frying. (CMP-17)

Statement of Problem and Substantiation for Public Comment

The proposed FR wording can appear to be more restrictive than intended and may be construed to apply only to the appliances in the list. The addition of "but not limited to" clarifies that the list constitutes examples.

Related Item

- FR-8854-NFPA 70-2024

Submitter Information Verification

Submitter Full Name: E. P. Hamilton

Organization: E. P. Hamilton & Associates, I

Affiliation: Self

Street Address:

City:

State:

Zip:

Submittal Date: Wed Jul 10 10:04:25 EDT 2024

Committee: NEC-P17

Public Comment No. 491-NFPA 70-2024 [Definition: Low-Voltage Contact Limit.]

Low-Voltage Contact Limit.

A voltage not exceeding the following values:

(1) 15 volts (RMS) for sinusoidal ac

(2) 21.2 volts peak for nonsinusoidal ac

(3) 30 volts for continuous dc

(4) 12.4 volts peak for dc that is interrupted at a rate of 10 to 200 Hz

(CMP-17)

Additional Proposed Changes

File Name	Description	Approved
CN_138.pdf		

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 138 appeared in the First Draft Report on First Revision No. 9010.

The Correlating Committee directs CMP-17 to review the definition "low-voltage contact limit" regarding the term having requirements and not complying with the NEC Style Manual 2.1.2.5. This needs to be sent to CMP-7 for correlation.

Related Item

- First Revision No. 9010

Submitter Information Verification

Submitter Full Name: CC Notes
Organization: NEC Correlating Committee
Street Address:
City:
State:
Zip:

Submittal Date: Tue Jul 30 19:56:38 EDT 2024
Committee: NEC-P17

Correlating Committee Note No. 138-NFPA 70-2024 [Definition: Low-Voltage Contact Limit.]

Submitter Information Verification

Committee: NEC-AAC
Submittal Date: Wed May 08 15:50:08 EDT 2024

Committee Statement

Committee Statement: The Correlating Committee directs CMP-17 to review the definition "low-voltage contact limit" regarding the term having requirements and not complying with the NEC Style Manual 2.1.2.5. This needs to be sent to CMP-7 for correlation.

First Revision No. 9010-NFPA 70-2024 [Definition: Low-Voltage Contact Limit.]

Ballot Results

✔ **This item has passed ballot**

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

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.
Bowmer, Trevor N.
Hickman, Palmer L.
Holub, Richard A.
Jackson, Peter D.
Kendall, David H.
Manche, Alan
Osborne, Robert D.
Porter, Christine T.
Schultheis, Timothy James
Williams, David A.

Public Comment No. 496-NFPA 70-2024 [Definition: Pool, Permanently Installed Swimming, Wading, I...]

Pool, Permanently Installed Swimming, Wading, Immersion, and Therapeutic. (Permanently Installed Swimming, Wading, Immersion, and Therapeutic Pools)

Those that are permanently constructed or installed in the ground, partially in the ground, above ground, inside of a building, or on a building, whether or not served by electrical circuits. (680) (CMP-17)

Additional Proposed Changes

File Name	Description	Approved
CN_143.pdf		

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 143 appeared in the First Draft Report on First Revision No. 9012.

The Correlating Committee directs CMP-17 to review the definition “Pool, Permanently Installed Swimming” and consider the term as “Pool, Permanently Installed” and use alternate terms for the various types of permanently installed pools. Additionally, beginning the first sentence of the definition with the word “pools” adds clarity.

Related Item

- First Revision No. 9012

Submitter Information Verification

Submitter Full Name: CC Notes

Organization: NEC Correlating Committee

Street Address:

City:

State:

Zip:

Submittal Date: Tue Jul 30 20:09:18 EDT 2024

Committee: NEC-P17

Correlating Committee Note No. 143-NFPA 70-2024 [Definition: Pool, Permanently Installed Swimming, Wading, I...]

Submitter Information Verification

Committee: NEC-AAC

Submittal Date: Wed May 08 16:53:23 EDT 2024

Committee Statement

Committee Statement: The Correlating Committee directs CMP-17 to review the definition “Pool, Permanently Installed Swimming” and consider the term as “Pool, Permanently Installed” and use alternate terms for the various types of permanently installed pools. Additionally, beginning the first sentence of the definition with the word “pools” adds clarity.

First Revision No. 9012-NFPA 70-2024 [Definition: Pool, Permanently Installed Swimming, Wading, I...]

Ballot Results

✔ **This item has passed ballot**

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

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.

Bowmer, Trevor N.

Hickman, Palmer L.

Holub, Richard A.

Jackson, Peter D.

Kendall, David H.

Manche, Alan

Osborne, Robert D.

Porter, Christine T.

Schultheis, Timothy James

Williams, David A.

Public Comment No. 495-NFPA 70-2024 [Definition: Pool, Storable (Storable Immersion Pool). (Stor...]

Pool, Storable (Storable Immersion Pool). (Storable Pool)

Pools of any water depth, used for swimming, wading, or immersion, installed entirely on or above the ground that are intended to be stored when not in use or are designed for ease of relocation. (680) (CMP-17)

Informational Note: A storable pool that is installed with a permanent deck around all or a portion of its perimeter is considered a permanently installed pool.

Additional Proposed Changes

File Name	Description	Approved
CN_142.pdf		

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 142 appeared in the First Draft Report on First Revision No. 9014.

The Correlating Committee directs CMP-17 to review the definition “Pool, Storable” and revise the informational note to comply with the NEC Style Manual 2.1.10.2 as it contains an interpretation.

Related Item

- First Revision No. 9014

Submitter Information Verification

Submitter Full Name: CC Notes
Organization: NEC Correlating Committee
Street Address:
City:
State:
Zip:

Submittal Date: Tue Jul 30 20:06:36 EDT 2024
Committee: NEC-P17

Correlating Committee Note No. 142-NFPA 70-2024 [Definition: Pool, Storable; used for Swimming, Wading, or I...]

Submitter Information Verification

Committee: NEC-AAC

Submittal Date: Wed May 08 16:52:11 EDT 2024

Committee Statement

Committee Statement: The Correlating Committee directs CMP-17 to review the definition “Pool, Storable” and revise the informational note to comply with the NEC Style Manual 2.1.10.2 as it contains an interpretation.

First Revision No. 9014-NFPA 70-2024 [Definition: Pool, Storable; used for Swimming, Wading, or I...]

Ballot Results

✔ **This item has passed ballot**

12 Eligible Voters

1 Not Returned

11 Affirmative All

0 Affirmative with Comments

0 Negative with Comments

0 Abstention

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.

Bowmer, Trevor N.

Hickman, Palmer L.

Holub, Richard A.

Jackson, Peter D.

Kendall, David H.

Manche, Alan

Osborne, Robert D.

Porter, Christine T.

Schultheis, Timothy James

Williams, David A.

Public Comment No. 7-NFPA 70-2024 [Definition: Pool, Storable (Storable Immersion Pool). (Stor...]

Pool, Storable (Storable Immersion Pool). (Storable Pool)

Pools of any water depth, used for swimming, wading, or immersion, installed entirely on or above the ground that are intended to be stored when not in use or are designed for ease of relocation. (680) (CMP-17)

Informational Note: A storable pool that is ~~installed with a permanent deck around~~ assembled on-site in accordance with the manufacturer's instructions and which abuts a permanent deck which is part of the pool installation and which is intended to provide ready access to the pool by swimmers, and which encloses all or a portion of ~~its~~ the pool's perimeter, is considered a permanently installed pool.

Statement of Problem and Substantiation for Public Comment

There is an unintended consequence in the revised FR wording. As written, the Informational Note can be misconstrued to mean that a storable pool sitting on a patio ("deck") that surrounds it is permanently installed, particularly given the expansion of the vertical criteria for a perimeter surface in680.26(B) from 2 ft below max water level to 3 ft. As written, this Informational Note can be construed to mean that a small storable "kiddie wading pool" sitting on a concrete patio ("deck" within 3 ft vertically of the maximum water level") is a permanently installed pool, which was never the intent of the Panel. The proposed revised wording in the IN provides clarification.

Related Item

- FR 9014-NFPA 70-2024

Submitter Information Verification

Submitter Full Name: E. P. Hamilton

Organization: E. P. Hamilton & Associates, I

Affiliation: Self

Street Address:

City:

State:

Zip:

Submittal Date: Wed Jul 10 10:09:53 EDT 2024

Committee: NEC-P17

Public Comment No. 494-NFPA 70-2024 [Definition: Pool.]

Pool.

Manufactured or field-constructed equipment designed to contain water and intended for use by persons for swimming, wading, immersion, recreational, or therapeutic purposes, but not including bodies of water incorporated as part of an industrial process, lakes, lagoons, surf parks, or other natural and artificially made bodies of water that could incorporate swimming and swimming areas. (680) (CMP-17)

Informational Note: Natural and man-made bodies of water, which includes lakes, lagoons, surf parks, or other similar bodies of water, are addressed in Article 682.

Additional Proposed Changes

File Name	Description	Approved
CN_141.pdf		

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 141 appeared in the First Draft Report on First Revision No. 9017.

The Correlating Committee directs CMP-17 to review the definition “Pool” and consider having the definition state what a “pool” is and reference examples that are not pools in an informational note. That information could also be contained in the scope of the article.

Related Item

- First Revision No. 9017

Submitter Information Verification

Submitter Full Name: CC Notes

Organization: NEC Correlating Committee

Street Address:

City:

State:

Zip:

Submittal Date: Tue Jul 30 20:05:08 EDT 2024

Committee: NEC-P17

Correlating Committee Note No. 141-NFPA 70-2024 [Definition: Pool.]

Submitter Information Verification

Committee: NEC-AAC
Submittal Date: Wed May 08 16:50:58 EDT 2024

Committee Statement

Committee Statement: The Correlating Committee directs CMP-17 to review the definition "Pool" and consider having the definition state what a "pool" is and reference examples that are not pools in an informational note. That information could also be contained in the scope of the article.

First Revision No. 9017-NFPA 70-2024 [Definition: Pool.]

Ballot Results

✔ **This item has passed ballot**

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

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.

Bowmer, Trevor N.

Hickman, Palmer L.

Holub, Richard A.

Jackson, Peter D.

Kendall, David H.

Manche, Alan

Osborne, Robert D.

Porter, Christine T.

Schultheis, Timothy James

Williams, David A.

Public Comment No. 8-NFPA 70-2024 [Definition: Pool.]

Pool.

Manufactured or field-constructed equipment designed to contain water and intended for use by persons for swimming, wading, immersion, recreational, or therapeutic purposes, including "lazy river" and similar attractions, but not including bodies of water incorporated as part of an industrial process, lakes, lagoons, surf parks, or other natural and artificially made bodies of water that could incorporate swimming and swimming areas. (680) (CMP-17)

Informational Note: Natural and man-made bodies of water, which includes lakes, lagoons, surf parks, or other similar bodies of water, are addressed in Article 682.

Statement of Problem and Substantiation for Public Comment

"Lazy river" attractions have been discussed in the panel, in the light that such attractions are pools which are intended to be included under Art. 680; however, the FR wording is not explicit in that regard. A recent fatal incident involving such an attraction justifies clarifying the text to explicitly identify these types of facilities as pools and not as natural and artificially-made bodies of waters.

Related Item

- FR 9017-NFPA 70-2024

Submitter Information Verification

Submitter Full Name: E. P. Hamilton

Organization: E. P. Hamilton & Associates, I

Affiliation: Self

Street Address:

City:

State:

Zip:

Submittal Date: Wed Jul 10 10:15:20 EDT 2024

Committee: NEC-P17

Public Comment No. 498-NFPA 70-2024 [Definition: Portable (as applied to equipment).]

Portable (as applied to equipment).

Equipment that is actually moved or can easily be moved from one place to another in normal use. (680) (CMP-17)

Additional Proposed Changes

File Name	Description	Approved
CN_145.pdf		

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 145 appeared in the First Draft Report.

The Correlating Committee directs CMP-17 to review the definition "Portable (as applied to equipment)" and consider revising this term to apply throughout the code.

Related Item

- Correlating Committee Note No. 145

Submitter Information Verification

Submitter Full Name: CC Notes

Organization: NEC Correlating Committee

Street Address:

City:

State:

Zip:

Submittal Date: Tue Jul 30 20:23:46 EDT 2024

Committee: NEC-P17

Correlating Committee Note No. 145-NFPA 70-2024 [Definition: Portable (as applied to equipment).]

Submitter Information Verification

Committee: NEC-AAC
Submittal Date: Wed May 08 17:02:01 EDT 2024

Committee Statement

Committee Statement: The Correlating Committee directs CMP-17 to review the definition “Portable (as applied to equipment)” and consider revising this term to apply throughout the code.

Ballot Results

✔ **This item has passed ballot**

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

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.
Bowmer, Trevor N.
Hickman, Palmer L.
Holub, Richard A.
Jackson, Peter D.
Kendall, David H.
Manche, Alan
Osborne, Robert D.
Porter, Christine T.
Schultheis, Timothy James
Williams, David A.

Public Comment No. 1733-NFPA 70-2024 [New Definition after Definition: Concealed Knob-and-Tube Wi...]

TITLE OF NEW CONTENT

New definition in Article 100 after Concealed Knob-and-Tube Wiring

Conductive Pavement Heating System . A system in which heat is generated by passing current through the pavement material and between electrodes embedded within the pavement material. (426) (CMP-17)

Statement of Problem and Substantiation for Public Comment

A new definition for Conductive Pavement Heating System has been added to Article 100 for this new technology.

This is a new definition to be added to support a new Part VI in Article 426 for electrically conductive pavement heating systems where the pavement is part of the heating circuit. This new part in Article 426 is to provide requirements for the safe installation of such systems that have been under development for several years with several installations completed for research purposes. The definition is needed to establish the new term for understanding how the requirements are to be applied to these new innovative snow melting and deicing systems.

This new definition is being recommended to be under the purview of CMP-17 and applicable to Article 426 only.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 1734-NFPA 70-2024 [Section No. 426.1]	
Public Comment No. 1735-NFPA 70-2024 [Sections Part VI., 426.50, 426.51]	
Public Comment No. 1734-NFPA 70-2024 [Section No. 426.1]	
Public Comment No. 1735-NFPA 70-2024 [Sections Part VI., 426.50, 426.51]	

Related Item

- PI 3479 and CI 8998

Submitter Information Verification

Submitter Full Name: Charles Mello
Organization: Cdcmello Consulting Llc
Affiliation: State of Iowa Department of Transportation
Street Address:
City:
State:
Zip:

Submittal Date: Mon Aug 26 19:47:42 EDT 2024
Committee: NEC-P17

Public Comment No. 1590-NFPA 70-2024 [Section No. 422.5]

422.5 GFCI Protection.

GFCI protection shall be provided in accordance with 422.5(A) through 422.5(C). Multiple GFCI devices shall be permitted but shall not be required.

(A) Circuit Rating.

The appliances indicated in 422.5(B) shall be GFCI protected if supplied by branch circuits that meet all the following conditions:

(1) Exceed the low-voltage contact limit, as defined in Article 100

(2) Do not exceed 150 volts to ground

(3) Do not exceed 60 amperes single-phase or 100 amperes 3-phase

(B) Appliances.

The following appliances shall be GFCI protected:

(1) ~~Automotive vacuum machines~~

(2) ~~Drinking water coolers and bottle fill stations~~

(3) ~~Cord- and plug-connected high-pressure spray washing machines~~

(4) ~~Tire inflation machines~~

(5) Vending machines

(6) ~~Sump pumps~~

(7) ~~Dishwashers~~

~~Informational Note No. 1: See 210.8 for GFCI protection requirements for branch-circuit outlets where covered locations warrant such protection.~~

~~Informational Note No. 2: Electrically cooled drinking water fountains are one type of drinking water cooler.~~

(C) Type and Location.

The GFCI shall be readily accessible, listed, and located in one or more of the following locations:

(1) ~~Within the branch-circuit overcurrent protective device~~

(2) In
~~a device or outlet within the supply circuitIn~~

(3) an integral part of the attachment plug

(4) Within the supply cord not more than 300 mm (12 in.) from the attachment plug

(5) Factory installed within the appliance

Statement of Problem and Substantiation for Public Comment

The suggested change removes the conflict between 210.8 and 422. the scope of Article 422 is "This article covers electrical appliances used in any occupancy." The UL standard for Appliances UL 751 has a requirement for GFCI protection in a vending machine is section 16.1.4 which states "A cord-connected vending machine shall be provided with a factory installed ground-fault
circuit-interrupter (GFCI)." Section 16.1.5 states that "The GFCI shall comply with UL 943 and be either: a) An integral part of the attachment plug; or b) Located such that it is in the supply cord within 12 in (305 mm) of the attachment plug."

GFCI requirements for specific appliances is not encroaching on the scope of Article 422 because the GFCI requirements are not there to protect the appliance. GFCI requirements provide protection for personnel which is the purview of Section 210.8. The significance of placing the requirements in 210.8 ensures that the branch circuit includes the GFCi protection regardless of the vintage of appliance that is installed on that circuit.

Related Item

• FR 8871

Submitter Information Verification

Submitter Full Name: Thomas Domitrovich
Organization: Eaton Corporation
Street Address:
City:
State:
Zip:
Submittal Date: Sat Aug 24 13:13:10 EDT 2024
Committee: NEC-P17

Public Comment No. 1900-NFPA 70-2024 [Section No. 422.5]

422.5 GFCI Protection.

GFCI protection shall be provided in accordance with 422.5(A) through 422.5(~~C~~ D). Multiple GFCI devices shall be permitted but shall not be required.

(A) Circuit Rating.

The appliances indicated in 422.5(B) shall be GFCI protected if supplied by branch circuits that meet all the following conditions:

(1) Exceed the low-voltage contact limit, as defined in Article 100

(2) Do not exceed 150 volts to ground

(3) Do not exceed 60 amperes single-phase or 100 amperes 3-phase

(B) Appliances.

The following appliances shall be GFCI protected:

(1) Automotive vacuum machines

(2) Drinking water coolers and bottle fill stations

(3) Cord- and plug-connected high-pressure spray washing machines

(4) Tire inflation machines

(5) Vending machines

(6) Sump pumps

(7) Dishwashers

Informational Note No. 1: See 210.8 for GFCI protection requirements for branch-circuit outlets where covered locations warrant such protection.

Informational Note No. 2: Electrically cooled drinking water fountains are one type of drinking water cooler.

(C)– **High Frequency Appliances**

If GFCI protection is required on the following appliances as per 210.8(A), the GFCI shall be listed and identified as High Frequency (HF):

(1) Refrigerators

(2) HVAC appliances

(D) Type and Location.

The GFCI shall be readily accessible, listed, and located in one or more of the following locations:

(1) Within the branch-circuit overcurrent protective device

(2) In a device or outlet within the supply circuit

(3) In an integral part of the attachment plug

(4) Within the supply cord not more than 300 mm (12 in.) from the attachment plug

(5) Factory installed within the appliance

Statement of Problem and Substantiation for Public Comment

The UL 943 standard for GFCIs is being updated to reduce nuisance tripping on loads which contain modernized electrical components such as variable frequency drives.

The next version of the UL 943 draft (expected Q3/Q4 2024) will introduce requirements for the High Frequency (HF) rating. GFCIs which meet pass the additional HF tests will be less prone to nuisance tripping.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 1902-NFPA 70-2024 [New Definition after Definition: Ground-Fault Circuit Inter...]	

Related Item

- FR 7788

Submitter Information Verification

Submitter Full Name:	Greg Woyczynski
Organization:	Association of Home Appliance
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Tue Aug 27 21:59:31 EDT 2024
Committee:	NEC-P17

Public Comment No. 1994-NFPA 70-2024 [Section No. 422.5]

~~**422.5** GFCI Protection.~~

~~GFCI protection shall be provided in accordance with 422.5(A) through 422.5(C) . Multiple GFCI devices shall be permitted but shall not be required.~~

~~**(A)** Circuit Rating.~~

~~The appliances indicated in 422.5(B) shall be GFCI protected if supplied by branch circuits that meet all the following conditions:~~

(1) ~~Exceed the low-voltage contact limit, as defined in Article 100~~

(2) ~~Do not exceed 150 volts to ground~~

(3) ~~Do not exceed 60 amperes single-phase or 100 amperes 3-phase~~

~~**(B)** Appliances.~~

~~The following appliances shall be GFCI protected:~~

(1) ~~Automotive vacuum machines~~

(2) ~~Drinking water coolers and bottle fill stations~~

(3) ~~Cord- and plug-connected high-pressure spray washing machines~~

(4) ~~Tire inflation machines~~

(5) ~~Vending machines~~

(6) ~~Sump pumps~~

(7) ~~Dishwashers~~

~~Informational Note No. 1: See 210.8 for GFCI protection requirements for branch-circuit outlets where covered locations warrant such protection.~~

~~Informational Note No. 2: Electrically cooled drinking water fountains are one type of drinking water cooler.~~

~~**(C)** Type and Location.~~

~~The GFCI shall be readily accessible, listed, and located in one or more of the following locations:~~

(1) ~~Within the branch-circuit overcurrent protective device~~

(2) ~~In a device or outlet within the supply circuit~~

(3) ~~In an integral part of the attachment plug~~

(4) ~~Within the supply cord not more than 300 mm (12 in.) from the attachment plug~~

(5) ~~Factory installed within the appliance~~

Statement of Problem and Substantiation for Public Comment

this public comment is being offered as a method to resolve the conflict between Article 422 and Article 210. the GFCI requirements are there for personnel protection and not protection of the appliance. One option may be to delete the requirements of GFCI from Article 422 unless the CMP wants GFCI as part of the appliance standard. The UL standard for vending machines includes a requirement for the vending machine to include GFCI in the cord. This could be left in this Article but because it is already a part of the product standard, the presence of this section isn't needed for this appliance. If other appliances should include GFCI as part of the product, it would be fair to include them in this section.

Related Item

• FR 8871

Submitter Information Verification

Submitter Full Name: Thomas Domitrovich

Organization: Eaton Corporation

Street Address:
City:
State:
Zip:

Submittal Date:	Wed Aug 28 14:35:20 EDT 2024
Committee:	NEC-P17

Public Comment No. 686-NFPA 70-2024 [Section No. 422.5]

422.5 GFCI Protection.

GFCI protection shall be provided in accordance with 422.5(A) through 422.5(C). Multiple GFCI devices shall be permitted but shall not be required.

(A) Circuit Rating.

The appliances indicated in 422.5(B) shall be GFCI protected if supplied by branch circuits that meet all the following conditions:

(1) Exceed the low-voltage contact limit, as defined in Article 100

(2) Do not exceed 150 volts to ground

(3) Do not exceed 60 amperes single-phase or 100 amperes 3-phase

(B) Appliances.

The following appliances shall be GFCI protected:

(1) Automotive vacuum machines

(2) Drinking water coolers and bottle fill stations

(3) Cord- and plug-connected high-pressure spray washing machines

(4) Tire inflation machines

(5) Vending machines

(6) Sump pumps

(7) Dishwashers

Informational Note No. 1: See 210.8 for GFCI protection requirements for branch-circuit outlets where covered locations warrant such protection.

Informational Note No. 2: Electrically cooled drinking water fountains are one type of drinking water cooler.

(C) Type and Location.

The GFCI shall be readily accessible, listed, and located in one or more of the following locations:

(1) Within the branch-circuit overcurrent protective device

(2) In a device or outlet within the supply circuit

(3) In an integral part of the attachment plug

(4) Within the supply cord not more than 300 mm (12 in.) from the attachment plug

(5) Factory installed within the appliance

Additional Proposed Changes

File Name	Description	Approved
CN_389.pdf		

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 389 appeared in the First Draft Report on First Revision No. 8871.

The Correlating Committee directs that a task group be formed with members from CMP 2 and CMP 17 to address the concerns raised over purview of GFCI protection requirement for appliances. Article 422 contains specific requirements for appliances and Article 210 provides the requirements for branch circuits. Correlation between these two articles is needed on this topic.

As part of Decision D#22-11 the NFPA Standards Council stated “Lastly the Appellant raises concerns that GFCI requirements related to appliances are not properly in the scope of Article 210 (and therefore the responsibility of CMP 2), rather, that appliances are addressed in Article 422 and therefore within the scope of CMP 17. The matter of technical scope among articles within the NEC is the responsibility for the NEC Correlating Committee, which is balloted on correlation between articles within the NEC. Section 210.8(D) addresses receptacle protection based on the equipment that may be used with the receptable, and therefore Council finds no reason to second guess the ballot of the NEC Correlating Committee on this issue. However, the Council encourages the NEC Correlating Committee to review this specific concern, to the extent there may be overlap that requires clarification between CMP 2 and CMP 17."

Related Item

- First Revision No. 8871

Submitter Information Verification

Submitter Full Name: CC Notes
Organization: NEC Correlating Committee
Street Address:
City:
State:
Zip:
Submittal Date: Fri Aug 02 11:14:44 EDT 2024
Committee: NEC-P17

Correlating Committee Note No. 389-NFPA 70-2024 [Section No. 422.5]

Submitter Information Verification

Committee: NEC-AAC
Submittal Date: Fri May 10 11:30:48 EDT 2024

Committee Statement

Committee Statement: The Correlating Committee directs that a task group be formed with members from CMP 2 and CMP 17 to address the concerns raised over purview of GFCI protection requirement for appliances. Article 422 contains specific requirements for appliances and Article 210 provides the requirements for branch circuits. Correlation between these two articles is needed on this topic.

As part of Decision D#22-11 the NFPA Standards Council stated “Lastly the Appellant raises concerns that GFCI requirements related to appliances are not properly in the scope of Article 210 (and therefore the responsibility of CMP 2), rather, that appliances are addressed in Article 422 and therefore within the scope of CMP 17. The matter of technical scope among articles within the NEC is the responsibility for the NEC Correlating Committee, which is balloted on correlation between articles within the NEC. Section 210.8(D) addresses receptacle protection based on the equipment that may be used with the receptable, and therefore Council finds no reason to second guess the ballot of the NEC Correlating Committee on this issue. However, the Council encourages the NEC Correlating Committee to review this specific concern, to the extent there may be overlap that requires clarification between CMP 2 and CMP 17.”

First Revision No. 8871-NFPA 70-2024 [Section No. 422.5]

Ballot Results

✔ **This item has passed ballot**

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

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.

Bowmer, Trevor N.

Hickman, Palmer L.

Holub, Richard A.

Jackson, Peter D.

Kendall, David H.

Manche, Alan

Osborne, Robert D.

Porter, Christine T.

Schultheis, Timothy James

Williams, David A.

Public Comment No. 1014-NFPA 70-2024 [Section No. 422.5(B)]

(B) Appliances.

The following appliances shall be GFCI protected:

(1) Automotive vacuum machines

(2) Drinking water coolers and bottle fill stations

(3) Cord- and plug-connected high-pressure spray washing machines

(4) Tire inflation machines

(5) Vending machines

(6) Sump pumps

(7) Dishwashers

(8) Electric ranges

(9) Wall-mounted ovens

(10) Counter-mounted cooking units

(11) Clothes dryers

(12) Microwave ovens

Informational Note No. 1: See 210.8 for GFCI protection requirements for branch-circuit outlets where covered locations warrant such protection.

Informational Note No. 2: Electrically cooled drinking water fountains are one type of drinking water cooler.

Statement of Problem and Substantiation for Public Comment

The items in this list are also found in 210.8(D) verbatim. With the proposed changes this would make both lists identical and aid in clarification for the user.

Related Item

• • Public Input No. 1770, • FR-8871-NFPA 70-2024

Submitter Information Verification

Submitter Full Name: Edward Brown

Organization: Independent Electrical Contrac

Street Address:

City:

State:

Zip:

Submittal Date: Sat Aug 10 18:25:58 EDT 2024

Committee: NEC-P17

Public Comment No. 1082-NFPA 70-2024 [Section No. 422.5(B)]

(B) Appliances.

The following appliances shall be GFCI protected:

(1) Automotive vacuum machines

(2) Drinking water coolers and bottle fill stations

(3) Cord- and plug-connected high-pressure spray washing machines

(4) Tire inflation machines

(5) Vending machines

(6) Sump pumps

(7) Dishwashers

~~Informational Note No. 1: See 210.8 for GFCI protection requirements for branch-circuit outlets where covered locations warrant such protection.~~

(1) **Electric ranges**

(2) **Wall-mounted ovens**

(3) **Counter-Mounted cooking units**

(4) **Clothes dryers**

(5) **Microwave ovens**

Informational Note No.

~~2:~~

1 Electrically cooled drinking water fountains are one type of drinking water cooler.

Statement of Problem and Substantiation for Public Comment

This public comment is a response to Public Input No. 1548-NFPA 70-2023 [Section No. 422.5(A) which was resolved by CMP-17. The resolution stated that "insufficient technical substantiation has been submitted to expand the list." CMP 2 has purview of the branch circuit requirements in 210.8(D) and CMP 17 has purview over the requirements in 422.5(A).

This resolution which stated no technical substation was submitted was not a valid response to the PI, when in fact the list had already been expanded per the Substantiation provided as part of SR 7966 during the 2023 Code cycle by CMP 2. Currently two different lists of appliances requiring GFCI exist in Article 210 and Article 422, and they do not match. The submitter of PI 1170 proposed that the list should match to facilitate users of the Code applying the requirements, the PI was not requesting an expansion of the list.

Having two appliance lists requiring GFCI protection that don't match in Articles 210 and 422 is confusing and difficult for users of this Code to reconcile. This PC, along with a related PC f#1081 for 210.8(D) updates the language to harmonize the requirements of 210.8(D) and the requirements of 422(5). This will add clarity for both installers and enforcement.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 1081-NFPA 70-2024 [Section No. 210.8(D)]	
Public Comment No. 1081-NFPA 70-2024 [Section No. 210.8(D)]	

Related Item

- PI 1548 PI 195

Submitter Information Verification

Submitter Full Name: Rebekah Hren
Organization: IPPNC LLC
Street Address:
City:
State:

Zip:
Submittal Date: Wed Aug 14 10:01:48 EDT 2024
Committee: NEC-P17

Public Comment No. 1164-NFPA 70-2024 [Section No. 422.5(B)]

(B) Appliances.

The following appliances shall be GFCI protected:

(1) Automotive vacuum machines

(2) Drinking water coolers and bottle fill stations

(3) High pressure spray washing machines

(4) Cord- and plug-connected high-pressure spray washing machines

(5) Tire inflation machines

(6) Vending machines

(7) Sump pumps

(8) Dishwashers

(9) Electric ranges

(10) Wall mounted ovens

(11) Counter mounted cooking units

(12) Clothes washers

(13) Microwave ovens

Informational Note No. 1: See 210.8 for GFCI protection requirements for branch-circuit outlets where covered locations warrant such protection.

Informational Note No. 2: Electrically cooled drinking water fountains are one type of drinking water cooler.

Statement of Problem and Substantiation for Public Comment

Relocating the specific appliances from 210.8(D) to this section will eliminate redundancy in the code.
A companion PC removes the list items from 210.8(D) with a pointer to 422.5.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 1162-NFPA 70-2024 [Section No. 210.8(D)]	
Public Comment No. 1162-NFPA 70-2024 [Section No. 210.8(D)]	

Related Item

• FR-7736, FR-8871

Submitter Information Verification

Submitter Full Name: David Hittinger
Organization: Independent Electrical Contractors
Affiliation: IEC Codes and Standards
Street Address:
City:
State:
Zip:

Submittal Date: Fri Aug 16 10:50:03 EDT 2024
Committee: NEC-P17

Public Comment No. 1275-NFPA 70-2024 [Section No. 422.5(B)]

(B) Appliances.

The following appliances shall be GFCI protected:

(1) Automotive vacuum machines

(2) Drinking water coolers and bottle fill stations

(3) Cord- and plug-connected high-pressure spray washing machines

(4) Tire inflation machines

(5) Vending machines

(6) Sump pumps

(7) Dishwashers

(8) Electric Ranges

(9) Wall-mounted ovens

(10) Counter-mounted cooking units

(11) Clothes dryers

(12) Microwave ovens

Informational Note No. 1: See 210.8 for GFCI protection requirements for branch-circuit outlets where covered locations warrant such protection.

Informational Note No. 2: Electrically cooled drinking water fountains are one type of drinking water cooler.

Statement of Problem and Substantiation for Public Comment

As requested by the Correlating Committee, a task group was created to address the correct location of the technical material currently found in both 210.8(D) and 422.5, with the aim of limiting that content to one location or the other. Unlike the GFCI requirements set forth in 210.8(A), (B), (C), (E), and (F), the requirements in (D) are not driven by physical location. They are specific to appliances, and therefore should reside in the appliance article.

Relocating all the specific appliances from list in 210.8(D) to this section and adding list items 8-12 appliances relocated from 210.8(D) to be included in the list of appliances requiring GFCI protection.

A companion PC removes the list items from 210.8(D) with a pointer to 422.5.

The task group consisted of the following members of Code-Making Panel 2 and Code-Making Panel 17: David Johnson (Chair), Ryan Jackson, Robert DellaValle, Greg Woyczynski, and Larry Wildermuth. The chair appreciates the time and efforts put forth by these individuals.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 1273-NFPA 70-2024 [Section No. 210.8(D)]	PC#1273
Public Comment No. 1273-NFPA 70-2024 [Section No. 210.8(D)]	

Related Item

• FR7736, FR8871

Submitter Information Verification

Submitter Full Name: David Johnson

Organization: CenTex IEC

Affiliation: Tack Group for correlation of 210.8(D) and 422.5.

Street Address:

City:

State:
Zip:
Submittal Date: Mon Aug 19 14:46:08 EDT 2024
Committee: NEC-P17

Public Comment No. 1853-NFPA 70-2024 [Section No. 422.5(B)]

(B) Appliances.

The following appliances shall be GFCI protected:

(1) Automotive vacuum machines

(2) Drinking water coolers and bottle fill stations

(3) Cord- and plug-connected high-pressure spray washing machines

(4) Tire inflation machines

(5) Vending machines

(6) Sump pumps

(7) Dishwashers

(8) Electric Ranges

(9) Wall-mounted ovens

(10) Counter-mounted cooking units

(11) Clothes dryers

(12) Microwave Ovens

Informational Note No. 1: See 210.8 for GFCI protection requirements for branch-circuit outlets where covered locations warrant such protection.

Informational Note No. 2: Electrically cooled drinking water fountains are one type of drinking water cooler.

Statement of Problem and Substantiation for Public Comment

The addition of these appliances to section 422.5 correlates with section 210.8 (D) where these were added for increased life safety by reducing electrocutions. Section 422.5 has a long history of providing GFCI protection for appliances. The addition of these appliances will save lives which is the primary objective of GFCI's.

The correlation between branch circuit electrocution protection and individual appliance electrocution protection allows for maintaining the protections where hazards continue to exist. Here are some current examples https://www.cpsc.gov/Recalls/2017/Following-Plumbers-Death-Electric-Ranges-Recalled-by-Arcelik-AS. There also are numerous clothes dryer electrocution of children plus non-fatal shock hazards, see https://www.yahoo.com/lifestyle/4-year-old-girl-electrocuted-dryer-heres-parents-need-know-175906515.html, https://www.justanswer.com/neurology/moztc-shocked-myself-clothes-dryer-timer-morning-it-s.html, https://www.dallasnews.com/news/2018/07/10/10-year-old-girl-died-rescuing-beloved-kittens-from-behind-a-dryer-in-east-texas-home/, and many others. There have been several shocks and electrocutions tied to microwaves. While most of these involve maintenance or repair activities. Per the Texas department of insurance."..improper use or maintenance of microwaves can cause some dangers, primarily fire or electric shock."

Related Item

• PI 1548 • PI 1770 • PI 3205

Submitter Information Verification

Submitter Full Name: Keith Waters
Organization: Schneider Electric
Street Address:
City:
State:
Zip:

Submittal Date: Tue Aug 27 17:35:40 EDT 2024
Committee: NEC-P17

Public Comment No. 1891-NFPA 70-2024 [Section No. 422.5(B)]

(B) Appliances.

The following appliances shall be GFCI protected:

(1) Automotive vacuum machines

(2) Drinking water coolers and bottle fill stations

(3) Cord- and plug-connected high-pressure spray washing machines

(4) Tire inflation machines

(5) Vending machines

(6) Sump pumps

(7) Dishwashers

<u>Exception No. 1: GFCI protection shall not be required for an electric range, wall-mounted oven, or counter-mounted cooking unit if all the following conditions are met:</u>

<u>a. The appliance is not portable</u>

<u>b. The receptacle is not installed within 1.8m (6 ft) of the top inside edge of the bowl of a sink</u>

<u>c. The receptacle is installed within 1.2m (4 ft) of the appliance enclosure</u>

<u>d. The receptacle is a single receptacle</u>

<u>This exception shall expire January 1, 2028</u>

Informational Note No. 1: See 210.8 for GFCI protection requirements for branch-circuit outlets where covered locations warrant such protection.

Informational Note No. 2: Electrically cooled drinking water fountains are one type of drinking water cooler.

Statement of Problem and Substantiation for Public Comment

AHAM is against expanding the list of appliances until UL standard requirements have been updated to resolve nuisance tripping, including requirements within the UL 943 standard for GFCIs. If additional appliances are not carried over from Chapter 2 to Chapter 4, this PC should be withdrawn. However, if additional appliances are carried over from Chapter 2 to Chapter 4, consumers must be protected from nuisance tripping.

The First Draft allows the use of modernized GFCIs, termed Class A-HF. These modernized GFCIs are not required in the First Draft which means the higher risk of GFCI nuisance tripping remains if the appliance is connected to a non-modernized Class A GFCI.

The code should allow a proactive approach in preventing GFCI nuisance tripping by making an exception for appliances which present a lower risk of shock. This lower risk is achieved through four conditions of acceptability listed in (a.) through (d.) A number of these conditions were added and edited in response to comments provided during the First Draft meetings.

An expiration date was also added in response to comments provided during the First Draft meeting. AHAM hopes that, by 2028, modernization will be required in the UL 943 standard for all Class A GFCIs, not just GFCIs which meet an optional rating.

<u>Related Item</u>

• FR 7788 • PI 1770

Submitter Information Verification

Submitter Full Name: Greg Woyczynski

Organization: Association of Home Appliance

Street Address:

City:

State:

Zip:

Submittal Date: Tue Aug 27 21:18:04 EDT 2024

Committee: NEC-P17

Public Comment No. 1865-NFPA 70-2024 [Section No. 422.5 [Excluding any Sub-Sections]]

GFCI protection shall be provided in accordance with 422.5(A) through 422.5(C). Multiple GFCI devices shall be permitted but shall not be required. The GFCI may be listed and identified as High Frequency (HF).

Statement of Problem and Substantiation for Public Comment

The UL 943 standard for GFCIs is being updated to reduce nuisance tripping on loads which contain modernized electrical components such as LED drivers, switched-mode power supplies, and variable frequency drives.

In the UL 943 preliminary review draft (April 2024), this modernized GFCI was referred to as Class A-HF. The next version of the UL 943 draft (expected Q3/Q4 2024) will change Class A-HF to a High Frequency (HF) rating. Although the name is changing, the underlying technical specifications are not.

This change to the First Draft will better align language in the NEC with the latest language in UL standards work.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 1857-NFPA 70-2024 [Section No. 210.8 [Excluding any Sub-Sections]]	

Related Item

- FR 7788

Submitter Information Verification

Submitter Full Name: Greg Woyczynski
Organization: Association of Home Appliance
Street Address:
City:
State:
Zip:

Submittal Date: Tue Aug 27 18:42:49 EDT 2024
Committee: NEC-P17

Public Comment No. 1595-NFPA 70-2024 [Section No. 422.10]

~~**422.10** Branch Circuits.~~

~~Branch circuits supplying appliances shall comply with 422.10(A) or 422.10(B) .~~

~~**(A)** Individual Branch Circuits.~~

~~Individual branch circuits supplying appliances shall comply with the following as applicable:~~

(1) ~~The ampacities of branch-circuit conductors shall not be less than the marked rating of the appliance or the marked rating of an appliance having combined loads.~~

(2) ~~The ampacities of branch-circuit conductors for motor-operated appliances not having a marked rating shall comply with Article 430 , Part II.~~

(3) ~~The branch-circuit rating for an appliance that is a continuous load, other than a motor-operated appliance, shall not be less than 125 percent of the marked rating, or not less than 100 percent of the marked rating if the branch-circuit device and its assembly are listed for continuous loading at 100 percent of its rating.~~

(4) ~~Branch circuits and branch-circuit conductors for household ranges and cooking appliances shall be permitted to comply with Table 120.55 and be sized in accordance with 210.19(C) .~~

~~**(B)** Branch Circuits Supplying Two or More Loads.~~

~~For branch circuits supplying appliances and other loads, the rating shall be determined in accordance with 210.23 .~~

Statement of Problem and Substantiation for Public Comment

This section is out of scope for Article 422 and already covered as part of Article 210. The scope of Article 422 is "This article covers electrical appliances used in any occupancy." Branch circuit requirements for appliances and motors and other loads are already addressed as part of Article 210.

Related Item

- FR 8838

Submitter Information Verification

Submitter Full Name: Thomas Domitrovich
Organization: Eaton Corporation
Street Address:
City:
State:
Zip:
Submittal Date: Sat Aug 24 13:24:17 EDT 2024
Committee: NEC-P17

Public Comment No. 1598-NFPA 70-2024 [Section No. 422.11]

422.11 Overcurrent Protection.

Appliances shall be protected against overcurrent in accordance with 422.11(A) through 422.11(G) and 422.10.

(A) Branch-Circuit Overcurrent Protection.

~~Branch circuits shall be protected in accordance with 240.4 .~~

If a protective device rating is marked on an appliance, the branch-circuit overcurrent protective device rating shall not exceed that rating.

(B) Household-Type Appliances with Surface Heating Elements.

Household-type appliances with surface heating elements having a maximum demand of more than 60 amperes calculated in accordance with Table 120.55 shall have their power supply subdivided into two or more circuits, each of which shall be provided with overcurrent protection rated at not over 50 amperes.

(C) Infrared Lamp Commercial and Industrial Heating Appliances.

Infrared lamp commercial and industrial heating appliances shall have overcurrent protection not exceeding 50 amperes.

(D) Open-Coil or Exposed Sheathed-Coil Types of Surface Heating Elements in Commercial-Type Heating Appliances.

Open-coil or exposed sheathed-coil types of surface heating elements in commercial-type heating appliances shall be protected by overcurrent protective devices rated at not over 50 amperes.

(E) Single Non-Motor-Operated Appliance.

If the branch circuit supplies a single non-motor-operated appliance, the rating of overcurrent protection shall comply with the following:

(1) Not exceed the overcurrent protection rating marked on the appliance.

(2) Not exceed 20 amperes if the overcurrent protection rating is not marked and the appliance is rated 13.3 amperes or less.

(3) Not exceed 150 percent of the appliance rated current if the overcurrent protection rating is not marked and the appliance is rated over 13.3 amperes. Where 150 percent of the appliance rating does not correspond to a standard overcurrent device ampere rating, the next higher standard rating shall be permitted.

(F) Electric Heating Appliances Employing Resistance-Type Heating Elements Rated More Than 48 Amperes.

(1) Electric Heating Appliances.

Electric heating appliances employing resistance-type heating elements rated more than 48 amperes, other than household appliances with surface heating elements covered by 422.11(B), and commercial-type heating appliances covered by 422.11(D), shall have the heating elements subdivided. Each subdivided load shall not exceed 48 amperes, and each subdivided load shall be protected at not more than 60 amperes.

These supplementary overcurrent protective devices shall be (1) factory-installed within or on the heater enclosure or provided as a separate assembly by the heater manufacturer; (2) accessible; and (3) suitable for branch-circuit protection.

The main conductors supplying these overcurrent protective devices shall be considered branch-circuit conductors.

(2) Commercial Kitchen and Cooking Appliances.

Commercial kitchen and cooking appliances using sheathed-type heating elements not covered in 422.11(D) shall be permitted to be subdivided into circuits not exceeding 120 amperes and protected at not more than 150 amperes where one of the following is met:

(1) Elements are integral with and enclosed within a cooking surface.

(2) Elements are completely contained within an enclosure identified as suitable for this use.

(3) Elements are contained within an ASME-rated and stamped vessel.

(3) Water Heaters and Steam Boilers.

Resistance-type immersion electric heating elements shall be permitted to be subdivided into circuits not exceeding 120 amperes and protected at not more than 150 amperes as follows:

(1) Where contained in ASME-rated and stamped vessels

(2) Where included in listed instantaneous water heaters

(3) Where installed in low-pressure water heater tanks or open-outlet water heater vessels

Informational Note: See IEC 60335-2-21, *Household and similar electrical appliances — Safety — Particular requirements for storage water heaters*, for information on low-pressure and open-outlet heaters are atmospheric pressure water heaters

(G) Motor-Operated Appliances.

Motors of motor-operated appliances shall be provided with overload protection in accordance with Article 430, Part III. Hermetic refrigerant motor-compressors in air-conditioning or refrigerating equipment shall be provided with overload protection in accordance with Article 440, Part VI. Where appliance overcurrent protective devices that are separate from the appliance are required, data for selection of these devices shall be marked on the appliance. The minimum marking shall be that specified in 430.7 and 440.4.

Statement of Problem and Substantiation for Public Comment

Branch circuit requirements for protection of branch circuits are not in the scope of Article 422. This change ensures the proper sections are all addressed as appropriate elsewhere in this code. the scope of Article 422 reminds us that this article only applies to electrical appliances. "This article covers electrical appliances used in any occupancy."

Related Item

- FR 8877

Submitter Information Verification

Submitter Full Name: Thomas Domitrovich

Organization: Eaton Corporation

Street Address:

City:

State:

Zip:

Submittal Date: Sat Aug 24 13:31:08 EDT 2024

Committee: NEC-P17

Public Comment No. 1443-NFPA 70-2024 [Section No. 422.18(A)]

(A) Support.

Ceiling-suspended (paddle) fans shall be supported independently of an outlet box or by one of the following:

(1) A listed outlet box or listed outlet box system identified for fan support installed in accordance with 314.27(B)

(2) A listed outlet box system, a listed weight-supporting ceiling receptacle (WSCR) , and a compatible factory-installed weight-supporting attachment fitting (WSAF) that is installed in accordance with 314.27(E)

(3) Exception: In bedrooms of one- and two-family dwellings, ceiling-suspended (paddle) fans shall be supported in accordance with both the following: (1) A listed outlet box or listed outlet box system identified for fan support installed in accordance with 314..27(C) (2) A listed outlet box system, a listed WSCR, and a compatible factory installed WSAF that is installed in accordance with 314.27(E).

(4) This exception shall become effective on January 1, 2029.

Additional Proposed Changes

File Name	Description	Approved
SKYX_Final_Report_20240828.pdf	Supporting Material SKYX Final Report	

Statement of Problem and Substantiation for Public Comment

The only change in this PC is to modify (A)(2) and add an effective date. The PC only addresses ceiling-suspended (paddle) fan installation in new construction or a significant remodel; there are no retroactive requirements. Additionally, a letter of compliance was provided to NFPA to satisfy the ANSI/NFPA Essential Patent Requirements; if the mandatory use of the WSCR is approved in the NEC-2026, SKYX Platforms will agree to license the WSCR for no licensing fee.

Based on prior Panel feedback, a standard NEMA configuration was attained and published in ANSI/NEMA WD 6, "American National Standard for Wiring Devices - Dimensional Specifications." The WSCR for ceiling-suspended (paddle) fans is keyed so that it will only accept the WSAF for ceiling fans. The WSCR for ceiling fans is a more robust receptacle, which is designed to support up to 70-pounds and the vibration from the dynamic load of a fan.

In the panel statement, it was acknowledged that "…these devices may improve safety and ease of installation…", but didn't want to "…restrict other options which are still in use and supported by manufacturers…" The WSCR has been determined to be compatible with all known ceiling outlet boxes. Additionally, an effective date was added to allow time for implementation by the industry, including depleting current inventory or inventory retrofitting. The panel statement indicated that mandated WSCR would restrict the options for installation. Currently, there are two options: traditional and the WSCR. In the new study detailed below, the WSCR has been proven to be a safer installation method; as a result, there should just be one option for new construction. If the requirement for the use of WSCRs for ceiling fans is accepted, SKYX Platforms will agree to license the WSCR for no licensing fee; all manufacturers would have access for use.

The Panel noted that the use of the WSCR "…may improve safety and ease of installation…". The NEC is the minimum electrical safety standard. If there are new technologies available to improve safety, they should be adopted as mandatory. For example, GFCI, AFCI, and tamper-resistant receptacles were new technologies to improve safety and are now mandated.

NEW STUDY: LADDER USE DURING INSTALLATIONS. To further quantify how much safer and easier the ceiling fan installation with the WSCR when compared to the traditional ceiling fan installation, a study with a 3rd party was commissioned to review factors that contribute to the severity of hazards during installation.

Although the study was completed using luminaires, it is reasonable to extrapolate the study results for the installation of ceiling fans. With more overhead work time and greater average fan weight, the safety improvement when using the WSCR versus traditional installation would be even more significant.

There were three installation types that were examined in this study: a) traditional to traditional, b) convert traditional to WSCR/WSAF and c) replacing existing luminaire with a WSAF to a new luminaire with WSAF. All luminaires were assembled prior to installation. The study conducted by Dr. Erika M. Pliner, PhD and Kurt E. Beschorner, PhD is attached and the major conclusions follow.

1. The more time on the ladder, the more risk for a fall or injury. The study found the average installation time on the ladder is 20 minutes for a) traditional, less than 4 minutes to b) convert from traditional to WSCR/WSAF, and less than a half minute for c) replacing an existing WSAF luminaire.
2. Time holding the luminaire during installation was examined. The study found a holding time of 1.33 minutes for a) traditional to traditional [when using a cross-bar to temporarily support the luminaire], 0.76 minutes [43% reduction in time] for b) traditional to WSCR, and 0.22 minutes [83% reduction from traditional] for a c) replacement of a new luminaire with

WSAF. For conditions b) and c), a temporary support for the luminaire is not necessary.
3. Time on the ladder that required the installer's shoulder(s) to be raised 90 degrees or more during the uninstallation and installation of a light fixture was examined. The average raised shoulder time for a) traditional installation to traditional installation is 13 minutes, 2.04 minutes for b) traditional to WSCR, and less than a minute for a c) replacement of a luminaire with WSAF
A reduced time on the ladder reduces the risk of a fall and injury. While on the ladder and performing multiple tasks, the risk of fall and injury is increased. If the WSCR is installed during construction, the installer never needs to touch the wires and be exposed to a shock hazard. With the WSCR, the inspector can easily confirm proper wiring through the use of a circuit tester, which could eliminate the need for an inspector to use a ladder.

Falls are a leading cause of injuries based on CDC data. Reducing fall hazards has been a major educational goal of OSHA for many years. Simplifying the task that needs to be performed on a ladder (which also reduces the time spent on a ladder) has been shown to greatly minimize the fall hazard. Multi-tasking while on a ladder contributes to the likelihood of falling. Clearly this applies to a traditional ceiling fan installation with many steps. Weight and off-set balance factors contribute to the fall hazard. The installer must not only balance himself but also the ceiling fan while on a ladder.

According to Pliner et al, a longer time to complete the task resulted in poorer performance in accomplishing the task and increased ladder fall risk exposure. This research involved older individuals, which reflects the aging population of the skilled electrical industry. In Pliner's 2020 doctoral dissertation study, it was clear that multi-tasking negatively affected task completion time.

Additionally, there are instances documented in the CPSC database of parts or entire ceiling fans falling, as well as the installers themselves falling.

NEW CONSTRUCTION INSTALLATION. The installer is wiring a 3-ounce fan WSCR into the ceiling versus the traditional wiring while supporting the weight and balancing the fan. On average, ceiling fans weigh 18 pounds. The simplified wiring minimizes the potential for injury from either falling or electric shock. With the WSCR, the inspector can easily confirm proper wiring through the use of a circuit tester, which could eliminate the need for an inspector to use a ladder.

FUTURE CEILING FAN INSTALLATION OR REPLACEMENT. With the WSCR already being installed in the ceiling, the ceiling fan is plug-and-play. This feature is convenient for the installer, as the ceiling fan can be installed at a later date.

In the past, televisions and many appliances were hardwired; imagine having to rewire whenever the appliance needs to be moved or replaced. Microwave ovens and toaster ovens likely wouldn't be as popular today if they were hardwired. These examples illustrate the importance of making the WSCR/WSAF mandatory. Hardwiring limits consumer flexibility to change decor and devices. When looking around the home, most electrical equipment is plug and play, except ceiling luminaires and ceiling fans.

DATA TO SUBSTANTIATE. A significant amount of information was collected and analyzed and was provided during the First Draft stage, including information from the U.S. Census Bureau, OSHA, NIOSH, CPSC, and CDC.

According to OSHA, falls are the leading cause of death in construction (see https://www.osha.gov/stop-falls), The use of ladders cannot be eliminated, but the simplified installation will reduce the time spent on ladders. It will also eliminate the need to juggle fixtures, while trying to make electrical connections. By engineering out the hazard, the human factors contributing to injuries or deaths are mitigated. The proposed changes to this section increase safety for the initial installation and for future exchanges of luminaires or ceiling-suspended (paddle) fans in one- and two-family dwellings. OSHA reports point to two professional electricians' deaths that potentially could've been prevented by the use of WSCR. See the following links: https://www.osha.gov/pls/imis/establishment.inspection_detail?id=18396960
https://www.osha.gov/pls/imis/establishment.inspection_detail?id=314163627 According to the

According to the American Ladder Institute, as published on February 15, 2018 on the ANSI Blog: https://blog.ansi.org/ali/common-causes-ladder-incidents/?amp=1, the number 3 cause of ladder incidents is overreaching while on the ladder. This is common when installing ceiling fans.

The CPSC's National Electronic Injury Surveillance System (NEISS) contains numerous incidents involving injuries from ceiling fans which was provided during the First Draft.

The document entitled "Relevant Incidents involving Ceiling (Paddle) Fans 2022-2013" reports on incidents where patient care was provided by one of those 96 hospitals. It is important to note that these incidents likely injuries caused by a falling fan. This is because NEISS reports on injuries caused by consumer products. Falls are the most common of all injuries, but Incidents that occurred from falls during installation may not show up in this report, because they were not caused by the fan or luminaire. They were cause by a ladder safety issue.

Additionally, there are instances documented in the CPSC database of parts or entire ceiling fans falling, as well as the installers themselves falling.

Many of the incidents involving ceiling fans are the result of improperly installed fans that have fallen on occupants. The WSCR for ceiling fans provides a safe and robust installation that includes a double-locking mechanism, along with an additional locking bracket to provide protection from the dynamic forces from the spinning fan motor.

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Related Item

- PI 2484

Submitter Information Verification

Submitter Full Name:	Patricia Barron
Organization:	SKYX Platforms
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Thu Aug 22 18:40:18 EDT 2024
Committee:	NEC-P17

Consulting Report

Time Analysis of Ceiling Light Fixture Installation: Influence of Plug-in Solutions

Prepared by:

Erika M Pliner, PhD
Kurt E Beschorner, PhD

Presented for:
SKYX Platforms Corp.

August 28th 2024

Erika M Pliner, PhD
empliner@gmail.com
(920) 328-8546

Kurt E Beschorner, PhD
kurt.beschorner@gmail.com
(412) 680-5495

Table of Contents

Team Expertise

Dr. Erika Pliner is an Assistant Professor in Mechanical Engineering at the University of Utah. She obtained her PhD in Bioengineering at the University of Pittsburgh with a specialization in whole-body biomechanics. In addition, she completed postdoctoral training in neuromechanics and physiology. She obtained her BS and MS in Mechanical Engineering at the University of Wisconsin-Milwaukee. Dr. Pliner's research applies core competencies on biomechanics, ergonomics and neuroscience to improve personal and occupational safety. She has designed and conducted multiple ladder safety research studies, identifying individual, environmental, and biomechanical risk factors of ladder falls in the occupational and domestic setting. She is the primary instructor of the Ergonomics and Occupational Biomechanics courses at the University of Utah.

Dr. Kurt Beschorner is an Associate Professor in Bioengineering at the University of Pittsburgh. He has specialized in fall prevention using methods of mechanics, understanding of humans and their motion, and ergonomics. He has led several projects to identify contributing factors of falling considering ladder design, individual risk factors, shoes, and flooring. He also is the Chief Executive Manager of Tread Traction Technologies, LLC where he works with companies to develop products that reduce falling risk. In this role, he has worked directly with footwear and walking surface companies to improve product design in ways that reduce fall risk. During this project, he operated in his role at Tread Traction Technologies, LLC and not through his position at the University of Pittsburgh.

Motivation

The installation of ceiling light fixtures subjects the worker or homeowner to risk of a ladder fall injury and musculoskeletal disorders.

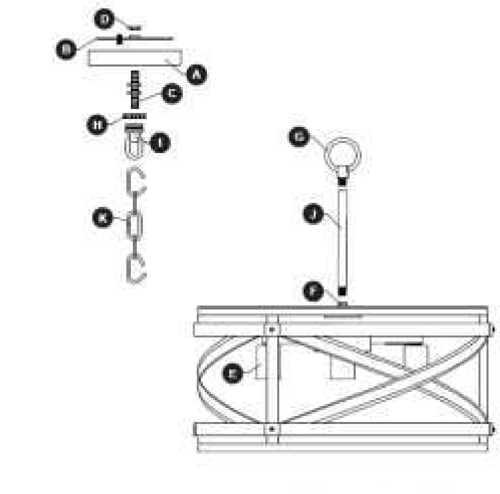
The hazardous nature of ladder use is supported by injury records among occupational workers and emergency department visits. Annually, ladders are the primary source to over 136,000 injuries requiring emergency care (D'Souza, Smith and Trifiletti 2007). In addition, ladders are the leading cause of fatality among work-related falls from a height (Bureau of Labor Statistics 2016). Ladder use is a common task among homebuilders, contractors, and homeowners that should be carefully managed and therefore has been the subject of regulation. Minimizing worker fatigue and ladder use exposure can reduce injury risk by improving balance control and limiting the opportunity for a fall, respectively. For example, ladder fall injury records of workers revealed the time to ladder fall injury was further delayed (indicating lower risk) among works who had longer accumulative rest breaks (Arlinghaus, Lombardi et al. 2012), which suggests the relevance of both fatigue and exposure to fall risk. Faster task completion times for ladder use tasks has been argued to reduce ladder fall risk in other peer-reviewed studies (Pliner, Sturnieks and Lord 2020, Pliner, Sturnieks et al. 2021). New consumer ladder-related products may achieve reduced fall risk if they enhance the efficiency of ladder work tasks and reduce the time spent on a ladder.

The installation of ceiling light fixtures requires overhead arm postures, upper limb effort to support the fixture, bimanual motor control. Overhead arm postures subject tissues in the upper extremities to additional strain during shoulder flexion and abduction (upper arm elevated above 90°). Individual strength is reduced in shoulder flexion and abduction (Stobbe 1982), leading to earlier fatigue (Chaffin 1973). Prolonged exertion, as can occur when holding a light fixture during installation, further exacerbate individual fatigue and pain (Caldwell and Smith 1966). The bimanual motor control during installation of a light fixture (e.g. wiring) hastens fatigue due to the increase in muscle activity that is required for precise actions (i.e. muscle co-contraction). The additive strenuous demands of ceiling light installation (i.e. overhead arm posture, fixture load, motor control) expose the worker or homeowner to a risk for musculoskeletal disorders. Repeated exposure of this type of task can lead to permanent functional disability (Johansson and Sojka 1991). New consumer products that reduce the time of these strenuous demands during ceiling fixture installation are expected to reduce the risk of musculoskeletal disorder.

Purpose

The objective of this project was to conduct a time analysis of ceiling light fixture installation between a traditional installation method and a novel installation method with new consumer products (Figure 1). The new consumer products comprised a weight support ceiling receptacle (WSCR) and weight-supporting attachment fitting (WSAF). The time analysis comprised four task-based measures, quantifying the 1) time on the ladder, 2) time the arm elevated above 90°, 3) time holding the fixture, and 4) the number of dropped items. Longer time durations in these task-based measures are associated with increased injury risk due to a fall from a ladder, user fatigue and musculoskeletal disorder. In particular, task-based measure 1 (time on the ladder) is directly related to fall risk and task-based measures 2 (time the arm elevated above 90°) and 3 (time holing fixture) are directly related to fatigue. Because fatigue is related to fall risk, task-based measures 2 and 3 are also related to fall risk. Task-based measure 4 (number of dropped items) is a performance metric related to mistakes where more dropped items indicate poorer performance in completing the fixture-changing task.

(a)



PART	DESCRIPTION	QTY.
A	Canopy	1
B	Mounting Bracket	1
C	Threaded Nipple	1
D	Hex Nut	3
E	Socket	3
F	Coupling	1

PART	DESCRIPTION	QTY.
G	Fixture Loop	1
H	Screw Collar Ring	1
I	Screw Collar Loop	1
J	Threaded Pipe	1
K	Chain	1

(b)

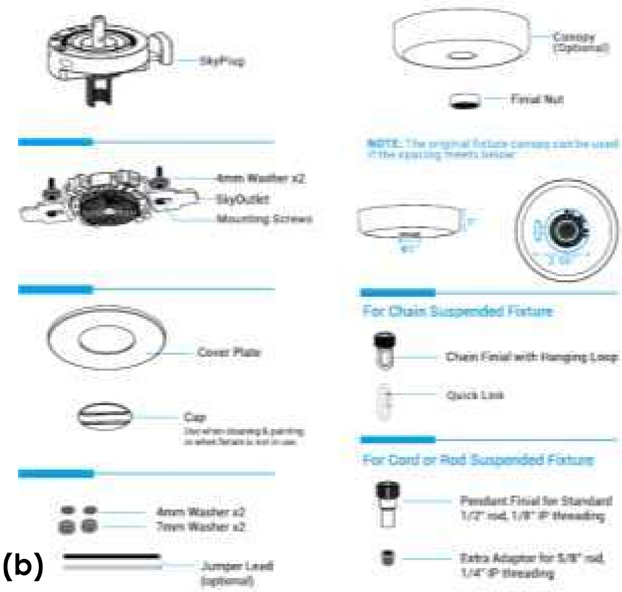


Figure 1: Diagram fo parts for a standard (a) and a novel (b) ceiling light fixture installation.

Methods

Participants

Ten adults [8 men; 2 women; mean (standard deviation) height: 1.78 (0.01) m] were recruited to complete replacement of a ceiling light fixture (referred to hereafter as users). Users were novice to light fixture installation with do-it-yourself project experience.

Data Collection

All users completed three light fixture changing trials. Each trial comprised uninstallation and installation of a light fixture. Three uninstallation/installation conditions were presented in randomized order (order of presentation in Appendix A):

Traditional to Traditional – The standard method to uninstall and install a light fixture (Figure 1a).

Traditional to WSCR/WSAF – The standard method to uninstall a light fixture (Figure 1a), installation of the weight support ceiling receptacle (WSCR), and installation of the light fixture with the weight-supporting attachment fitting (WSAF) (Figure 1b).

WSAF to WSAF – Uninstallation and installation of a light fixture with a weight-supporting attachment fitting (WSAF) (Figure 1b).

The same chain light fixture was used in all conditions (Appendix B; Kichler Lighting LLC, Solon, OH). The diameter (18.5 inches) and weight (10.0 lbs.) of this light fixture fell within one standard deviation of the mean diameter and weight of commercially available light fixtures (Appendix C). Installation instructions were provided for the traditional and novel installation methods (Appendix D-F). To complete the light fixture changing tasks, users climbed a 6-foot fiberglass step ladder with a 250 lbs. load capacity (Werner Co., Itasca, IL). Placement of the ladder was fixed by the project coordinators. The ladder was placed in a location that minimized overreach during the uninstallation/installation task for the average user. Users were provided with non-powered tools to complete the task.

Users were asked to rest for 2-minutes between each uninstallation/installation phase and trial. The **Traditional to Traditional** and **WSAF to WSAF** conditions comprised two phases: uninstallation and installation. The **Traditional to WSCR/WSAF** condition comprised three phases: uninstallation, installation of WSCR, and installation.

Video recordings were captured for each trial. The sagittal plane (side view) of the users completing the task was captured. The spatial resolution of this view captured the user, light fixture and ladder. The temporal resolution of the video was captured at 60 frames per second (60 Hz).

Data Analysis

Video data was post-processed in commercial video editing software to permit frame-by-frame analysis (Adobe Premiere Pro, San Jose, CA). Onset, offset and occurrence of task-based measures were denoted along the video timeline via 'Markers' (marker is defined in this report as an event occurring at a specific time). All 'Markers' were assessed by single biomechanist (i.e. a human-movement expert) to promote consistency and accuracy across users and conditions. Specifics defining each time-based measure are as follows:

Time on the ladder (Figure 2, green marker) – from first foot onset with the ladder to last foot offset with the ladder.

Figure 2: Green marker denoting ladder onset, ‘LADDER_ON’. Ladder offset denoted as ‘LADDER_OFF’.

Time the arm above 90° (Figure 3, orange marker) – movement analysis of the left arm. From when the arm displayed visual shoulder flexion or abduction greater than 90°.

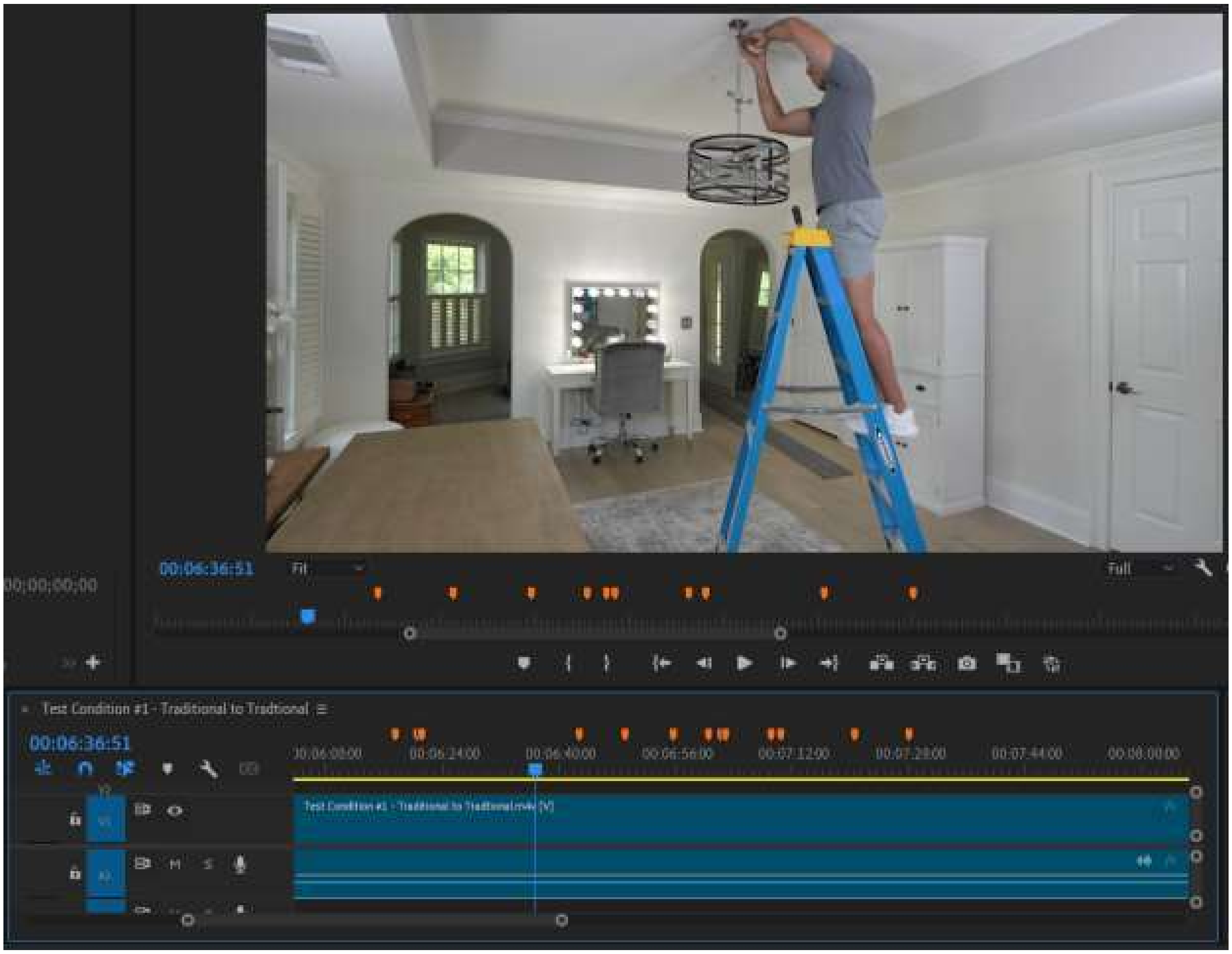


Figure 3: Orange marker denoting left arm above 90° onset, ‘SHO_90_ON’. Arm above 90° offset denoted as ‘SHO_90_OFF’.

Time holding the fixture (Figure 4, purple marker) – from loading one or both of the upper arms with the weight of the light fixture to off-loading the weight of the light fixture.

Figure 4: Purple marker denoting fixture load onset, 'FIXTURE_LOAD_ON'. Fixture load offset denoted as 'FIXTURE_LOAD_OFF'.

Dropped items (Figure 5, yellow marker) – occurrence of an item (e.g. tool, wire cap, light fixture) unintentionally dropping.

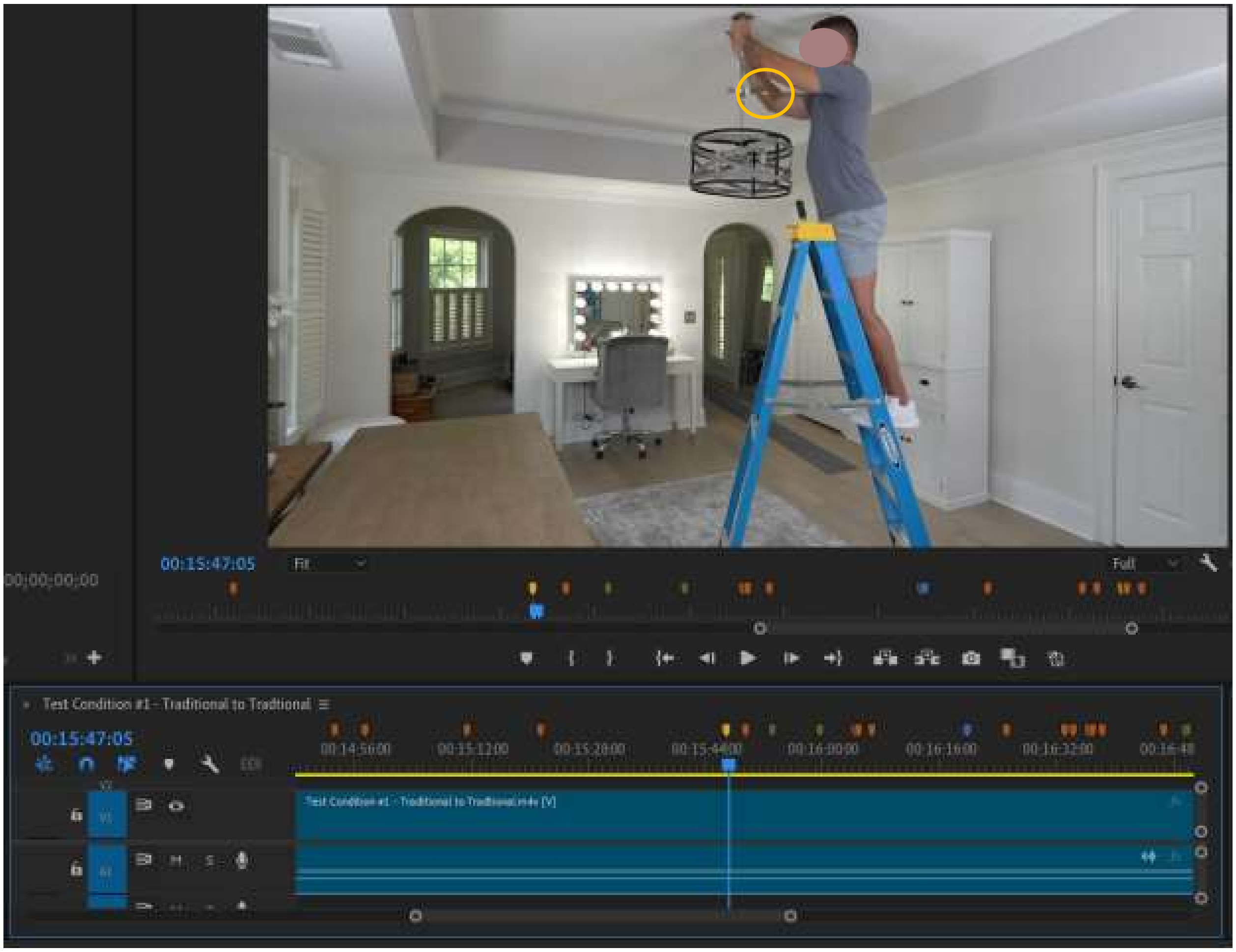


Figure 5: Yellow marker denoting occurrence of a dropped item, 'PART_DROP'.

End of uninstallation (Figure 6, white marker) – occurrence of the conclusion of the uninstallation phase.

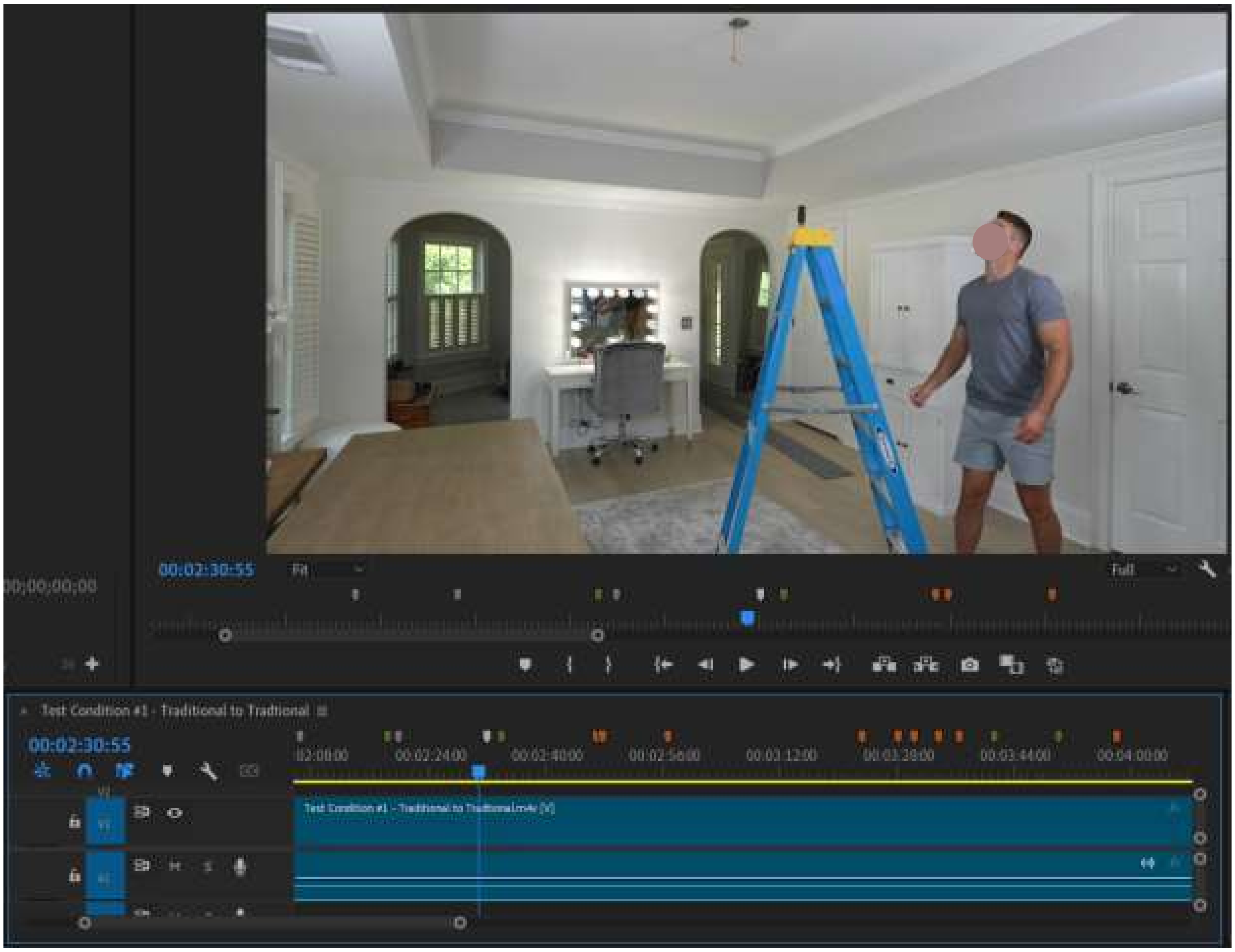


Figure 6: White marker denoting occurrence of the end of uninstallation, 'END_OF_UNINSTALL'. End of WSCR installation denoted as 'END_OF_SKYX_INSTALL'.

End of WSCR installation (Figure 6, white marker) - occurrence of the conclusion of the WSCR installation phase.

Onsets, offsets and occurrence of markers were exported from Adobe Premiere Pro to a comma separated values (CSV) spreadsheet. The duration of timing events was quantified between onsets and offsets. The sum of timing durations and the sum of dropped item occurrences was calculated. Total summed time and occurrence of task-based measures were calculated for each user, condition and phase.

Statistical Analysis

To assess time differences of task-based measures between traditional and novel light fixture installation methods, one-way ANOVAs were performed on time-based measures with condition as the predictor variables. If condition was found to be significant, a Tukey's Honestly Significant Difference (HSD) post-hoc test was performed to assess which groups differed. To meet the assumptions of the parametric statistical analyses, natural logarithmic transformations were performed on task-based measures to achieve a normal data distribution. The occurrence of dropped items was not prevalent across all conditions to be tested statistically. We expect the **Traditional to Traditional** installation method to result in the longest time durations and most dropped item occurrences.

To confirm validity in the research design of this project, paired t-tests were performed on time-base measures (time on ladder, time holding fixture, time arm above 90°) within the uninstallation and installation phases between the **Traditional to Traditional** and **Traditional to WSCR/WSAF** conditions and **Traditional to WSCR/WSAF** and **WSAF to WSAF** conditions, respectively. We expected the null hypothesis to not be rejected in these tests due to task requirements being identical in these phases (i.e. both uninstalling a light fixture with the traditional method and both installing a light fixture with the novel method). Confirming these outcomes would suggests appropriate randomization in this project's study design.

Results

Results by Condition

The **Traditional to Traditional** condition resulted in a significantly greater time on the ladder ($F_{2,27}=1034$; $p<0.001$) (Figure 7), arm time above 90° ($F_{2,27}=392$; $p<0.001$) (Figure 8), and time holding the light fixture ($F_{2,27}=34$; $p<0.001$) (Figure 9) than the other two conditions. The **WSAF to WSAF** resulted in significantly less time on the ladder and arm time above 90° than the **Traditional to WSCR/WSAF** condition. The occurrence of dropped items was nearly exclusive to the **Traditional to Traditional** condition (Figure 10). The size of these effects was large. The time on ladder was over 20 minutes for the **Traditional to Traditional** condition but was less than 5 minutes for the **Traditional to WSCF/WSAF** and under 1 minute for the **WSAF to WSAF** condition. Thus, the presence of the ceiling receptacle reduces the time on the ladder by more than 90% (**WSAF to WSAF** compared to **Traditional to Traditional**). Furthermore, the time with an arm elevated above 90° was reduced from about 13 minutes for the **Traditional to Traditional** condition to under 3 minutes when converting from a **Traditional to WSCF/WSAF** and under 1 minutes for a **WSAF to WSAF** installation. The time holding the light fixture was also markedly reduced albeit a smaller effect than the other two assessed time metrics. The user spent nearly 2 minutes holding the fixture in the **Traditional to Traditional** condition, which was reduced to under 1 minute in the **Traditional to WSCF/WSAF** and under half a minute in the **WSAF to WSAF** condition. Lastly, the average user dropped between 2 and 3 objects during **Traditional to Traditional** condition but these instances were rare for the other two installation conditions (Figure 10).

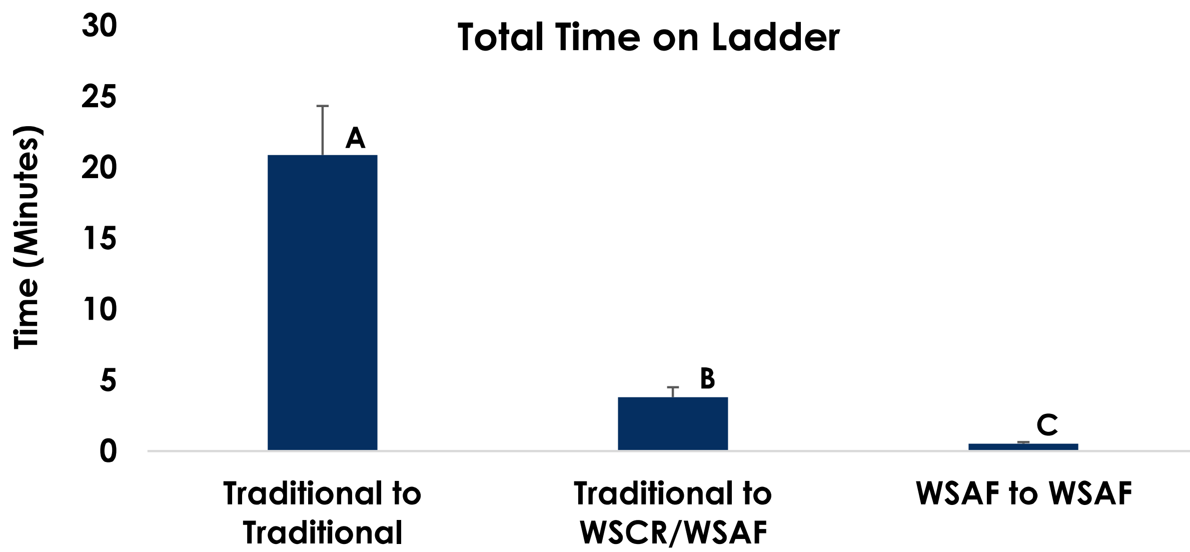


Figure 7: The average total time users spent on the ladder for each uninstallation/installation condition. Error bars denote the standard deviation. Non-matching letters denote groups that are statistically different from one another.

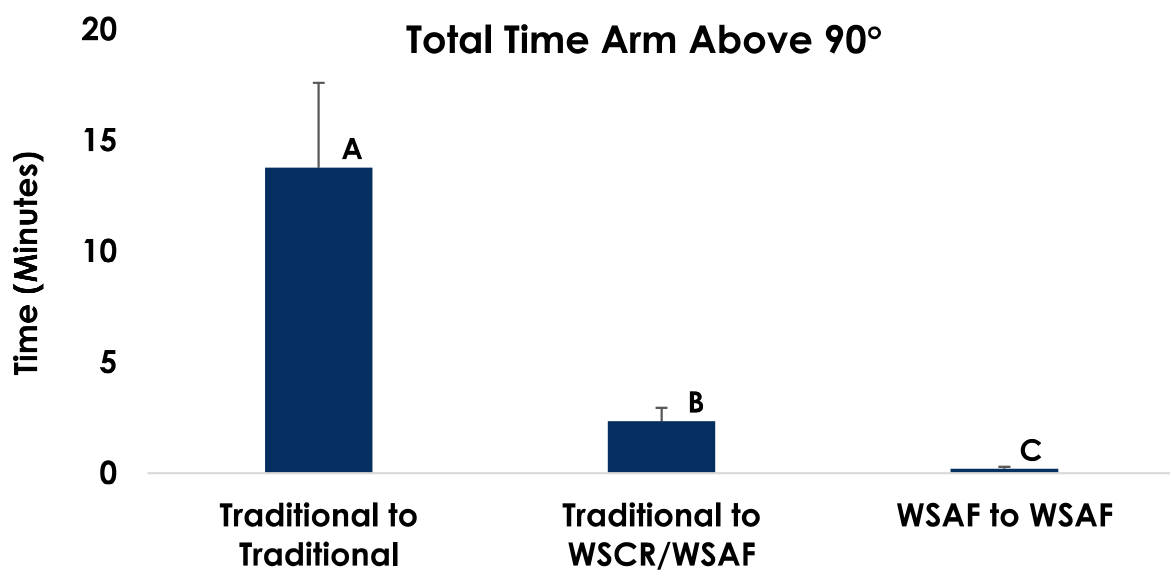


Figure 8: The average total time users had their arm above 90° for each uninstallation/installation condition. Error bars denote the standard deviation. Non-matching letters denote groups that are statistically different from one another.

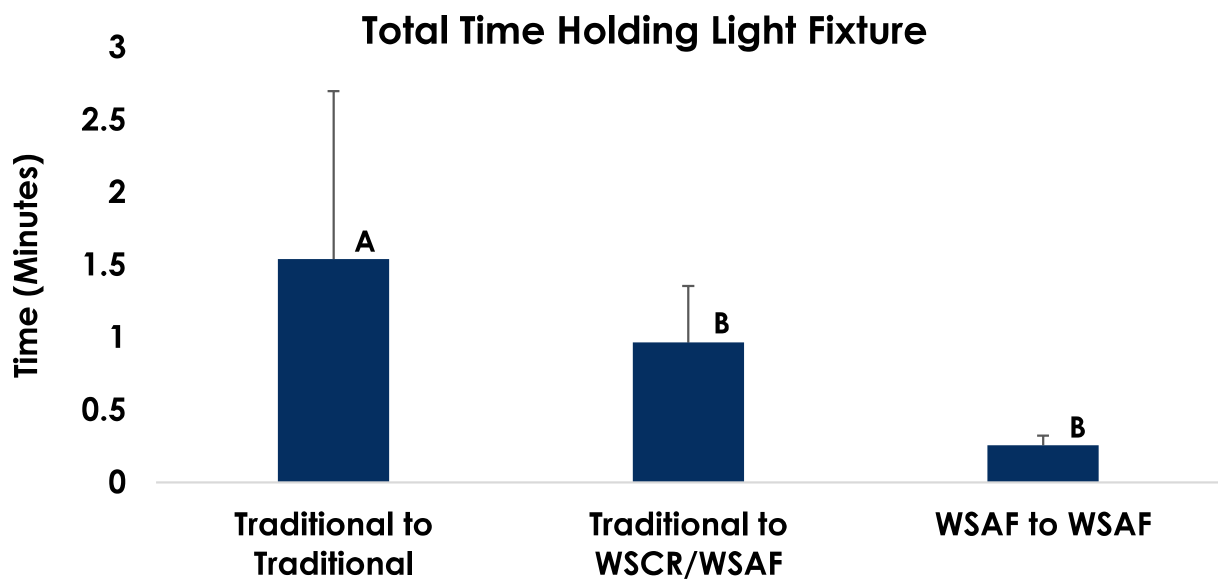


Figure 9: The average total time users were holding the light fixture for each uninstallation/installation condition. Error bars denote the standard deviation. Non-matching letters denote groups that are statistically different from one another.

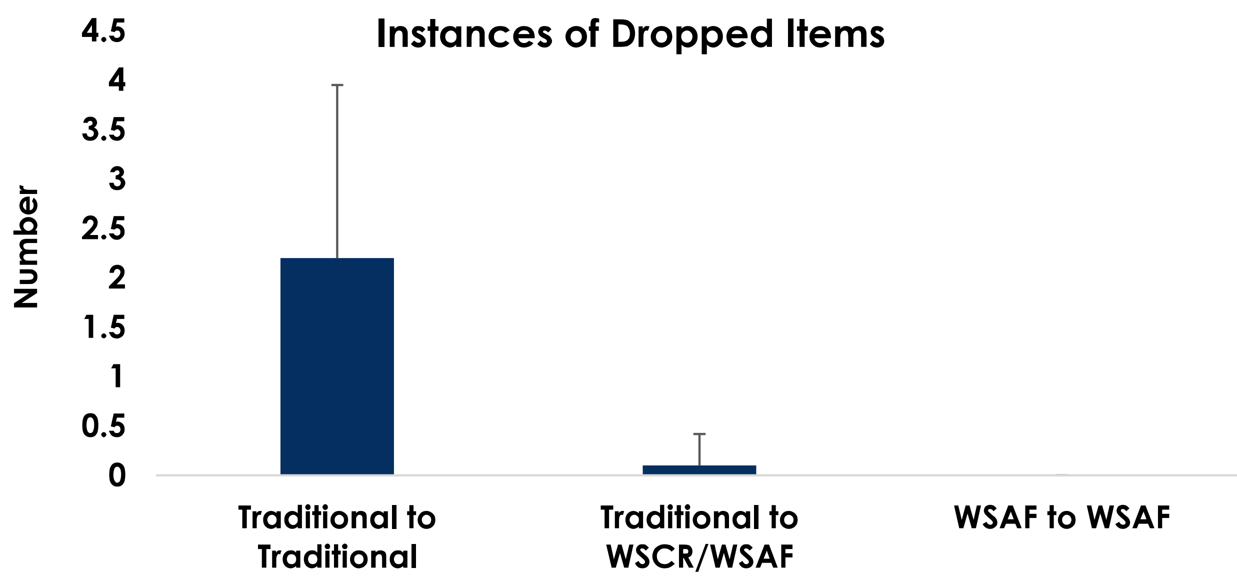
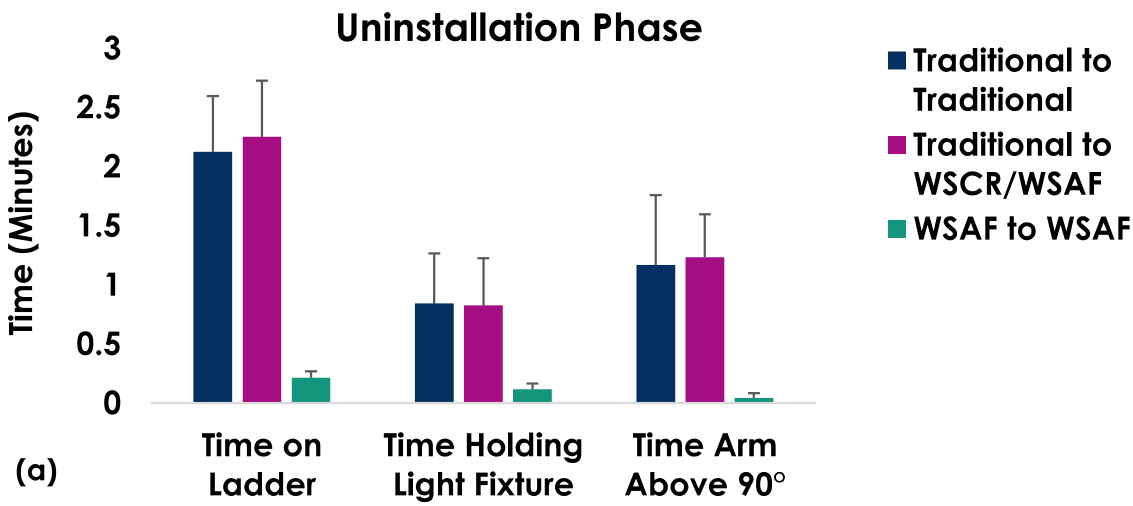


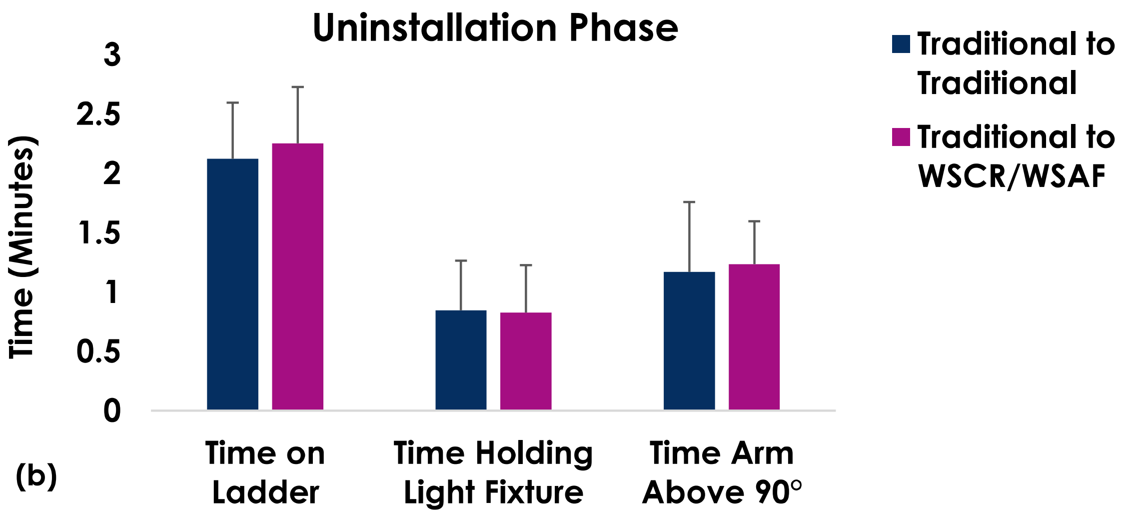
Figure 10: The average total number of dropped items for each uninstallation/installation condition. Error bars denote the standard deviation. Note: no items were dropped during the WSAF to WSAF condition for all users in the project.

Results by Phase

There was no significant differences in time on ladder, time holding the fixture, and arm time above 90° during the uninstallation phase between the **Traditional to Traditional** and **Traditional to WSCR/WSAF** condition (Figure 11). Similarly, there was no significant differences in time on ladder, time holding the fixture, and arm time above 90° during the installation phase between the **Traditional to WSCR/WSAF** and **WSAF to WSAF** condition (Figure 12). Users were on the ladder for about 1 minute and had their arm above 90° for less than 1 minute during the WSCR installation phase (Figure 13). Users were not exposed to addition fixture holding time during the WSCR installation phase.



(a)



(b)

Figure 11: The average total time users spent on the ladder, time holding light fixture and time arm above 90° for each uninstallation phase all three conditions (a) and only two of the conditions (b, conditions that required a traditional uninstallation). Error bars denote the standard deviation.

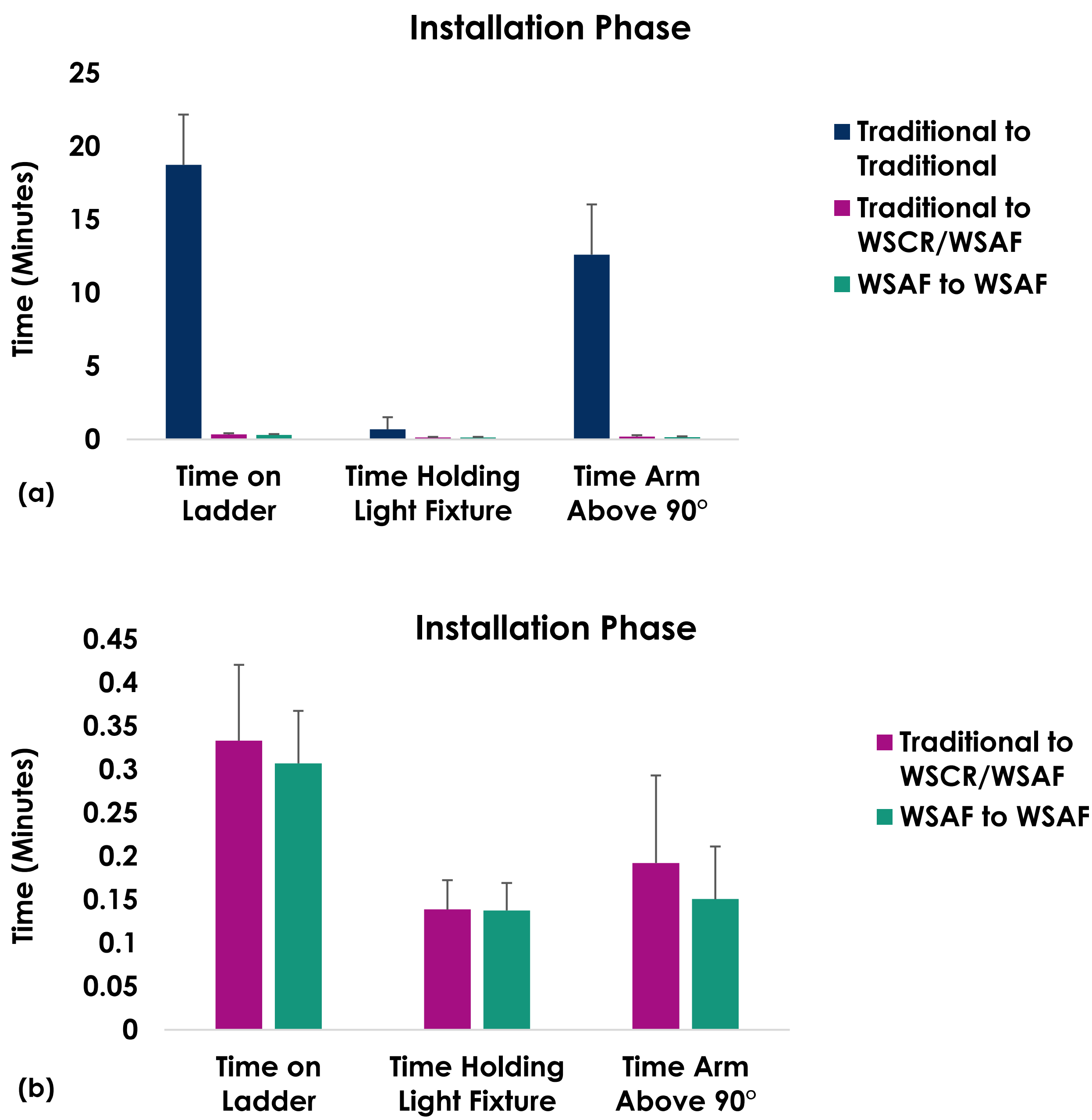


Figure 12: The average total time users spent on the ladder, time holding light fixture and time arm above 90° for each installation phase all three conditions (a) and only two of the conditions (b, conditions that required a novel installation). Error bars denote the standard deviation.

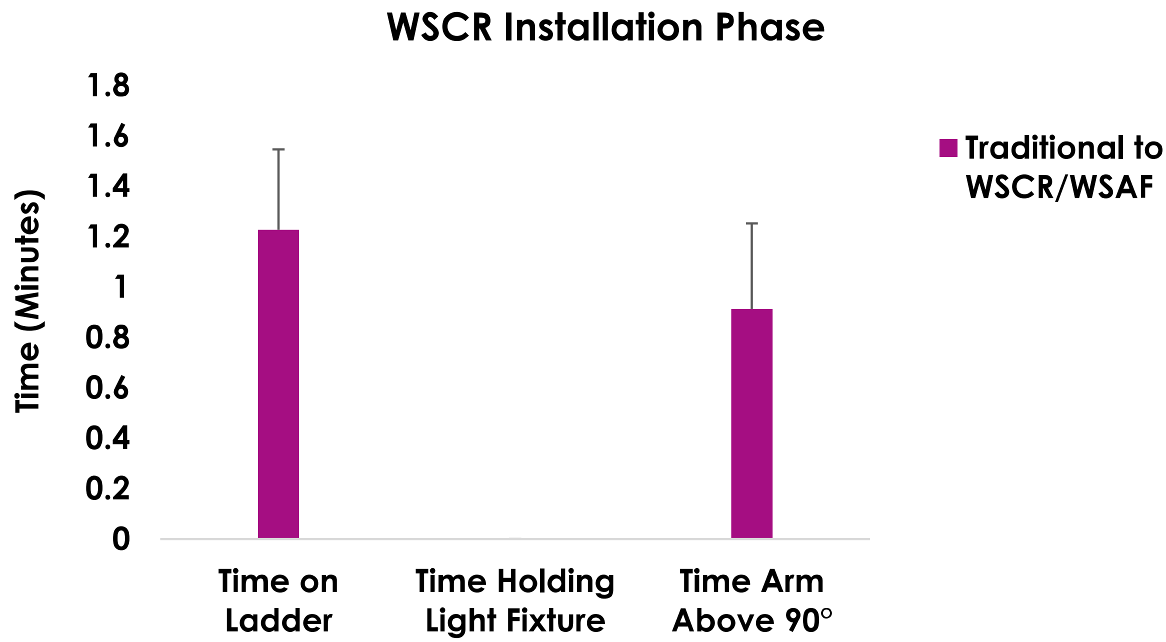


Figure 13: The average total time users spent on the ladder, time holding light fixture and time arm above 90° for the WSCR installation phase for the traditional to WSCR/WSAF condition (the only condition with this phase). During this phase, there was no need for the user to hold the light fixture (no values). Error bars denote the standard deviation.

Interpretation of Results

This analysis determined that a weight-supporting plug-in attachment significantly reduces the time of hazardous and strenuous activities that are associated with light fixture installation and improves performance when considering all metrics that were considered in this study. Notably, the study revealed progressive improvements from a traditional light fixture replacement (**Traditional to Traditional** where a weight-supporting plug-in attachment was not used) to the installation and use of a weight-supporting plug-in attachment (**Traditional to WSCR/WSAF**) and then further improvement when replacing a fixture where the weight-supporting plug-in attachment was already installed (**WSAF to WSAF**). Given these results, the use of weight-supporting plug-in attachments are expected to reduce fatigue and upper extremity musculoskeletal injury risk (through reduced time spent with the arms elevated and reduced time spent holding the fixture). Furthermore, the use of these attachments are anticipated to reduce ladder fall risk compared to changing of light fixture without these attachments through a major reduction in time spent on the ladder and by reducing the impacts of fatigue. The high occurrence of dropped items suggests that performance is enhanced by these attachments. Dropped items could lead to lost components during installation, which potentially exposes the user to injury risk (if they move abruptly on the ladder in an attempt to catch the falling object or in the case of dropping a large object like the fixture), and may require to complete additional corrective actions such as descending the ladder to retrieve a lost item and then repeating the task that was being conducted when it was dropped.

The analysis described in this report does not address all aspects of safety that may be relevant to light fixture installation. For example, several aspects of ladder fall risk were not considered including the weight distribution on the ladder (i.e., center of pressure) and its impact on tipping of the ladder, the ability of the user to respond to balance disturbances, and whether slip and fall risk might have been influenced during ascent and descent of the user on the ladder. Furthermore, direct measures of fatigue and tissue loading were not conducted, which would provide more detailed insights on musculoskeletal injury risk. Furthermore, the study is unable to estimate the magnitude of risk reduction for either fall risk or musculoskeletal injury.

Impact of Report

This final report provides supportive background, methodological procedures, results, and objective interpretation of ceiling light fixture installation across traditional and novel installation methods. Notably, the report concludes that weight-supporting plug-in attachment offers substantial reductions in time spent on a ladder, time with elevated arm postures, time spent holding the light fixtures, and the number of dropped items. These findings indicate that these attachments are expected to reduce fall risk, reduce risk of upper extremity musculoskeletal injury risk, and enhance installation performance.

Knowledge gained from this report can assist in improving worker and homeowner safety. This report may be relevant as:

- Directed safety and injury risk information for workers and homeowners on ceiling fixture installation.
- Additional guidance for National Electrical Code (NEC) standards related to 314.27 Outlet Boxes (A) Boxes at Luminaire or Lampholder Outlets; (C) Boxes at Ceiling-Suspended (Paddle) Fan Outlets.

Appendix

Appendix A: Randomization order of uninstallation/installation conditions by user.

User	Gender	Height (m)	Trial 1	Trial 2	Trial 3
1	M	1.85	Traditional to WSCR/WSAF	WSAF to WSAF	Traditional to Traditional
2	M	1.83	Traditional to Traditional	Traditional to WSCR/WSAF	WSAF to WSAF
3	M	1.83	Traditional to Traditional	Traditional to WSCR/WSAF	WSAF to WSAF
4	M	1.83	Traditional to WSCR/WSAF	Traditional to Traditional	Traditional to WSCR/WSAF
5	M	1.80	WSAF to WSAF	Traditional to Traditional	Traditional to WSCR/WSAF
6	W	1.60	WSAF to WSAF	Traditional to WSCR/WSAF	Traditional to Traditional
7	M	1.80	Traditional to Traditional	WSAF to WSAF	Traditional to WSCR/WSAF
8	M	1.75	Traditional to Traditional	Traditional to WSCR/WSAF	WSAF to WSAF
9	W	1.70	WSAF to WSAF	Traditional to WSCR/WSAF	Traditional to Traditional
10	M	1.83	Traditional to WSCR/WSAF	WSAF to WSAF	Traditional to Traditional

Appendix B: Kichler Stetton 3-Light Anvil Iron Farmhouse Drum Hanging Pendant Light

Dimensions

Chain Length (inches)	**36**	Size	**Medium**
Height (inches)	**9.25**	Weight (lbs.)	**10.031**
Maximum Hanging Height (inches)	**46**	Width (inches)	**18.5**
Minimum Hanging Height (inches)	**10**	Wire Length (inches)	**72**

Appendix C: Diameter and weight of commercially available ceiling light fixtures.

Light Fixture Dia. and weights - 05.31.2024.x

Appendix D: Standard instructions to install a chain light fixture.

KICHLER 3 LIGHT
PENDANT INSTRUTIO

Appendix E: Instructions to install a weight supporting ceiling receptacle (WSCR).

SkyOutlet IM
20240126V3.pdf

https://skyx.vids.io/videos/4490d1b41d1ae1cdcd/install-the-skyoutlet

Appendix F: Instructions to install a weight-supporting attachment fitting (WSAF) for a chain fixture.

Standard Kit IM
20240409V3.pdf

https://skyx.vids.io/videos/d390d1b41d1be5c35a/install-a-skyplug-chain-fixture

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Public Comment No. 1453-NFPA 70-2024 [Section No. 424.3]

424.3 Reconditioned Equipment.

Reconditioned equipment shall comply with 424.3(A) and 424.3(B).

(A)– - Permitted- ~~to be Installed~~ .

Reconditioned equipment shall be permitted- ~~to be installed~~ , except as indicated in 424.3(B).

(B)– - Not Permitted- ~~to be Installed~~ .

Reconditioned electric space-heating cables shall not be permitted- ~~to be installed~~ .

Statement of Problem and Substantiation for Public Comment

This public comment is made to address an issue with the first draft language changes. The proposed language in this first revision allows electrical equipment to be reconditioned in place as the language pertains to the installation process and not to when any equipment is reconditioned in place. With the existing language in this first revision, the only time reconditioned equipment would not be permitted is if it is being installed. The Code does apply to existing equipment when additions or modifications are being made. The proposed language change from "installed" to "permitted" is more inclusive.

Related Item

- FR 8941

Submitter Information Verification

Submitter Full Name: Thomas Domitrovich

Organization: Eaton Corporation

Street Address:

City:

State:

Zip:

Submittal Date: Fri Aug 23 09:09:10 EDT 2024

Committee: NEC-P17

Public Comment No. 20-NFPA 70-2024 [Section No. 424.3]

424.3 Reconditioned Equipment.

Reconditioned equipment shall comply with 424.3(A) and 424.3(B).

Informational Note: See NEMA CS 100-2020 "Technical Position on Reconditioned Equipment" and NEMA standards publications GD 1-2019 "Evaluating Water-Damaged Electrical Equipment," GD 2-2021 "Evaluating Fire- and Heat-Damaged Electrical Equipment," and GD 3-2019 "Evaluating Earthquake Damaged Electrical Equipment Guide" for guidance as to what electrical equipment and components can and cannot be safely reconditioned and properly marked as such.

(A) Permitted to be Installed.

Reconditioned equipment shall be permitted to be installed, except as indicated in 424.3(B).

(B) Not Permitted to be Installed.

Reconditioned electric space-heating cables shall not be permitted to be installed.

Statement of Problem and Substantiation for Public Comment

Because this change allows some use of reconditioned equipment the addition of an Informational Note to refer readers to the appropriate NEMA standards and publications to reduce the potential for confusion and misapplication is justified.

Related Item

- FR 8941-NFPA 70-2024

Submitter Information Verification

Submitter Full Name: E. P. Hamilton
Organization: E. P. Hamilton & Associates, I
Affiliation: Self
Street Address:
City:
State:
Zip:

Submittal Date: Wed Jul 10 11:08:01 EDT 2024
Committee: NEC-P17

Public Comment No. 96-NFPA 70-2024 [Section No. 424.4(B)]

(B) Branch-Circuit ~~Conductor~~ Sizing.

~~The branch-circuit conductor(s) ampacity shall not be less than 125 percent of the load of the fixed~~ Fixed electric space-heating equipment and any associated motor(s) shall be considered a continuous load .

Statement of Problem and Substantiation for Public Comment

The panel rejected my PI with the statement “The sizing of the overcurrent protective device is already addressed in other sections and would be redundant.” Unfortunately, this statement by the panel is not accurate.
Without this 'correction,' the conductors are sized at 125% and the OCPD is sized at 100%. Since the 125% rule in 210.20(A) for the OCPD only applies to a "continuous load." No where in Article 424 does it specify that the loads in Article 424 are considered 'continuous.'
Note: EV branch circuits rule [625.41] was revised in the first draft (my PI) to the same text.

Related Item

- 3207

Submitter Information Verification

Submitter Full Name: Mike Holt
Organization: Mike Holt Enterprises Inc
Street Address:
City:
State:
Zip:

Submittal Date: Tue Jul 16 18:09:22 EDT 2024
Committee: NEC-P17

Public Comment No. 804-NFPA 70-2024 [Section No. 424.38(B)]

(B) Uses Not Permitted.

Heating cables shall not be installed as follows:

(1) In closets, other than as noted in 424.38(C)

(2) Over the top of walls where the wall intersects the ceiling

(3) Over partitions that extend to the ceiling, unless they are isolated single runs of embedded cable

(4) Under or through walls

(5) Over cabinets whose clearance from the ceiling is less than the minimum horizontal dimension of the cabinet to the nearest cabinet edge that is open to the room or area

(6) In tub- ~~and shower walls~~

(7) Under cabinets or similar built-ins having no clearance to the floor

-

Statement of Problem and Substantiation for Public Comment

Currently floor warming in showers using heating cables and heating panels is permitted as long as they are suitable for wet locations. It is believed that heating cables or heating panels in shower walls should be permitted similarly to any other walls, according to the upcoming 2026 edition of Section 424.48. The reasoning for this, is because in the extremely minor cases of total equipment malfunction, an electrical shock to a person standing in the shower is much less unlikely to occur from the walls then from the floor. Heating from shower walls is permitted per the Canadian Electrical Code 2024, and the upcoming new edition CSA C22.2 No. 130 will provide the testing requirements for heating from walls and from ceilings.

Related Item

• 839-NFPA 70-2020

Submitter Information Verification

Submitter Full Name: Gilles Gagnon

Organization: TemP4 Inc.

Affiliation: Schluter Systems L.P.

Street Address:

City:

State:

Zip:

Submittal Date: Mon Aug 05 14:52:18 EDT 2024

Committee: NEC-P17

Public Comment No. 11-NFPA 70-2024 [Section No. 425.2]

425.~~2~~ ~~Listed~~ 2 Listing Requirements.

Fixed industrial process heating equipment shall be listed.

Statement of Problem and Substantiation for Public Comment

Grammatical correction. The word "listed" used in this context is grammatically incorrect.

Related Item

- FR 8906-NFPA 70-2024

Submitter Information Verification

Submitter Full Name: E. P. Hamilton
Organization: E. P. Hamilton & Associates, I
Affiliation: Self
Street Address:
City:
State:
Zip:

Submittal Date: Wed Jul 10 10:27:37 EDT 2024
Committee: NEC-P17

Public Comment No. 752-NFPA 70-2024 [Section No. 425.2]

425.2 ~~Listed Requirements~~ Listing Requirements .

Fixed industrial process heating equipment shall be listed.

Statement of Problem and Substantiation for Public Comment

"Listing Requirements" should be the title of this section, as indicated in the NEC Style Manual.

Related Item

- FR 8906

Submitter Information Verification

Submitter Full Name: Ryan Jackson
Organization: Self-employed
Street Address:
City:
State:
Zip:

Submittal Date: Sun Aug 04 15:57:40 EDT 2024
Committee: NEC-P17

Public Comment No. 1734-NFPA 70-2024 [Section No. 426.1]

426.1 Scope.

This article covers fixed outdoor electric deicing and snow-melting equipment and the installation of these systems.

(A) Embedded.

Embedded in driveways, ~~walks~~ walkways , steps, roads, and other areas.

(B) Exposed.

Exposed on drainage systems, bridge structures, roofs, roads, and other structures.

Informational Note: See ANSI/IEEE 515.1-2012, *Standard for the Testing, Design, Installation and Maintenance of Electrical Resistance Trace Heating for Commercial Applications*, for further information. See IEEE 844/CSA 293 series of standards for fixed outdoor electric deicing and snow-melting equipment.

(C) Combination. Combinations of embedded and exposed equipment in driveways, walkways, steps, roads, bridge structures and similar locations.

Statement of Problem and Substantiation for Public Comment

The scope of Article 426 has been modified to accommodate the new and innovative technology for conductive pavement systems for snow melting and deicing. The text in 426.1(A) and (B) has been revised to better identify “walkways” rather than “walks”. In addition, “roads” has been added. Even present technology under Article 426 can be and has been used in roadways.

Since this new technology is neither fully embedded nor fully exposed, a new item “(C)” has been added to ensure scope coverage for systems that are a combination of embedded and exposed elements. The electrodes for the conductive pavement system are fully embedded into the pavement but since the pavement itself is part of the heating circuit, that is obviously exposed.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 1733-NFPA 70-2024 [New Definition after Definition: Concealed Knob-and-Tube Wi...]	
Public Comment No. 1735-NFPA 70-2024 [Sections Part VI., 426.50, 426.51]	
Public Comment No. 1733-NFPA 70-2024 [New Definition after Definition: Concealed Knob-and-Tube Wi...]	
Public Comment No. 1735-NFPA 70-2024 [Sections Part VI., 426.50, 426.51]	

Related Item

- PI 4168 and CI 8998

Submitter Information Verification

Submitter Full Name: Charles Mello
Organization: Cdcmello Consulting Llc
Affiliation: State of Iowa Department of Transportation
Street Address:
City:
State:
Zip:

Submittal Date: Mon Aug 26 20:03:24 EDT 2024
Committee: NEC-P17

Public Comment No. 1454-NFPA 70-2024 [Section No. 426.3]

426.3 Reconditioned Equipment.

Reconditioned equipment shall not be permitted- ~~to be installed~~ .

Statement of Problem and Substantiation for Public Comment

This public comment is made to address an issue with the first draft language changes. The proposed language in this first revision allows electrical equipment to be reconditioned in place as the language pertains to the installation process and not to when any equipment is reconditioned in place. With the existing language in this first revision, the only time reconditioned equipment would not be permitted is if it is being installed. The Code does apply to existing equipment when additions or modifications are being made. The proposed language change from "installed" to "permitted" is more inclusive.

Related Item

- FR 8944

Submitter Information Verification

Submitter Full Name: Thomas Domitrovich

Organization: Eaton Corporation

Street Address:

City:

State:

Zip:

Submittal Date: Fri Aug 23 09:13:47 EDT 2024

Committee: NEC-P17

Public Comment No. 689-NFPA 70-2024 [Section No. 427.1]

427.1 Scope.

This article covers electrically energized heating systems and the installation of these systems used with pipelines, vessels, and other applications for trace heating.

Informational Note: See IEEE 515-2017, *Standard for the Testing, Design, Installation and Maintenance of Electrical Resistance Trace Heating for Industrial Applications*, for further information. Also see applicable sections of the IEEE 844/CSA 293 series of standards for alternate technologies for fixed electric heating equipment for pipelines and vessels.

Additional Proposed Changes

File Name	Description	Approved
CN_398.pdf		

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 398 appeared in the First Draft Report on First Revision No. 8917.

CMP 17 should consider the informational note in regard to the NEC® Style Manual, Section 2.1.10.3.
The second sentence does not comply with the format requirement,
nor point to a specific standard and should be considered for revision or deletion.

Related Item

- First Revision No. 8917

Submitter Information Verification

Submitter Full Name: CC Notes
Organization: NEC Correlating Committee
Street Address:
City:
State:
Zip:
Submittal Date: Fri Aug 02 11:19:41 EDT 2024
Committee: NEC-P17

Correlating Committee Note No. 398-NFPA 70-2024 [Section No. 427.1]

Submitter Information Verification

Committee: NEC-AAC

Submittal Date: Fri May 10 12:22:19 EDT 2024

Committee Statement

Committee Statement: CMP 17 should consider the informational note in regard to the NEC® Style Manual, Section 2.1.10.3. The second sentence does not comply with the format requirement, nor point to a specific standard and should be considered for revision or deletion.

First Revision No. 8917-NFPA 70-2024 [Detail]

Ballot Results

✔ **This item has passed ballot**

12 Eligible Voters

1 Not Returned

11 Affirmative All

0 Affirmative with Comments

0 Negative with Comments

0 Abstention

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.

Bowmer, Trevor N.

Hickman, Palmer L.

Holub, Richard A.

Jackson, Peter D.

Kendall, David H.

Manche, Alan

Osborne, Robert D.

Porter, Christine T.

Schultheis, Timothy James

Williams, David A.

Public Comment No. 1455-NFPA 70-2024 [Section No. 427.3]

427.3 Reconditioned Equipment.

Reconditioned equipment shall not be permitted- ~~to be installed~~ .

Statement of Problem and Substantiation for Public Comment

This public comment is made to address an issue with the first draft language changes. The proposed language in this first revision allows electrical equipment to be reconditioned in place as the language pertains to the installation process and not to when any equipment is reconditioned in place. With the existing language in this first revision, the only time reconditioned equipment would not be permitted is if it is being installed. The Code does apply to existing equipment when additions or modifications are being made. The proposed language change from "installed" to "permitted" is more inclusive.

Related Item

- FR 8947

Submitter Information Verification

Submitter Full Name: Thomas Domitrovich

Organization: Eaton Corporation

Street Address:

City:

State:

Zip:

Submittal Date: Fri Aug 23 09:15:55 EDT 2024

Committee: NEC-P17

Public Comment No. 155-NFPA 70-2024 [Section No. 680.8(B)]

(B) Equipment Construction.

~~Equipment grounding conductors~~ <u>EGC's</u> shall be connected to a fixed metal part of the assembly. Any removable metal part of the assembly shall be mounted on or bonded to the fixed metal part.

Statement of Problem and Substantiation for Public Comment

This PC proposes to use the acronym EGC in place of the term equipment grounding conductor. Paragraphs 2.1.2.9 and 3.2.3 of the NEC Style Manual permit the use of acronyms. Additionally, EGC is already used at 680.7(B),

Related Item

- FR 9049

Submitter Information Verification

Submitter Full Name: Vincent Della Croce
Organization: Siemens
Street Address:
City:
State:
Zip:
Submittal Date: Mon Jul 22 14:24:44 EDT 2024
Committee: NEC-P17

Public Comment No. 547-NFPA 70-2024 [Section No. 680.10(B)]

~~**(B)** Electrically Powered Swimming Pool Heat Pumps and Chillers.~~

~~**(1)** Rating.~~

~~Electrically powered swimming pool heat pumps and chillers using the circulating water system and providing heating, cooling, or both shall be rated for their intended use.~~

~~**(2)** Branch Circuit.~~

~~The ampacity of the branch-circuit conductors and the ampere rating or setting of overcurrent protective devices shall be sized to comply with the nameplate.~~

Statement of Problem and Substantiation for Public Comment

The text that is marked for deletion contains nothing that is not already addressed in Chapters 1-4. This is a violation of the Style Manual, as 90.3 already covers the issue.

Related Item

- FR 9150

Submitter Information Verification

Submitter Full Name: Ryan Jackson
Organization: Self-employed
Street Address:
City:
State:
Zip:

Submittal Date: Wed Jul 31 10:01:38 EDT 2024
Committee: NEC-P17

Public Comment No. 1128-NFPA 70-2024 [Section No. 680.12(B)]

(B) Receptacles.

Receptacles shall meet the following requirements:

(1) At least one GFCI-protected 125-volt, 15- or 20-ampere receptacle shall be located within an equipment room.

(2) All other receptacles within an equipment room, vault, or pit shall ~~be GFCI protected or SPGFCI protected, as applicable, under the following conditions:~~

(3) ~~If supplied by branch circuits rated 150 volts or less to ground, 60 amperes or less, single-phase, or 100 amperes or less, 3-phase~~

(4) ~~If supplied by branch circuits exceeding 150 volts to ground but not exceeding 480 volts phase-to-phase~~

have GFCI protection complying with 680.5(B) or SPGFCI protection complying with 680.5(C), as applicable.

Statement of Problem and Substantiation for Public Comment

There is no need to repeat the details found in 680.5(B) and (C). Other sections of Article 680, such as 680.21(C) and (D) 680.22(A)(4), and 680.22(B)(4) simply reference the requirements of 680.5(B) and (C). There is no reason why this rule should not do the same.

Related Item

- First Revision No. 9045-NFPA 70-2024

Submitter Information Verification

Submitter Full Name: Don Ganiere
Organization: none
Street Address:
City:
State:
Zip:

Submittal Date: Thu Aug 15 17:12:39 EDT 2024
Committee: NEC-P17

Public Comment No. 688-NFPA 70-2024 [Section No. 680.12(B)]

(B) Receptacles.

Receptacles shall meet the following requirements:

(1) At least one GFCI-protected 125-volt, 15- or 20-ampere receptacle shall be located within an equipment room.

(2) All other receptacles within an equipment room, vault, or pit shall be GFCI protected or SPGFCI protected, as applicable, under the following conditions:

a. If supplied by branch circuits rated 150 volts or less to ground, 60 amperes or less, single-phase, or 100 amperes or less, 3-phase

b. If supplied by branch circuits exceeding 150 volts to ground but not exceeding 480 volts phase-to-phase

Additional Proposed Changes

File Name	Description	Approved
CN_391.pdf		

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 391 appeared in the First Draft Report on First Revision No. 9054.

CMP 17 should consider revising the requirement here to refer to the general rule in 680.5 (First Revision 9045) instead of repeating the details in this section. The Correlating Committee notes that the definition for SPGFCI in Article 100 has been revised.

Related Item

• First Revision No. 9054

Submitter Information Verification

Submitter Full Name: CC Notes
Organization: NEC Correlating Committee
Street Address:
City:
State:
Zip:

Submittal Date: Fri Aug 02 11:18:28 EDT 2024
Committee: NEC-P17

Correlating Committee Note No. 391-NFPA 70-2024 [Section No. 680.12(B)]

Submitter Information Verification

Committee: NEC-AAC
Submittal Date: Fri May 10 12:08:21 EDT 2024

Committee Statement

Committee Statement: CMP 17 should consider revising the requirement here to refer to the general rule in 680.5 (First Revision 9045) instead of repeating the details in this section. The Correlating Committee notes that the definition for SPGFCI in Article 100 has been revised.

FR-9054-NFPA 70-2024

Ballot Results

✔ **This item has passed ballot**

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

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.
Bowmer, Trevor N.
Hickman, Palmer L.
Holub, Richard A.
Jackson, Peter D.
Kendall, David H.
Manche, Alan
Osborne, Robert D.
Porter, Christine T.
Schultheis, Timothy James
Williams, David A.

Public Comment No. 814-NFPA 70-2024 [Section No. 680.12(B)]

(B) Receptacles.

Receptacles shall meet the following requirements:

(1) At least one GFCI-protected 125-volt, 15- or 20-ampere receptacle shall be located within an equipment room.

(2) All other receptacles within an equipment room, vault, or pit shall be GFCI protected or SPGFCI protected, as applicable, ~~under the following conditions:~~

(3) ~~If supplied by branch circuits rated 150 volts or less to ground, 60 amperes or less, single-phase, or 100 amperes or less, 3-phase~~

(4) ~~If supplied by branch circuits exceeding 150 volts to ground but not exceeding 480 volts phase-to-phase~~

in accordance with 680.5.

Statement of Problem and Substantiation for Public Comment

As indicated in the Correlating Committee Note, this requirement can be simplified by simply pointing to 680.5.

Related Item

- FR 9045

Submitter Information Verification

Submitter Full Name: Ryan Jackson
Organization: Self-employed
Street Address:
City:
State:
Zip:

Submittal Date: Mon Aug 05 17:00:03 EDT 2024
Committee: NEC-P17

Public Comment No. 815-NFPA 70-2024 [Section No. 680.14(A)]

(A) Wiring Methods.

Wiring methods shall be suitable for use in corrosive environments. Rigid metal conduit, intermediate metal conduit, rigid polyvinyl chloride conduit, reinforced thermosetting resin conduit, liquidtight flexible nonmetallic conduit, and liquidtight flexible metal conduit shall be considered suitable for use. Aluminum ~~conduit and tubing~~ wiring methods shall not be permitted.

Statement of Problem and Substantiation for Public Comment

As written, aluminum cables are permitted while aluminum raceways are not. None of these options provide sufficient corrosion protection, so the rule should be clarified and expanded to address all wiring methods.

Related Item

- FR 9060

Submitter Information Verification

Submitter Full Name: Ryan Jackson
Organization: Self-employed
Street Address:
City:
State:
Zip:

Submittal Date: Mon Aug 05 17:03:44 EDT 2024
Committee: NEC-P17

Public Comment No. 14-NFPA 70-2024 [Section No. 680.21(C)]

(C) Ground-Fault Protection.

Outlets serving pool motors shall have ground-fault protection complying with 680.5(B) or 680.5(C), as applicable. For a variable-speed pool motor employing a variable-frequency drive (VFD), the ground-fault protection shall be located on the branch circuit connected to the input terminals of the VFD, and not on the circuit between the output terminals of the VFD and the motor.

Exception: Listed low-voltage motors not requiring grounding, with ratings not exceeding the low-voltage contact limit that are supplied by listed transformers or power supplies that comply with 680.23(A)(2), shall be permitted to be installed without ground-fault protection.

Statement of Problem and Substantiation for Public Comment

FR language in Section 680.21(C) does not clearly address proper and safe application of GFCI and SPGFCI protection for variable-speed motors. The proposed language is added to clarify that the ground-fault protected outlet serving the motor must be installed on the line (input) side of the variable-frequency drive (VFD). As written, current language can misinterpreted to require the GFCI/SPGFCI be installed on the output (motor) side of the VFD (which is being incorrectly interpreted to be the outlet serving the motor). The output of a VFD, which is what actually connects to the variable speed motor, is a pulse-width modulated variable-voltage output which is incompatible with the internal power supply of the GFCI or SPGFCI (which utilizes the line voltage to power the electronics). The result is that a GFCI or SPGFCI connected in such a fashion offers no ground-fault protection for the motor and may catastrophically fail. This is not the same issue as nuisance tripping from GFCIs which are properly installed on the input side of the VFD.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 13-NFPA 70-2024 [Section No. 680.21(D)]	

Related Item

- FR 9153-NFPA 70-2024

Submitter Information Verification

Submitter Full Name: E. P. Hamilton
Organization: E. P. Hamilton & Associates, I
Affiliation: Self
Street Address:
City:
State:
Zip:

Submittal Date: Wed Jul 10 10:41:56 EDT 2024
Committee: NEC-P17

Public Comment No. 13-NFPA 70-2024 [Section No. 680.21(D)]

(D) Pool Pump Motor Replacement.

~~Where~~

, Reconditioning, or Repair

If a pool pump motor in 680.21(C) is replaced, reconditioned, or repaired, the ~~replacement or repaired pump motor shall be provided with ground-fault protection complying with 680.5(B) or 680.5(C) , as applicable~~ outlet serving it shall comply with 680.21(C) .

Statement of Problem and Substantiation for Public Comment

This FR revision failed ballot because it made unintended elimination of some GFCI/SPGFCI requirements, which was not the intent of the Panel. The revised wording provides the clarification intended in the FR revision language but incorporates the intended .GFCI/SPGFCI requirements.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 14-NFPA 70-2024 [Section No. 680.21(C)]	

Related Item

- FR 9153-NFPA 70-2024

Submitter Information Verification

Submitter Full Name: E. P. Hamilton
Organization: E. P. Hamilton & Associates, I
Affiliation: Self
Street Address:
City:
State:
Zip:

Submittal Date: Wed Jul 10 10:31:38 EDT 2024
Committee: NEC-P17

Public Comment No. 692-NFPA 70-2024 [Section No. 680.21(D)]

(D) Pool Pump Motor Replacement.

Where a pool pump motor in 680.21(C) is replaced or repaired, the replacement or repaired pump motor shall be provided with ground-fault protection complying with 680.5(B) or 680.5(C), as applicable.

Additional Proposed Changes

File Name	Description	Approved
CN_392.pdf		

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 392 appeared in the First Draft Report.

The Correlating Committee directs CMP 17 to add any reconditioned equipment requirements to the XXX.3 section in accordance with NEC Style Manual Section 2.2.1. Once it is established which type(s) of reconditioned equipment are permitted to be installed, the panel can then state the GFCI requirements in this section referring back to the general rule as is done in FR-9153.

Related Item

- Correlating Committee Note No. 392

Submitter Information Verification

Submitter Full Name: CC Notes
Organization: NEC Correlating Committee
Street Address:
City:
State:
Zip:
Submittal Date: Fri Aug 02 11:23:23 EDT 2024
Committee: NEC-P17

Correlating Committee Note No. 392-NFPA 70-2024 [Section No. 680.21(D)]

Submitter Information Verification

Committee: NEC-AAC

Submittal Date: Fri May 10 12:11:50 EDT 2024

Committee Statement

Committee Statement: The Correlating Committee directs CMP 17 to add any reconditioned equipment requirements to the XXX.3 section in accordance with NEC Style Manual Section 2.2.1. Once it is established which type(s) of reconditioned equipment are permitted to be installed, the panel can then state the GFCI requirements in this section referring back to the general rule as is done in FR-9153.

Ballot Results

✔ **This item has passed ballot**

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

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.
Bowmer, Trevor N.
Hickman, Palmer L.
Holub, Richard A.
Jackson, Peter D.
Kendall, David H.
Manche, Alan
Osborne, Robert D.
Porter, Christine T.
Schultheis, Timothy James
Williams, David A.

Public Comment No. 816-NFPA 70-2024 [Section No. 680.21(D)]

(D) Pool Pump Motor Replacement.

~~Where~~ If a pool pump motor ~~in 680.21(C)~~ is replaced, reconditioned, or repaired, the ~~replacement or repaired pump motor shall be provided with ground-fault protection complying with 680.5(B) or 680.5(C), as applicable.~~ outlet for the motor shall be GFCI protected or SPGFCI protected, as applicable, in accordance with 680.5.

Statement of Problem and Substantiation for Public Comment

This comment addresses the concerns in the negative voting on CI 9153.

Related Item

- CI 9153

Submitter Information Verification

Submitter Full Name: Ryan Jackson
Organization: Self-employed
Street Address:
City:
State:
Zip:

Submittal Date: Mon Aug 05 17:08:33 EDT 2024
Committee: NEC-P17

Public Comment No. 693-NFPA 70-2024 [Section No. 680.22(A)(4)]

(4) Ground-Fault Circuit-Interrupter (GFCI) and Special Purpose Ground-Fault Circuit-Interrupter (SPGFCI) Protection.

All receptacles located within 6.0 m (20 ft) of the inside walls of a pool shall have GFCI protection complying with 680.5(B) or SPGFCI protection complying with 680.5(C), as applicable, under the following conditions:

(1) If supplied by branch circuits rated 150 volts or less to ground, 60 amperes or less, single-phase, or 100 amperes or less, 3-phase

(2) If supplied by branch circuits exceeding 150 volts to ground but not exceeding 480 volts phase-to-phase

Additional Proposed Changes

File Name	Description	Approved
CN_393.pdf		

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 393 appeared in the First Draft Report on First Revision No. 9065.

CMP 17 should consider revising this requirement to state the receptacles located within 6.0 m (20 ft) of the inside walls of a pool shall have GFCI protection in accordance with 680.5(B) or SPGFCI protection in accordance with 680.5(C), as applicable, to eliminate the redundancy between these sections.

Related Item

- First Revision No. 9065

Submitter Information Verification

Submitter Full Name: CC Notes
Organization: NEC Correlating Committee
Street Address:
City:
State:
Zip:
Submittal Date: Fri Aug 02 11:24:53 EDT 2024
Committee: NEC-P17

Correlating Committee Note No. 393-NFPA 70-2024 [Section No. 680.22(A)(4)]

Submitter Information Verification

Committee: NEC-AAC

Submittal Date: Fri May 10 12:13:21 EDT 2024

Committee Statement

Committee Statement: CMP 17 should consider revising this requirement to state the receptacles located within 6.0 m (20 ft) of the inside walls of a pool shall have GFCI protection in accordance with 680.5(B) or SPGFCI protection in accordance with 680.5(C), as applicable, to eliminate the redundancy between these sections.

First Revision No. 9065-NFPA 70-2024 [Section No. 680.22(A)(4)]

Ballot Results

✔ **This item has passed ballot**

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

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.
Bowmer, Trevor N.
Hickman, Palmer L.
Holub, Richard A.
Jackson, Peter D.
Kendall, David H.
Manche, Alan
Osborne, Robert D.
Porter, Christine T.
Schultheis, Timothy James
Williams, David A.

Public Comment No. 817-NFPA 70-2024 [Section No. 680.22(A)(4)]

(4) Ground-Fault Circuit-Interrupter (GFCI) and Special Purpose Ground-Fault Circuit-Interrupter (SPGFCI) Protection.

All receptacles located within 6.0 m (20 ft) of the inside walls of a pool shall have GFCI protection complying with 680.5(B) or SPGFCI protection ~~complying~~ <u>in accordance</u> with 680.5(C), as applicable~~, under the following conditions:~~

(1) ~~If supplied by branch circuits rated 150 volts or less to ground, 60 amperes or less, single-phase, or 100 amperes or less, 3-phase~~

(2) ~~If supplied by branch circuits exceeding 150 volts to ground but not exceeding 480 volts phase-to-phase~~

<u>.</u>

Statement of Problem and Substantiation for Public Comment

This simplifies the language by simply pointing to 680.5.

Related Item

- FR 9065

Submitter Information Verification

Submitter Full Name: Ryan Jackson
Organization: Self-employed
Street Address:
City:
State:
Zip:

Submittal Date: Mon Aug 05 17:13:30 EDT 2024
Committee: NEC-P17

Public Comment No. 22-NFPA 70-2024 [New Section after 680.22(C)]

(D) Portable Signs

Portable electric signs shall not be placed within pools or within 1.5 m (5 ft) measured horizontally from the inside walls of a pool.

Statement of Problem and Substantiation for Public Comment

680.22 Lighting, Receptacles and Equipment contains requirements for electrical receptacles and devices including luminaires, lighting outlets, ceiling-suspended fans, switching devices, other outlets, and other equipment, which are located in proximity to pools. FR 9129 added a similar provision for electric signs, which would be more appropriately included in the text of 680.22 under 2.1.4.1 of the Style Manual, as it is also electrical equipment in proximity to a pool. The revised language submitted simply moves the intact language of the new 680.29 and relocates as 680.22(D). See also accompanying Public Comment 23-NFPA 70-2024.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 23-NFPA 70-2024 [Section No. 680.29]	

Related Item

- Public Comment 23-NFPA 70-24

Submitter Information Verification

Submitter Full Name: E. P. Hamilton

Organization: E. P. Hamilton & Associates, I

Affiliation: Self

Street Address:

City:

State:

Zip:

Submittal Date: Wed Jul 10 11:16:18 EDT 2024

Committee: NEC-P17

Public Comment No. 17-NFPA 70-2024 [Section No. 680.23(B)(2)]

(2) Wiring Extending Directly to the Forming Shell.

Conduit shall be installed from the forming shell to a junction box or other enclosure conforming to the requirements in 680.24. Conduit shall be rigid metal, intermediate metal, liquidtight flexible nonmetallic, or rigid polyvinyl chloride conduit.

(a) *Metal Conduit.* Metal conduit shall be listed and be red brass or stainless steel.

Informational Note: See UL 6A, *Electrical Rigid Metal Conduit—Aluminum, Red Brass, and Stainless Steel*, for information on the listing criteria for red brass and stainless steel conduit.

(b) *Nonmetallic Conduit.* Where a nonmetallic conduit is used, an 8 AWG insulated solid or stranded copper bonding jumper shall be installed in this conduit unless a listed low-voltage lighting system not requiring grounding is used. The bonding jumper shall be terminated in the forming shell, and also in the junction box ~~or~~ , the transformer enclosure, or the GFCI enclosure. The termination of the 8 AWG bonding jumper in the forming shell shall be covered with, or encapsulated in, a listed potting compound to protect the connection from the possible deteriorating effect of pool water.

Statement of Problem and Substantiation for Public Comment

There is an unintended consequence in the 680.23(B)(2)(b) FR language, which can create confusion, as it could be construed to mean the bonding jumper could be connected on only one end. The revised language provides the necessary clarification.

Related Item

- FR 9086-NFPA 70-2024

Submitter Information Verification

Submitter Full Name: E. P. Hamilton
Organization: E. P. Hamilton & Associates, I
Affiliation: Self
Street Address:
City:
State:
Zip:

Submittal Date: Wed Jul 10 10:57:02 EDT 2024
Committee: NEC-P17

Public Comment No. 818-NFPA 70-2024 [Section No. 680.24(D)]

(D) Grounding Terminals.

Grounding terminals shall comply with ~~the requirements in~~ 680.24(D)(1) and 680.24(D)(2), as applicable.

(1) Number of Grounding Terminals.

Junction boxes, transformer and power-supply enclosures, and GFCI enclosures connected to a conduit that extends directly to a forming shell or mounting bracket of a no-niche luminaire shall be provided with a number of grounding terminals that ~~are no~~ is no fewer than one more than the number of conduit entries.

(2) Connected to Panelboard Enclosure.

The grounding terminals of a junction box, transformer enclosure, or other enclosure in the supply circuit to a wet-niche or no-niche luminaire and the field-wiring chamber of a dry-niche luminaire shall be connected to an equipment grounding conductor, which is directly connected to the panelboard enclosure.

Statement of Problem and Substantiation for Public Comment

This comment deletes unnecessary words to comply with 4.1.3 of the NEC Style Manual, and changes "are" to "is" where the sentence refers to a singular word (number, not "numbers").

Related Item

- FR 9099

Submitter Information Verification

Submitter Full Name: Ryan Jackson
Organization: Self-employed
Street Address:
City:
State:
Zip:

Submittal Date: Mon Aug 05 17:20:15 EDT 2024
Committee: NEC-P17

Public Comment No. 10-NFPA 70-2024 [Section No. 680.24(D)(1)]

(1) Number of Grounding Terminals.

Junction boxes, transformer and power-supply enclosures, and GFCI enclosures connected to a conduit that extends directly to a forming shell or mounting bracket of a no-niche luminaire shall be provided with a number of grounding terminals that ~~are~~ is no fewer than one more than the number of conduit entries.

Statement of Problem and Substantiation for Public Comment

Grammatical correction. The use of the word "are" in this instance is grammatically incorrect.

Related Item

- FR 9099-NFPA 70-2024

Submitter Information Verification

Submitter Full Name: E. P. Hamilton
Organization: E. P. Hamilton & Associates, I
Affiliation: Self
Street Address:
City:
State:
Zip:
Submittal Date: Wed Jul 10 10:25:00 EDT 2024
Committee: NEC-P17

Public Comment No. 292-NFPA 70-2024 [Section No. 680.26(B)(1)]

(1) Conductive Pool Shells.

Bonding to conductive pool shells shall be provided as specified in 680.26(B)(1)(a) or 680.26(B)(1)(b). Cast-in-place concrete, pneumatically applied or sprayed concrete, and concrete block with painted or plastered coatings shall all be considered conductive materials due to water permeability and porosity. Reconstructed pool shells shall also meet the requirements of this section. Vinyl liners and fiberglass composite shells shall be considered nonconductive materials and not subject to these requirements.

(a) *Structural Reinforcing Steel.* Unencapsulated structural reinforcing steel shall be bonded together by steel tie wires or the equivalent. Where structural reinforcing steel is encapsulated in a nonconductive compound, a copper conductor grid shall be installed in accordance with 680.26(B)(1)(b).

(b) - ~~*Copper Conductor Grid*~~ *Conductive Grid* . A copper or 40% copper-clad steel conductor grid shall be provided in accordance with the following:

(3) Be constructed of minimum 8 AWG bare solid copper or 40% copper-clad steel conductors bonded to each other at all points of crossing in accordance with 250.8 or other approved means

(4) Conform to the contour of the pool

(5) Be arranged in a 300 mm (12 in.) by 300 mm (12 in.) network of conductors in a uniformly spaced perpendicular grid pattern with a tolerance of 100 mm (4 in.)

(6) Be secured within or under the pool no more than 150 mm (6 in.) from the outer contour of the pool shell

Additional Proposed Changes

File Name	Description	Approved
CCS_Corrosion_paper_Rev2.pdf	Technical Report Highlighting Corrosion Mechanism of Cut Ends of 40% CCS	
2024.08.27_CCS_Corrosion_Testing_-_Exponent_Report.pdf	Corrosion Testing	
2024.08.27_Lightning_Testing_Report.pdf	Transient / Lightning Current Comparative Research of Electrical Connections: Cu and 40% CCS Conductors	

Statement of Problem and Substantiation for Public Comment

The following is the CMP17 panel statement from the First Revision of the 2026 Cycle regarding this question: "CMP17 has concerns including corrosion at the ends of copper-clad steel conductors and copper-clad reenforcing steel installed in concrete, earth, or other corrosive environments. CMP17 also requests data showing how the product reacts to exothermic welding, as that process is a permitted method of connection in this section."

The panel's concerns are addressed here:

First, 40% CCS has a similar corrosion performance profile to copper on the galvanic scale. When Cu/CCS conductors are electrically connected in simulated seawater (sodium chlorides - considered an extremely corrosive environment), the rate of galvanic corrosion differs by only a few percentage points when compared to Cu/Cu and CCS/CCS pairs. This is in stark contrast to when bare steel and copper (or bare steel and 40% CCS) are coupled together in simulated seawater, as the differences in the rates of galvanic corrosion are a level of magnitude greater: +/- 15 X higher.

The data demonstrates that for pool locations, 40% CCS would perform equivalently to, if not better than, copper in general terms.
But it also indicates that it would perform equally or better than copper both in concrete (caustic) and acidic soils. When comparing the general corrosion rates in simulated seawater of the two metals individually, 40% CCS actually has a lower corrosion rate than copper. The general corrosion rate of 40% CCS was calculated to be 2.92 thousandths of an inch per year, whereas the corrosion rate for copper was nearly three times higher -- 8.35 thousandths of an inch per year.

Please find the attached report from Exponent, a U.S. scientific research firm with an active practice in the disciplines of corrosion science and forensics. Scientific reporting by Exponent must undergo a strict internal quality control process, as much of the company's work is peer reviewed for educational purposes or used in forensic evaluations for litigation. Corrosion science is a branch of materials science, and both authors of the report are PhD level materials scientists.

The corrosion mechanism of the cut ends of 40% CCS is well understood, as literally hundreds of millions of feet of 40% CCS wire and cable are in use today around the world in below grade utility applications. Ferrous oxides form immediately at the cut ends of CCS when buried in soil. Over time, as these ferrous oxides continue to grow thicker, they form a hard protective barrier on the steel, prohibiting further corrosion of the core.

Second, regarding 40% CCS's ability to be exothermically welded, the world's largest and most recognized manufacturer of exothermic welding systems and equipment, nVent Erico, recently published information on its website in September 2023 reconfirming the compatibility of their exothermic systems with 40% CCS conductors. This information may be found at https://blog.nvent.com/nvent-erico-and-copperweld-partnership/. The knowledge surrounding this question has been settled for decades. In fact, most 40% CCS strand in use today for substation grounding is exothermically welded.

I encourage CMP17 members to also view the technical substantiation included in NEC 2026 Public Comments 218, 193, 194 and 195. These PCs deal with various Article 250 grounding and bonding applications pertaining to 40% CCS. The data therewith should provide further insight into Article 680 questions regarding the performance of 40% CCS.

Related Item

- PI 2019

Submitter Information Verification

Submitter Full Name:	Peter Graser
Organization:	Copperweld Bimetallics, LLC.
Affiliation:	ABA
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Sat Jul 27 17:14:55 EDT 2024
Committee:	NEC-P17

Lightning Impulse Testing of 40% Copper-Clad Steel (CCS) Conductors and Associated Connectors

Lightning Impulse Testing of 40% Copper-Clad Steel (CCS) Conductors

and Associated Connectors

Prepared For:

Copperweld Bimetallics, LLC.
Brentwood, TN 37027
For Use and Publication in the NFPA Standards Setting Process

Prepared By:

Peter Lindahl, Ph.D., CFEI
Senior Managing Engineer, Electrical & Computer Science

Malima Wolf, Ph.D., CFEI
Managing Engineer, Thermal Sciences

Exponent, Inc.
1075 Worcester St.,
Natick, MA 01760

August 27, 2024

Exponent, Inc.

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Acronyms and Abbreviations

µΩ	microohms
A	ampere or amps
AC	alternating current
Al	aluminum
AWG	American Wire Gauge
CCS	copper-clad steel; also 40% CCS NOTE: When referencing the tests outlined in this report, CCS refers to copper-clad steel where the product is designed to have 40% of the conductivity of the same-sized copper conductor at 60 Hz.
Cu	copper
DC	direct current
EGC	equipment grounding conductor
GE	grounding electrode
GEC	grounding electrode conductor
Hz	hertz
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
J	Joules
kA	kiloamps
kHz	kilohertz
kJ	kilojoules
kV	kilovolts
mm	millimeter
ms	milliseconds
NEC	National Electrical Code (NFPA 70)
NFPA	National Fire Protection Association
UL	Underwriters Laboratories
V	voltage or volts
µs	microseconds
Ω	Ohms

1.0 Introduction

1. The National Fire Protection Association (NFPA) is a non-profit organization that publishes over 300 consensus codes and standards intended to minimize the possibility and effects of fire and other risks.

2. NFPA 70: National Electrical Code (NEC) is a consensus standard produced by NFPA that is designed to govern electrical installations.[1] Article 250 of the NEC provides requirements related to grounding and bonding of electrical installations.

3. NFPA 780: Standard for the Installation of Lightning Protection Systems (NFPA 780) is a standard produced by NFPA to provide lightning protection system (LPS) installation requirements.[2]

4. 40% copper-clad steel (CCS)[3,4] was recently proposed as a material for use as a grounding electrode conductor (GEC) in the NEC. It was also recently proposed as a material for use as an LPS down conductor in NFPA 780.[5]

5. To provide code setters insight into the performance of CCS in GEC and LPS applications, Copperweld Bimetallics LLC (Copperweld), retained Exponent, Inc. (Exponent) to develop and conduct testing programs to evaluate the lightning-conduction performance of CCS conductors when interfaced with typical GEC and LPS connection hardware. For this testing, Copperweld requested that Exponent also perform testing on equivalently sized copper conductors to provide reference for CCS conductor performance.

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1 NFPA 70: 2023. National Electrical Code.

2 NFPA 780: 2023. Standard for the Installation of Lightning Protection Systems.

3 ASTM B910/B910M-07: 2018. Standard Specification for Annealed Copper-Clad Steel Wire.

4 Copper-clad steel is a composite material consisting of a steel core and an outer layer of copper metallurgically bonded together. 40% copper-clad steel as an electrical conductor has a nominal conductivity at 60 Hz of 40% that of an equivalently sized copper conductor.

5 Exponent understands that these proposals were submitted through the NFPA's public input process.

2.0 Executive Summary

6. Exponent conducted two testing programs to evaluate the lightning conduction performance of 40% copper-clad steel (CCS) conductors when used in grounding electrode conductor (GEC) and lightning protection system (LPS) down-conductor applications. All tests performed involving CCS conductors were also performed involving equivalently sized copper conductors to provide a performance reference.

2.1 Connector Testing with CCS and Copper Conductors

7. The first testing program utilized the IEC 62561-1:2023[6] standard as a guide to evaluate the resiliency of CCS conductor terminations in standard connector components. In these tests, emulated lightning impulse currents were imparted on 90° connection points in GEC-style terminations and LPS-style conductor splice connections. The conduction of the emulated lightning impulse in this connection configuration puts electrical, thermal, and electromagnetic stresses on the conductor terminations.

2.1.1 Testing Overview

8. Tested assemblies included:

- 8 AWG and 4 AWG solid CCS and solid copper conductors interfaced with equipotential termination busbars typical of use in 200 A electrical service panels,
- 4/0 19-strand CCS and copper conductors interfaced with LPS cross connectors listed for Class I and Class II LPS installations, and
- 4/0 19-strand CCS and copper conductors interfaced with LPS two-bolt straight ("in line") connectors listed for Class I and Class II LPS installations.

9. Samples of each assembly type were tested using nominally 30 kA unipolar emulated lightning impulse current waveforms. Additional samples involving busbars were tested

[6] IEC 62561-1:2023 Lightning protection system components (LPSC) – Part 1: Requirements for connection components.

using nominally 66 kA oscillatory waveforms, and additional samples involving LPS connectors were tested using nominally 100 kA oscillatory waveforms.

10. Tested assemblies were evaluated based on their visual appearance (connector integrity), the extent of any conductor displacement, the contact resistance through the connector, and the magnitude of torque required to loosen the connector bolts.

2.1.2 Testing Results

11. None of the tested assemblies, involving either CCS or copper conductors, exhibited any visual signs of connector or conductor degradation in integrity. No cracks, deformation, or loose parts were observed.

12. None of the tested assemblies exhibited any movement in the conductors from their original termination points as a result of the applied emulated lightning impulses.

13. None of the tested assemblies exhibited significant increases in contact resistances as a result of the applied impulse currents, and all connections exhibited contact resistances well below the maximum contact resistance limit of 3 mΩ as set forth by the IEC 62561-1:2023 standard.

14. All busbar assemblies tested met the IEC 62561-1:2023 loosening torque requirement that states that the loosening torques must be greater than 25% and less than 150% of the torque required to tighten the busbar terminal bolts. This was true for both CCS and copper conductors.

15. Similarly, all LPS two-bolt straight connector assemblies tested met this loosening torque requirement. This was true for both CCS and copper conductors.

16. Of the LPS cross connector assemblies tested, two interfaced with copper conductors and one interfaced with CCS conductors exhibited bolt loosening torques lower than those required by the IEC 62561-1:2023 standard. It is important to note however that the LPS connectors used in testing are sold in the United States and thus subject to listing in accordance with UL 96 and not to the IEC 62561-1:2023 standard.

17. Thus, despite the failures exhibited by the assemblies involving LPS cross connectors, there was no indication that the CCS conductors contributed to these results.

2.2 Connector Testing with CCS and Copper Conductors

18. The second testing program subjected CCS and copper conductors to emulated lightning currents, and the resulting transient voltages were measured to characterize the over-voltages that may be generated on the conductors during lightning events.

2.2.1 Testing Overview

19. Tested samples included:

- 8 AWG solid copper and solid CCS conductors,
- 4 AWG solid copper and solid CCS conductors, and
- 4/0 19-strand copper and CCS conductors.

20. Testing involved imparting nominally 1 kA, 5 kA, 10 kA, and 20 kA unipolar emulated lightning waveforms on straight sections of each conductor type and using high-impedance voltage probes to measure the differential transient voltage generated across an approximately three-foot section of conductor.

2.2.2 Testing Results

21. The peak differential voltages generated on CCS conductors were similar to those generated on equivalently sized copper conductors. This was true for all current magnitudes and across all conductor sizes. Additionally, the voltage peaks occurred during the fast rise-time of the lightning waveforms.

22. These results indicate that the presence of the steel core and the lower overall 60 Hz conductivity of the CCS conductors compared to the copper conductors did not have significant impacts on the magnitudes of the transient voltages. Instead, these voltages appear most affected by the inductance created by the conductor and circuit geometry.

3.0 Testing Overview

3.1 Testing Programs

23. Exponent undertook two testing programs to evaluate the lightning conduction performance of 40% copper-clad steel (CCS) conductors and associated connectors when used as grounding electrode conductors (GECs) and lightning protection system (LPS) down-conductors. These tests were designed to evaluate this performance when using equivalently sized copper conductors as a reference.

24. The first testing program utilized the IEC 62561-1:2023[7] standard as a guide for investigating the resiliency of CCS conductor terminations in standard connector components. In these tests, two conductors and one connector were configured to form a 90° connection point. Emulated lightning impulse currents were then imparted into one conductor, through the 90° connection point, and then out the other conductor. In addition to the electrical and thermal stresses this current imparted on the conductor termination points, the 90° geometry of the test also subjected electromechanical forces on the conductors and connectors due to the interaction of the generated magnetic fields and the conducted current. Diagrams of example setups showing the general testing configuration for various connector types are provided in Figure 1.

25. The testing performed during this investigation focused on the following connector types:

- Equipotential termination busbars typical of use in 200 A electrical service panels,
- LPS cross connectors listed for Class I and Class II LPS installations, and
- LPS two-bolt straight (or "in line") connectors listed for Class I and Class II LPS installations.[8]

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7 IEC 62561-1:2023 Lightning protection system components (LPSC) – Part 1: Requirements for connection components.

8 Class I and Class II are defined in NFPA 780: 2023. Standard for the Installation of Lightning Protection Systems. §3.3.31.

26. The busbar connectors were tested in combination with both 8 AWG and 4 AWG solid CCS and solid copper conductors. The LPS cross connection connectors and the LPS straight two-bolt connectors were tested in combination with 4/0 19-strand CCS and 4/0 19-strand copper conductors.

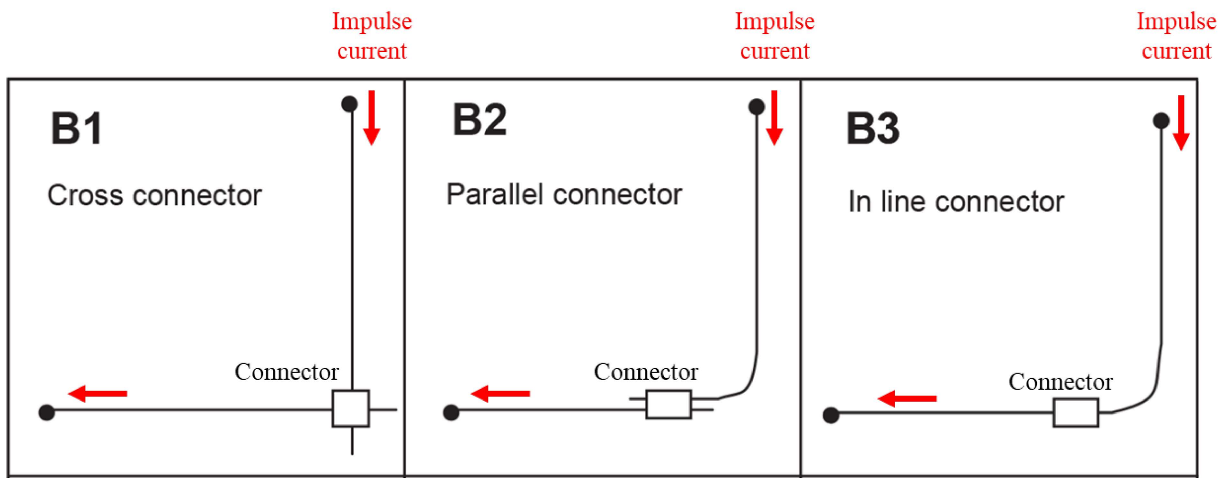

Figure 1. Example configurations of IEC 62561-1: 2023 electrical impulse test setup diagrams.[9] Annotations added by Exponent.

3.2 Lightning Current Impulse Waveforms

27. Lightning flashes discharge electricity from cloud(s) to earth and consist of one or more lightning strokes. Short strokes are the components of lightning flashes that discharge impulse currents to earth. These impulse currents are characterized by extremely fast rise times and longer decay times as shown in Figure 2, reproduced here from IEC62305-1: Protection against lightning – Part 1: General principles.

28. These waveforms are often defined by three parameters, the front time (T_1), the time to half value (T_2), and the peak current (I). The front time defines the time required for the waveform to increase to 90% of its peak value, while the half value defines the time it takes for the current to decay to half its peak value.

[9] IEC 62561-1:2023 Lightning protection system components (LPSC) – Part 1: Requirements for connection components. Annex B. Figure B.1.

29. The 10/350 μs (front time of 10 μs, time to half of 350 μs) waveform is often used by various standards for evaluating the performance of various electrical and electronic systems intended to protect against the effects of lightning strikes.

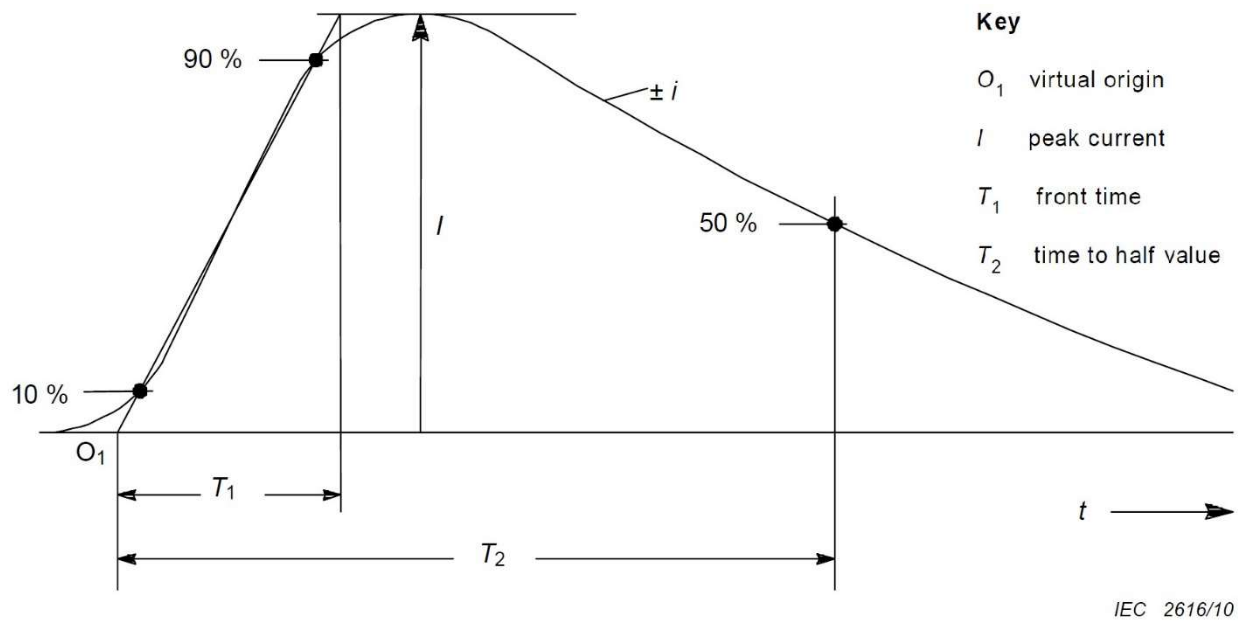

Figure 2. Representative impulse current shape defined by the front time, time to half value, and peak current parameters.[10]

30. IEC 62561-1:2023 defines the requirements for metallic connection components that form part of a lightning protection system (LPS). Table 1 in this standard, reproduced here as Table 1 of this report, specifies the peak current and specific energy required for testing components of Class H (heavy duty) and Class N (normal duty). The specific energy is the time integral of the square of the lightning impulse current.

31. While a specific waveform is not required, the informational note provided with Table 1 indicates that an exponentially decaying unipolar[11] waveform with a time to half value of 350 μs and corresponding peak current will fulfill the specific energy requirement.

[10] IEC62305-1: Protection against lightning – Part 1: General principles. Annex A. Figure A.1.

[11] IEC 62561-1:2023 §6.6.1 states that "the impulse current shall show no reversal…" which Exponent interprets as requiring a unipolar waveform.

Table 1. Lightning impulse parameters required for testing in accordance with IEC 62561-1:2023.[12]

Classification	I_{imp} kA ±10 %	W/R kJ/Ω $^{+45}_{-10}$ %
H	100	2 500
N	50	625
NOTE The parameters specified in this Table 1 can typically be achieved by an exponentially decaying lightning impulse current having a time to half value in the range of 350 µs according to IEC 62305-1.		

32. Historically, the 10/350 µs was selected as a representative test waveform to emulate a high-energy lightning impulse waveform.[13] For example, the Class H requirements of 100 kA and 2500 kJ/Ω according to IEC 62305-1, correspond to the 95th percentile of lightning strikes.[14]

33. To perform our investigation, Exponent contracted with a third-party lightning test laboratory. This lab can produce unipolar 10/350 µs impulse waveforms with peak currents up to approximately 30 kA. An example waveform recorded during testing is provided in Figure 3. While this waveform does not meet the magnitudes specified under IEC 62561-1:2023 Table 1, the waveform peak current does approximately correspond to a median first positive lightning stroke, a rarer but generally more energetic lightning stroke, and it exceeds the median peak currents for first negative and subsequent negative strokes, the more frequent types of lightning strokes.[15] Therefore, this 30 kA 10/350 µs unipolar waveform is representative of a typical lightning stroke and therefore useful for our evaluation.

34. The third-party laboratory does have the capability of producing an oscillatory 100 kA peak current with a time to half value that meets the requirements of IEC62561-1:2023, however, because this current oscillates positive and negative, it imparts a different electromagnetic force profile on the connector assembly than the unipolar waveform.

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12 Table 1 is reproduced from IEC 62561-1:2023, §6.6.1: General test conditions.

13 G. Clifford. Putting 10/350 Under the Microscope. Electrical Construction & Maintenance. November 2003.

14 IEC62305-1: Protection against lightning – Part 1: General principles. See Tables 3 and 5 regarding lightning protection level (LPL) maximum parameters and probabilities these parameters will exceed those of lightning strikes. Additionally, see Appendix A, Tables A.1, A.2, and Figure A.5.

15 IEC62305-1: Protection against lightning – Part 1: General principles. Annex A. Table A.1.

Its higher energy nature does still provide large electrical and thermal stresses on the connector assembly. An example of the 100 kA oscillatory waveform recorded during testing is provided in Figure 4.

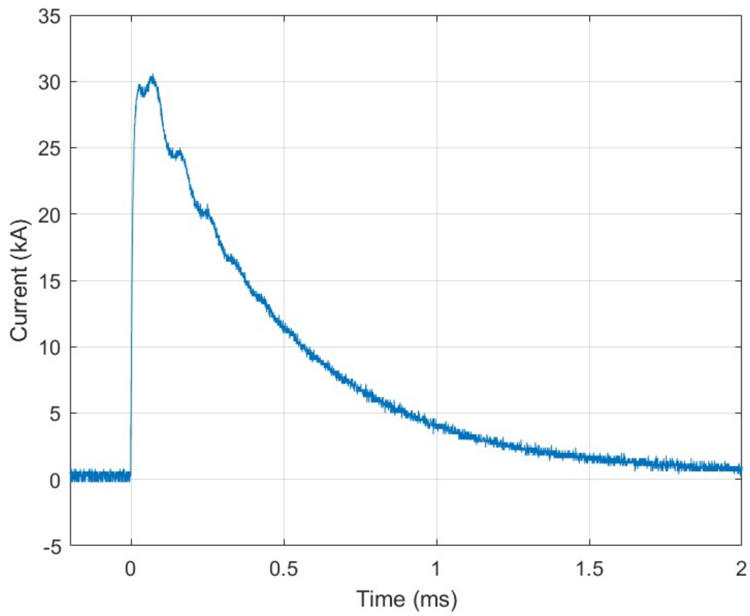


Figure 3. Example unipolar waveform recorded during testing. The waveshape of the impulses used approximately matched the 10/350 μs waveform.

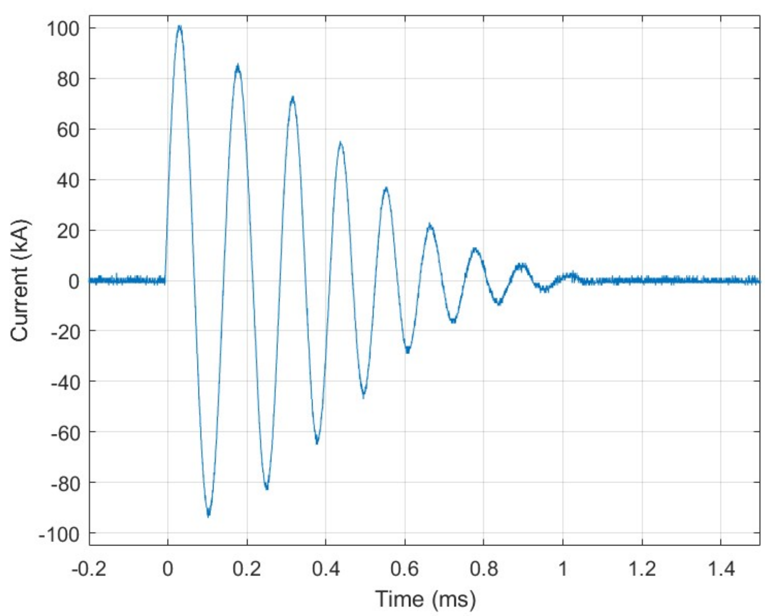


Figure 4. Example oscillatory impulse waveform recorded during testing. The "envelope" of this waveform measured as approximately 20/450 μs.

4.0 Connector Testing with CCS and Copper Conductors

4.1 Busbar Testing Setup

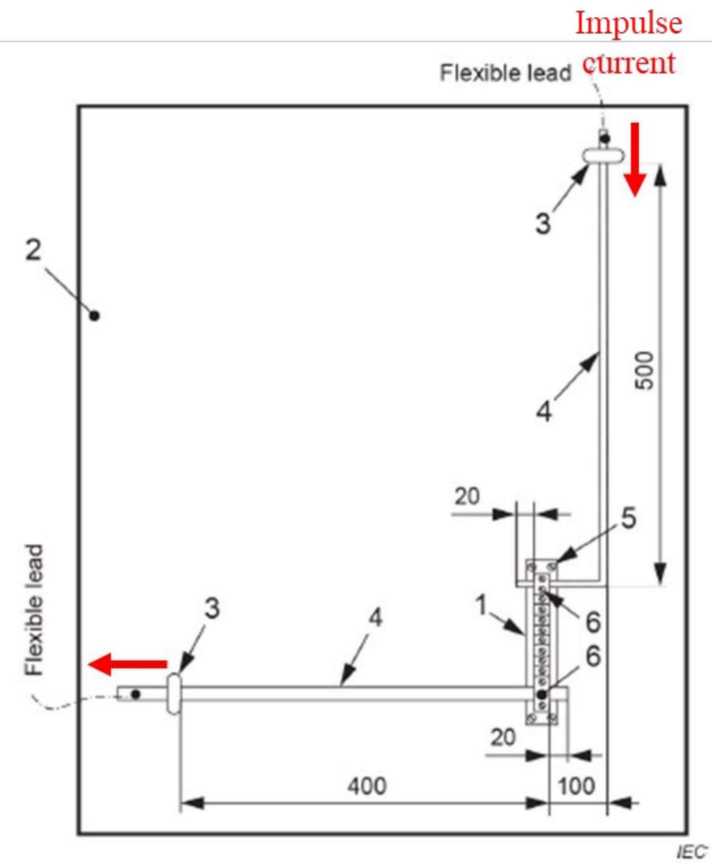
35. The busbar test setups were constructed using busbars intended for use in 200 A service panels. Samples were interfaced with 8 AWG solid CCS conductors, 8 AWG solid copper conductors, 4 AWG solid CCS conductors, or 4 AWG solid copper conductors. The busbars used in testing were listed for use with both sizes of conductor. These test setups were constructed following the arrangement for the testing of equipotential bonding bars in IEC 62561-1:2023.[16] This arrangement diagram is reproduced here in Figure 5. All specified dimensions are in millimeters.

36. No corrosion conditioning of the busbar samples was required per IEC 62561-1:2023 as the busbar samples are intended for indoor installations.[17]

37. Figure 6 shows a completed busbar test setup with 4 AWG wiring.

[16] IEC 62561-1:2023 Lightning protection system components (LPSC) – Part 1: Requirements for connection components. §6.4.f.

[17] IEC 62561-1:2023 Lightning protection system components (LPSC) – Part 1: Requirements for connection components. §6.5.



Key

1 Equipotential bonding bar

2 Plate made of insulating material

3 Rigid fastener

4 Conductor

5 Fixing points of equipotential bonding bar

6 Connection to be tested

Figure 5. Diagram of busbar testing setup. Dimensions are provided in millimeters.[18] Annotations added by Exponent.

[18] IEC 62561-1:2023 Lightning protection system components (LPSC) – Part 1: Requirements for connection components. §6.4.f. Figure 4.

Figure 6. Example busbar and 4 AWG GEC test setup.

4.2 Lightning Protection System Connector Testing Setup

38. Two types of LPS connectors were used in testing:

- Bronze two-bolt cross connectors, and
- Brass two-bolt straight connectors.

39. Setups were constructed using 4/0 AWG, 19-strand conductors of either copper or CCS. Both the cross-connectors and straight connectors are listed for use in Class I and Class II LPS systems and can accommodate conductors up to 0.56” in diameter. The 4/0-19 strand conductors are approximately 0.53” in diameter and thus fit the connector size requirement. CCS is not a listed material for use as an LPS conductor, however the 4/0 19-strand CCS conductor does meet the strand diameter, weight, and area minimums for Class II conductors of copper as listed in UL 96.[19]

40. The cross connector setups were constructed following the arrangement for cross connection component assemblies as specified in IEC 62561-1:2023 6.4.f, reproduced here as Figure 7. All specified dimensions are in millimeters.

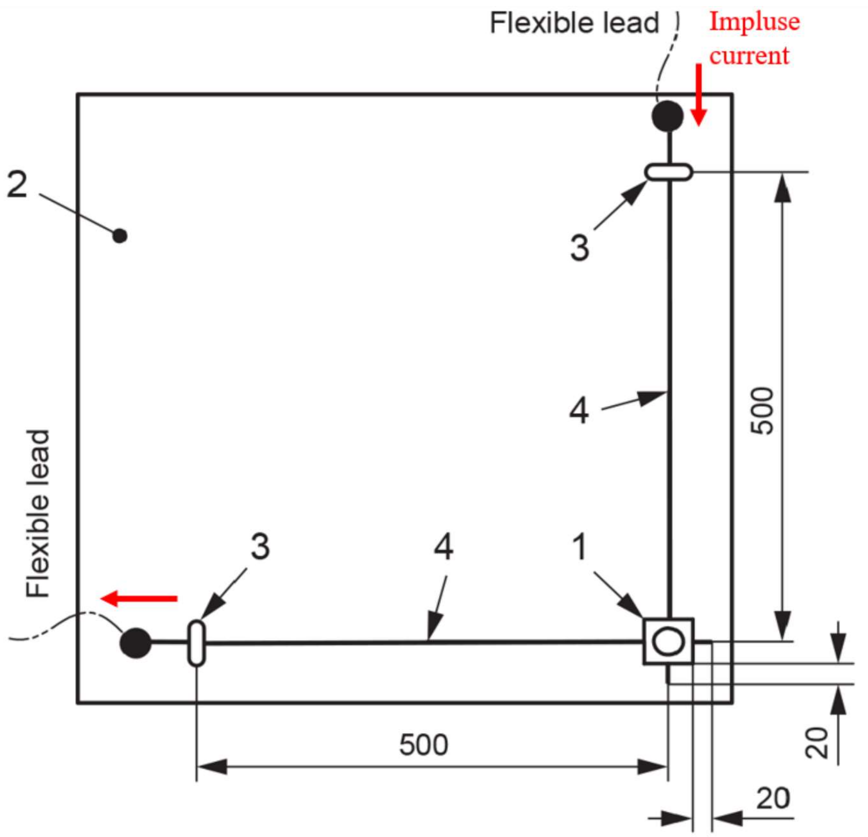
41. The straight connector setups were constructed following Figure B.1 (B3) and Figure 2 as specified in IEC 62561-1:2023 6.4 f. These figures are reproduced here as Figure 8. All specified dimensions are in millimeters.

42. IEC 62561-1:2023, requires LPS splice connector assemblies be corrosion conditioned prior to electrical impulse testing. The Lightning Protection System testing setups were aged and conditioned (as described in Annex D of IEC 62561-1:2023) using a salt mist treatment followed by a humid sulfurous atmosphere treatment.[20]

43. Figure 9 and Figure 10 show examples of assembled cross and straight connectors with conductors, respectively, prior to the corrosion conditioning process. Figure 11 contains a photograph of an example completed assembly after the corrosion process.

[19] UL 96: 2023, Lightning Protection Components. Table 21.1.

[20] See IEC 62561-1:2023, Annex D for further details.

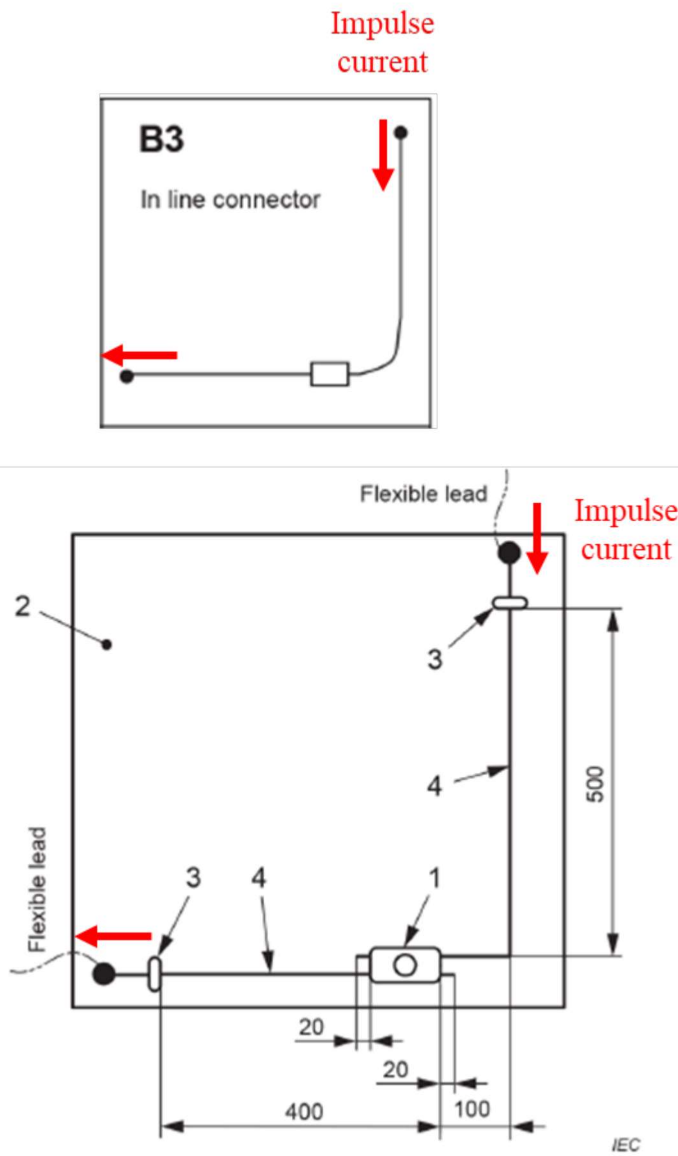


Key

1 Cross-connection component
2 Plate made of insulating material
3 Rigid fastener
4 Conductor and metal installation

Figure 7. Cross connection component test assembly diagram. All dimensions are provided in millimeters.[21] Annotations added by Exponent.

[21] IEC 62561-1:2023 Lightning protection system components (LPSC) – Part 1: Requirements for connection components. §6.4.f. Figure 1.



Key

1 Parallel connection component

2 Plate made of insulating material

3 Rigid fastener

4 Conductor and metal installation

Figure 8. Straight-connection (in-line) component test assembly diagram (top, Figure B.1 (B3)) and parallel connection component test assembly diagram (bottom, Figure 2)). The proper test setup of the in-line component matches the dimensions of the parallel component test setup. All dimensions are provided in millimeters.[22] Annotations added by Exponent.

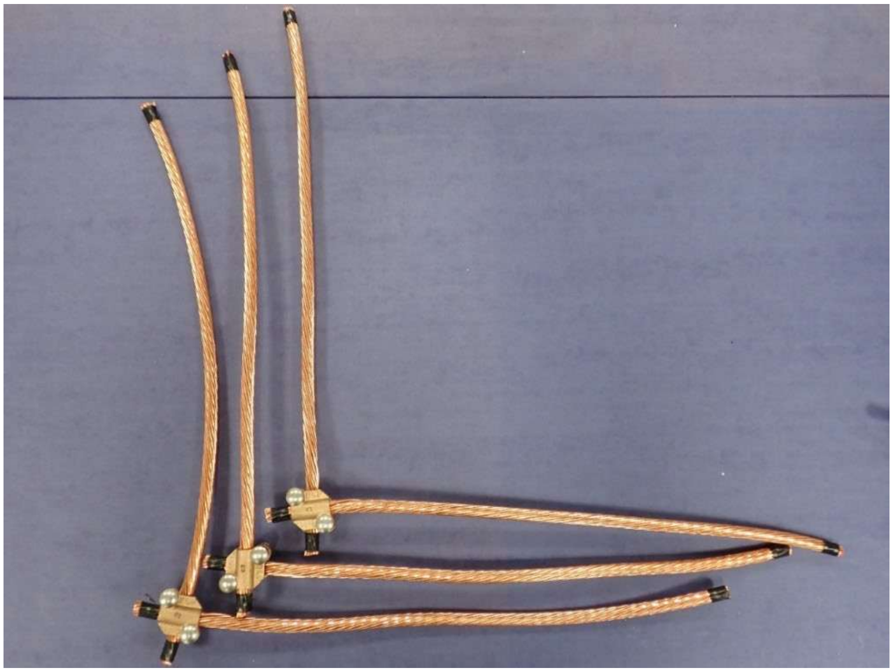


Figure 9. Photograph of example cross-connector LPS assemblies prior to corrosion conditioning.

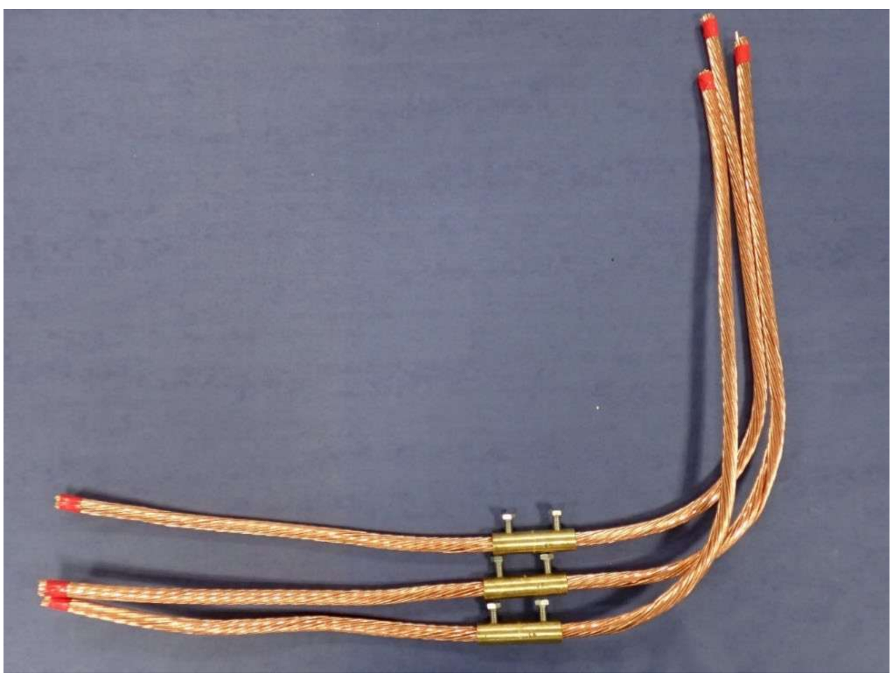


Figure 10. Photograph of example two-bolt straight connector LPS assemblies prior to corrosion conditioning.

[22] IEC 62561-1:2023 Lightning protection system components (LPSC) – Part 1: Requirements for connection components. §6.4.f. Figure 2.

Figure 11. Example cross connector assembly following the corrosion conditioning process.

4.3 Testing and Evaluation

44. Prior to testing, the contact resistance through each connector assembly was measured using a Raytech Micro Junior 2 microohm meter operated at the 10 A application setting. For the LPS connector assemblies that received the corrosion conditioning, the contact resistance was measured after the assembly process (but before the conditioning process) and after the conditioning process (but before the impulse testing). These measurements are not required by IEC 62561-1:2023, however they provide the ability to assess any changes in contact resistance as a result of the corrosion application or the impulse testing. For these measurements, the sense leads of the microohm meter were clamped to the conductors on either side of the connector and as close to the connector as possible as

prescribed by IEC 62561-1:2023.[23] Figure 12 shows a photograph of an example contact resistance measurement.

45. As dictated by IEC 62561-1:2023, each test assembly was stressed three times by the applied impulse current with the time interval between individual impulses sufficient to allow the assembly to cool down to approximately ambient temperature.[24]

46. Following the three applications of impulse current, each test assembly was evaluated through four acceptance criteria as prescribed by IEC 62561-1:2023, for "non-permanent" connection components:

- Connector Integrity – A visual inspection was performed to identify any connector cracks, loose parts, or deformation, any of which would constitute a failed test.
- Conductor Displacement – The displacement of the conductors following testing was measured and recorded. Any displacement needs to be less than 17 mm after the completion of testing.
- Contact Resistance – A final contact resistance measurement was collected after testing. This measurement is to be equal or less than 3 mΩ.
- Loosening Torque – The torque required to loosen the bolts of the connector were recorded. This loosening torque is required to be great than 0.25 and less than 1.5 times the applied tightening torque.

47. The torque applied to each connector was based on the tightening torque provided by the connector manufacturers. These values and the loosening torque boundary values for each connector and conductor size are provided in Table 2.

Table 2. Nominal torque applied during assembly of connectors and the post-testing boundaries for loosening torque.

Connection Type	Conductor Size	Torque Specification (in-lbs)	Loosening Torque (in-lbs)	
			Lower Bound	Upper Bound
200 A Busbar	8 AWG	25	6.25	37.5
200 A Busbar	4 AWG	35	8.75	52.5
Cross-Connector	4/0	80	20	120
Straight Connector	4/0	80	20	120

23 IEC 62561-1:2023 Lightning protection system components (LPSC) – Part 1: Requirements for connection components. §6.6.2.

24 IEC 62561-1:2023 Lightning protection system components (LPSC) – Part 1: Requirements for connection components. §6.6.1.

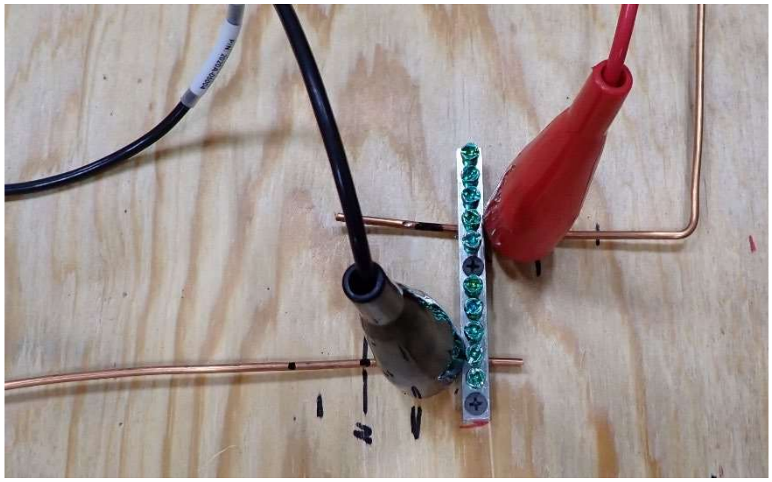


Figure 12. Example contact resistance measurement measured from points on the conductors as close as possible to the connector.

4.4 Testing Results

48. Table 3 provides a full list of samples tested along with the nominal impulse waveform applied to each sample. As described in IEC 62561-1:2023 6.6.1, each sample received three impulse waveforms. Each applied impulse waveform was recorded using a Pearson 1423 current monitor output to a Tektronix TDS3034C Oscilloscope, and the peak current and specific energy were calculated for each test. Appendix A, Table A - 1 through Table A - 4 provide these parameters for each impulse applied.

Table 3. List of test samples along with applied impulse waveform.

Sample Name	Connector Type	Conductor Material	Conductor Size	Nominal Waveform
8 AWG Cu 1	Busbar	Copper	8 AWG	30 kA 10/350 µs unipolar
8 AWG Cu 2	Busbar	Copper	8 AWG	66 kA 20/450 µs oscillatory
8 AWG CCS 1	Busbar	CCS	8 AWG	30 kA 10/350 µs unipolar
8 AWG CCS 2	Busbar	CCS	8 AWG	66 kA 20/450 µs oscillatory
4 AWG Cu 1	Busbar	Copper	4 AWG	30 kA 10/350µs unipolar
4 AWG Cu 2	Busbar	Copper	4 AWG	66 kA 20/450 µs oscillatory
4 AWG CCS 1	Busbar	CCS	4 AWG	30 kA 10/350µs unipolar
4 AWG CCS 2	Busbar	CCS	4 AWG	66 kA 20/450 µs oscillatory
C1	LPS Cross	Copper	4/0	30 kA 10/350µs unipolar
C2	LPS Cross	Copper	4/0	30 kA 10/350µs unipolar
C3	LPS Cross	Copper	4/0	100 kA 20/450 µs oscillatory
C4	LPS Straight	Copper	4/0	30 kA 10/350µs unipolar

Sample Name	Connector Type	Conductor Material	Conductor Size	Nominal Waveform
C5	LPS Straight	Copper	4/0	30 kA 10/350µs unipolar
C6	LPS Straight	Copper	4/0	100 kA 20/450 µs oscillatory
S1	LPS Cross	CCS	4/0	30 kA 10/350µs unipolar
S2	LPS Cross	CCS	4/0	30 kA 10/350µs unipolar
S3	LPS Cross	CCS	4/0	100 kA 20/450 µs oscillatory
S4	LPS Straight	CCS	4/0	30 kA 10/350µs unipolar
S5	LPS Straight	CCS	4/0	30 kA 10/350µs unipolar
S6	LPS Straight	CCS	4/0	100 kA 20/450 µs oscillatory

4.5 Connector Integrity and Conductor Displacement

49. All samples were visually inspected and photographically documented after testing. None of the samples had any loose parts; no discoloration, cracking, warping, or any other deformation impairing normal use were identified. Further, none of the samples had any observable change in position.

4.6 Contact Resistance

50. All contact resistance values measured on connector samples post-testing were well-below the 3 mΩ requirement of IEC 62561-1:2023. For the busbar connectors, the largest post-test contact resistance measured was 241.7 µΩ for CCS conductors (Sample 8 AWG CCS 1) and 183.7 µΩ for copper conductors (Sample 8 AWG Cu 2). These measurements are both an order of magnitude lower than the requirement. The full set of contact resistance measurements are provided in Appendix A, Table A - 5 through Table A - 8.

51. Additionally, there was not an obvious increase in contact resistance measurements post-testing compared to pre-testing. This is true for both copper and CCS conductor samples. Some contact resistance measurements slightly increased, but most slightly decreased. These small variabilities in contact resistance values may simply be due to variability in the placements of the microohm meter probes pre- and post-testing.

52. For the LPS connectors, the largest post-test contact resistance measurement was 68.4 μΩ for CCS conductors (Sample S2) and 32.2 μΩ for copper conductors (Sample C5). Similar to the busbar connectors, there was not an obvious increase in contact resistance measurements following the conditioning process nor the testing process. Resistance measurements obtained after the corrosion conditioning were generally lower than those obtained after conditioning, and these resistance measurements did not significantly increase after impulse testing.

53. While the measured contact resistance values of conductors using CCS did tend to be larger than those using copper, this is expected as the measurement incorporates some resistance of the bulk conductor material. Despite this, the application of the corrosion processes and the emulated impulse lightning waveforms to the CCS samples did not generate obvious increases in the contact resistance.

4.7 Loosening Torque

54. All samples were loosened using calibrated digital torque wrenches set to the peak torque setting. Per IEC 62561-1:2023, "*In the case of connectors with more than one screw, only the loosening torque of the first screw is relevant to this test which shall be different each time.*"[25] For the 200 A busbars and LPS straight connectors, the two conductors are connected independently, and loosening of each screw can be measured independently. For the LPS cross connectors, the tightness of the two bolts securing the connection is not independent, and thus, only the loosening torque for the first bolt loosened on each connector was recorded. The full set of loosening torque values are provided in Appendix A, Table A - 9 through Table A - 12.

55. All busbar assemblies met the IEC 62561-1:2023 loosening torque requirements for all conductor sizes, materials, and applied impulse waveforms. The torque required to loosen the connections made in these connectors ranged from 38% of the applied torque to 86% of the applied torque.

[25] IEC 62561-1:2023 Lightning protection system components (LPSC) – Part 1: Requirements for connection components. §6.6.2.d.

56. All two-bolt straight LPS connector assemblies also met the loosening torque requirements for all conductor sizes, materials, and applied impulse waveforms. The torque required to loosen these connectors ranged from 47% of the applied torque to 87% of the applied torque.

57. However, two of the cross connector samples interfaced with copper conductors and one cross connector sample interfaced with CCS conductors failed the loosening torque criteria. These samples had loosening torques less than 25% of the applied torque. Further, on average the measured loosening torque of the cross connectors interfaced with copper conductors was approximately 33% of the applied torque and that of the connectors interfaced CCS was approximately 29%. While these low values indicate that many of the cross connectors only exceeded the requirement by a small amount, because the connectors interfaced with CCS and copper conductors both exhibited similar average loosening torque values indicates that the loosening torque may not be strongly dependent on the conductor material.

58. It is also important to note that both the LPS straight-connectors and cross connectors are listed for use in the United States in accordance with UL 96, which does not require comparable testing. The authors of this report do not have any knowledge of any testing of these connectors to IEC 62561-1:2023 requirements, and the authors have no knowledge of any field-failures or other issues with these connectors.

5.0 Transient Voltage in CCS and Copper Conductors

5.1 Testing Setup

59. To compare over-voltages generated on equivalently sized CCS and copper conductors, we subjected nominally straight sections of CCS and copper conductors to 10/350 µs current impulses of varying peak currents and measured the voltage difference across a set length section of each conductor. For all tests, the length of the straight conductor was cut to approximately 58 inches and the differential voltage was measured across a 37-inch section of the straight piece. The straight length of conductor was placed horizontally approximately 2.5 inches above the copper plated table that served as the return path for the impulse current. An annotated photograph of the setup is provided in Figure 13.

60. One sample each of 8 AWG solid copper, 4 AWG solid copper, 4/0 19-strand copper conductors, and their equivalently sized CCS conductors were tested. Each test consisted of applying one or more 10/350 µs impulse at each of approximately 1 kA, 5 kA, and 10 kA peak currents and three or more 10/350 µs impulse at 20 kA.

61. The differential voltage (V+ minus V-) was measured using sense wires affixed to the conductor under test using split bolt connectors. These sense wires connected to high-impedance probes shielded in conduit with their outputs recorded using a Tektronix DPO 4034 oscilloscope.

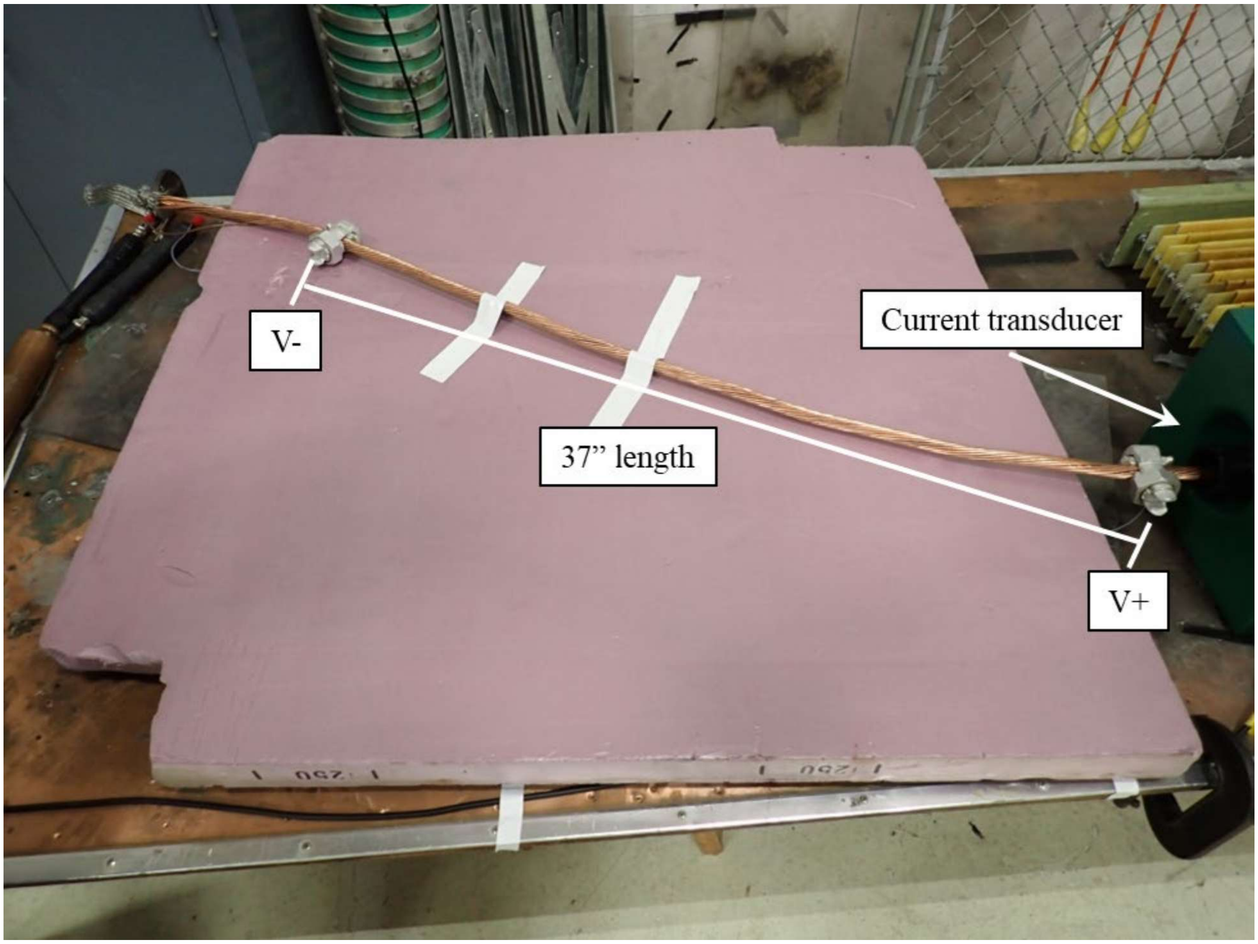


Figure 13. Lightning transient over-voltage measurement test setup.

5.2 Testing Results

62. Figure 14 and Figure 15 below provide examples of impulse current and the resulting differential voltage waveforms measured during over-voltage testing of a 4 AWG copper conductor and a 4 AWG CCS conductor, respectively. In these tests, the applied peak current was approximately 20 kA.

63. Subfigure (a) in each figure shows the full applied current impulse waveform on the bottom plot and the complete voltage response on the top plot. These figures show that the peak voltages generated occur during the front time of the current impulse, when the rate of change in the current (change in current divided by the change in time) is the highest. This is expected as the peak over-voltages during the fast rate of change in current are driven by the circuit inductance rather than resistance.

64. Subfigure (b) in each figure shows a shorter time portion of the waveform focused on just the front time of the impulse waveforms. Again, the impulse current is on the bottom plot and the measured voltage is on the top plot. Due to “ringing” imparted by the impulse current at the onset of discharge, the voltage measurement also contains ringing which disappears after a few microseconds. This ringing was filtered out in software by applying a low-pass filter[26] to the measurement resulting in the red line that approximately represents the measurement if the ringing was not present.

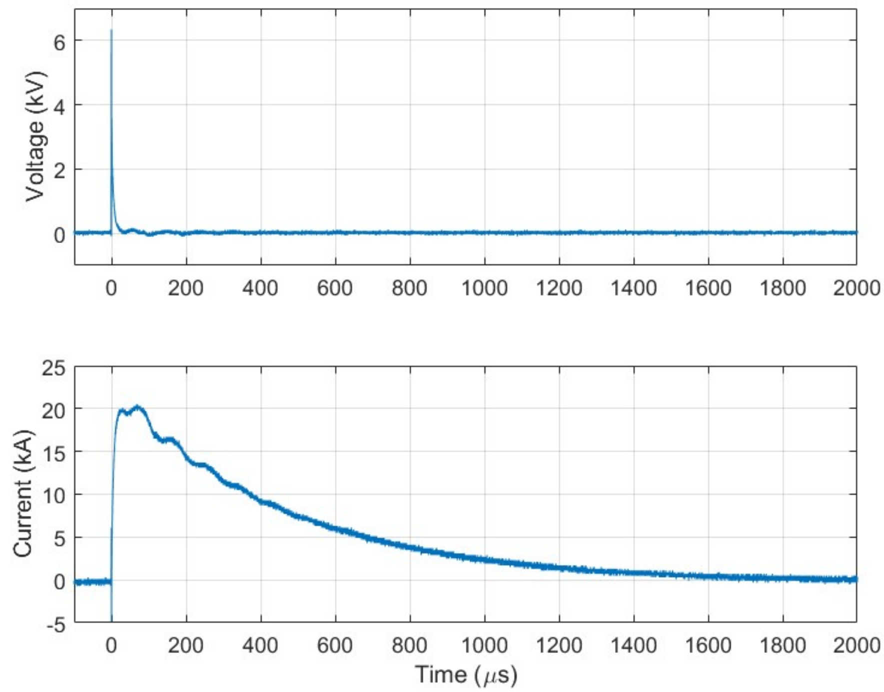
65. Comparing Figure 14 and Figure 15, the peak voltages observed with ringing are 6.1 kV for copper and 6.3 kV for CCS. With the ringing filtered out, these voltages are 3.2 kV for copper and 3.0 kV for CCS.

66. Appendix A, Table A - 13 through Table A - 18 provide these values for the full set of tests performed. The differential peak voltages measured were similar between equivalently sized copper and CCS conductors for all conductor sizes. For example, the average filtered transient peak voltage value in response to nominally 20 kA peak currents were:

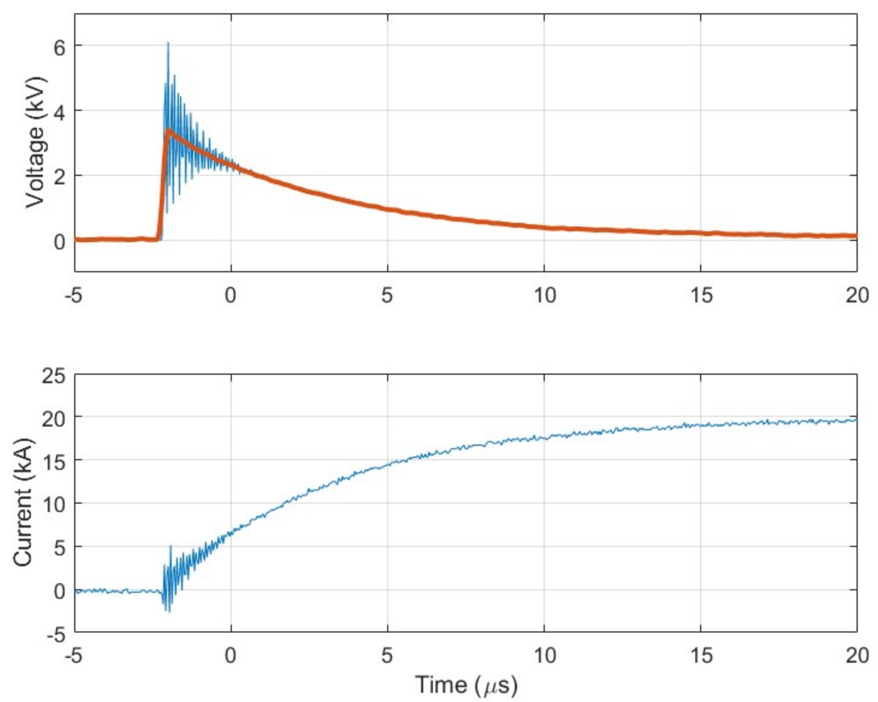
- 3.4 kV for 8 AWG CCS and 3.5 kV for 8 AWG copper,
- 3.1 kV for 4 AWG CCS and 3.4 kV for 4 AWG copper, and
- 2.8 kV for 4/0 CCS and 2.9 kV for 4/0 copper.

67. Thus, the presence of the steel core and the lower overall 60 Hz conductivity of the CCS conductors compared to the copper conductors did not appear to significantly affect the magnitudes of the transient voltages generated from emulated lightning waveforms. Instead, these voltages appear largely related to the inductance created by the conductor and circuit geometry.

[26] The filter was applied using MATLAB software and was designed as a zero-phase moving average filter with a 0.2 μs window.

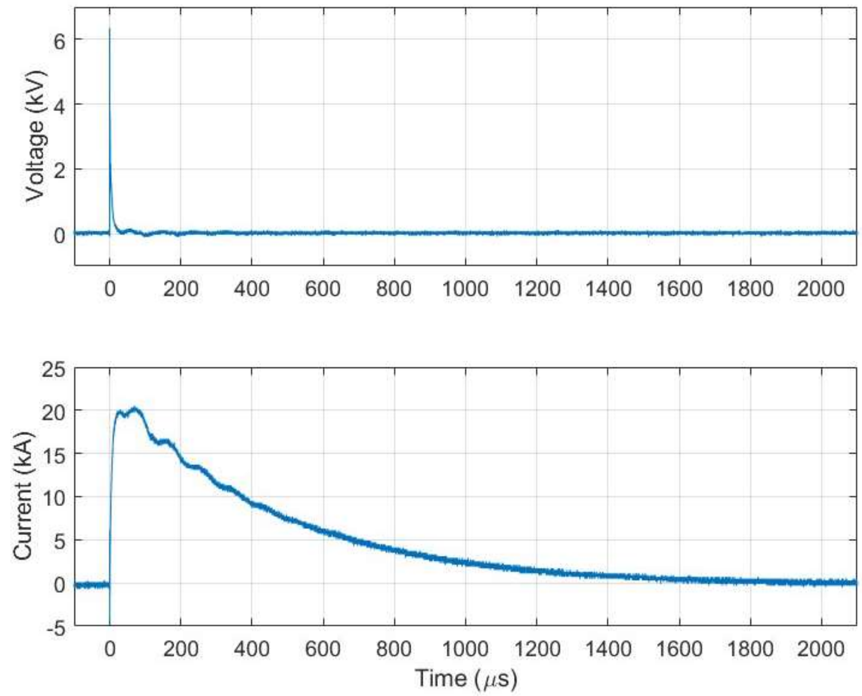


(a)

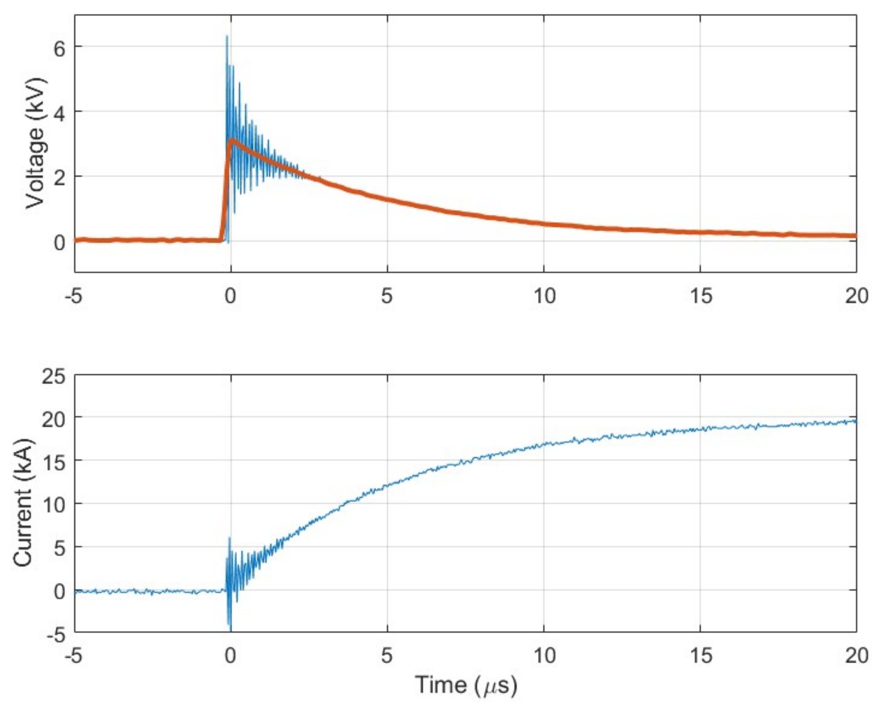


(b)

Figure 14. Example over-voltage measurement from a 4 AWG copper conductor subjected to a 20 kA peak 10/350 μs waveform. (a) Provides the full measurement over 2 ms and (b) provides the measurement over the first 20 μs.



(a)



(b)

Figure 15. Example over-voltage measurement from a 4 AWG CCS conductor subjected to a 20 kA peak 10/350 μs waveform. (a) Provides the full measurement over 2 ms and (b) provides the measurement over the first 20 μs.

6.0 Limitations

68. This report includes details of a testing program to evaluate the lightning-conduction related performance of 40% CCS in applications for use as a grounding electrode conductor and a lightning protection system down-conductor. This work was conducted at the request of Copperweld Bimetallics LLC.

69. The material contained herein is presented to a reasonable degree of scientific and engineering certainty and may not adequately address the needs of any or all users of this report. Any re-use of this report, or any of its contents, is made at the sole risk of the user. No guarantee or warranty as to future relevance is expressed or implied.

70. Exponent reserves the right to supplement this report and to expand or modify its contents based on review of additional material as it becomes available and/or through any additional work or review of additional work performed by others.

71. In the testing described above, we have relied on materials and information provided by Copperweld Bimetallics LLC. We cannot verify the correctness of this input and rely on Copperweld Bimetallics LLC for accuracy.

72. Although Exponent has exercised usual and customary care in preparing this summary presentation, the responsibility for the design, manufacture, and quality of their products remains fully with Copperweld Bimetallics LLC.

Appendix A
Full Data Sets of Test Results

Appendix A: Full Data Sets of Test Results

1. This appendix contains the full test results in tabular form for all samples tested.

Connector Testing Results Tables

Table A - 1. List of busbar connector assemblies tested with a unipolar impulse waveform. The table provides the measured parameters of the applied impulse.

	Impulse 1		Impulse 2		Impulse 3	
Sample Name	**Peak Current (kA)**	**Specific Energy (kJ/Ω)**	**Peak Current (kA)**	**Specific Energy (kJ/Ω)**	**Peak Current (kA)**	**Specific Energy (kJ/Ω)**
4 AWG Cu 1	30.0	244	30.0	248	29.8	248
4 AWG CCS 1	30.0	252	30.0	252	30.0	252
8 AWG Cu 1	30.0	252	30.0	252	30.0	252
8 AWG CCS 1	30.0	248	29.8	248	30.0	248

Table A - 2. List of busbar connector assemblies tested with the oscillatory impulse waveform. The table provides the measured parameters of the applied impulse.

	Impulse 1		Impulse 2		Impulse 3	
Sample Name	**Peak Current (kA)**	**Specific Energy (kJ/Ω)**	**Peak Current (kA)**	**Specific Energy (kJ/Ω)**	**Peak Current (kA)**	**Specific Energy (kJ/Ω)**
4 AWG Cu 2	100	1640	64	900	66	860
4 AWG CCS 2	66	1000	66	1020	68	1004
8 AWG Cu 2	66	920	66	920	66	990
8 AWG CCS 2	66	830	64	820	65	800

Table A - 3. List of LPS cross connector and two-bolt straight connector assemblies tested with a unipolar impulse waveform. The table provides the measured parameters of the applied impulse.

	Impulse 1		Impulse 2		Impulse 3	
Sample Name	Peak Current (kA)	Specific Energy (kJ/Ω)	Peak Current (kA)	Specific Energy (kJ/Ω)	Peak Current (kA)	Specific Energy (kJ/Ω)
C1	30	250	30	248	30	248
C2	30	248	30	248	30	248
S1	30	248	30	248	30	248
S2	30	248	30	248	29.8	248
C4	30	248	30	248	30	248

	Impulse 1		Impulse 2		Impulse 3	
C5	30	248	30	248	30	248
S4	30	248	30	248	30	248
S5	30	248	30	248	30	248

Table A - 4. List of LPS cross connector and two-bolt straight connector assemblies tested with an oscillatory impulse waveform. The table provides the measured parameters of the applied impulse.

	Impulse 1		Impulse 2		Impulse 3	
Sample Name	**Peak Current (kA)**	**Specific Energy (kJ/Ω)**	**Peak Current (kA)**	**Specific Energy (kJ/Ω)**	**Peak Current (kA)**	**Specific Energy (kJ/Ω)**
C3	N/A[1]	N/A	96	2080	100	1700
S3	97	1840	98	2180	100	2140
C6	100	2160	100	1620	100	2120
S6	100	2080	100	1940	100	2080

Table A - 5. Contact resistance measurements through the busbar connectors before and after application of the three 30 kA unipolar impulse waveforms.

			Contact Resistance (µΩ)	
Sample Name	**Conductor Materials**	**Conductor Size**	**Pre-Test**	**Post-Test**
4 AWG Cu 1	Copper	4 AWG	131.9	153.8
4 AWG CCS 1	CCS	4 AWG	139.7	143.8
8 AWG Cu 1	Copper	8 AWG	160	122.8
8 AWG CCS 1	CCS	8 AWG	222	241.7

Table A - 6. Contact resistance measurements through the busbar connectors before and after application of the three 66 kA oscillatory impulse waveforms.

			Supply to Return Conductor Resistance (µΩ)	
Sample Name	Conductor Materials	Conductor Size	Pre-Test	Post-Test
4 AWG Cu 2	Copper	4 AWG	135.6	122.7
4 AWG CCS 2	CCS	4 AWG	159.3	149.5
8 AWG Cu 2	Copper	8 AWG	190	183.7
8 AWG CCS 2	CCS	8 AWG	272.3	235.2

[1] Data recording failed during this impulse.

Table A - 7. Contact resistance measurements through the LPS connectors before and after application of the three 30 kA unipolar impulse waveforms.

				Supply to Return Conductor Resistance (μΩ)		
Sample Name	**Conductor Materials**	**Conductor Size**	**Connector Type**	**Pre-Conditioning**	**Post-Conditioning**	**Post-Test**
C1	Copper	4/0	Cross	31.1	19.8	20.4
C2	Copper	4/0	Cross	15.9	18.1	17.5
S1	CCS	4/0	Cross	91.4	89.8	65.2
S2	CCS	4/0	Cross	149	139.9	68.4
C4	Copper	4/0	Straight	35.4	21.2	22.5
C5	Copper	4/0	Straight	37.9	33.7	32.2
S4	CCS	4/0	Straight	52	42.9	40.8
S5	CCS	4/0	Straight	48.9	42.5	43.9

Table A - 8. Contact resistance measurements through the busbar connectors before and after application of the three 66 kA oscillatory impulse waveforms.

				Supply to Return Conductor Resistance (μΩ)		
Sample Name	**Conductor Materials**	**Conductor Size**	**Connector Type**	**Pre-Conditioning**	**Post-Conditioning**	**Post-Test**
C3	Copper	4/0	Cross	47.6	23	18.2
S3	CCS	4/0	Cross	129.4	111.3	61.6
C6	Copper	4/0	Straight	21.8	21.9	31.4
S6	CCS	4/0	Straight	73.4	45.6	54.9

Table A - 9. Loosening torque values for the busbar samples subjected to the 30 kA unipolar impulse waveforms. The values in parentheses are the percent of the applied torque (25 in-lbs for 8 AWG and 35 in-lbs for 4 AWG).

			Loosening Torque (in-lbs)	
Sample Name	Conductor Materials	Conductor Size	Supply Terminal	Return Terminal
4 AWG Cu 1	Copper	4 AWG	30 (86%)	26 (76%)
4 AWG CCS 1	CCS	4 AWG	24 (69%)	24 (70%)
8 AWG Cu 1	Copper	8 AWG	15 (62%)	18 (73%)
8 AWG CCS 1	CCS	8 AWG	20 (79%)	17 (67%)

Table A - 10. Loosening torque values for the busbar samples subjected to the 66 kA oscillatory impulse waveforms. The values in parentheses are the percent of the applied torque (25 in-lbs for 8 AWG and 35 in-lbs for 4 AWG).

Sample Name	Conductor Materials	Conductor Size	Loosening Torque (in-lbs)	
			Supply Terminal	Return Terminal
4 AWG Cu 2	Copper	4 AWG	19 (55%)	17 (48%)
4 AWG CCS 2	CCS	4 AWG	22 (64%)	22.75 (65%)
8 AWG Cu 2	Copper	8 AWG	11 (43%)	9.567 (38%)
8 AWG CCS 2	CCS	8 AWG	10 (40%)	13.12 (52%)

Table A - 11. Loosening torque values for the LPS connector samples subjected to the 30 kA unipolar impulse waveforms. The values in parentheses are the percent of the applied torque (80 in-lbs).

Sample Name	Conductor Materials	Conductor Size	Connector Type	Loosening Torque (in-lbs)	
				Supply Side or Outside Bolt	Return Side or Inside Bolt
C1	Copper	4/0	Cross	19 (24%)	N/A
C2	Copper	4/0	Cross	N/A	42 (53%)
S1	CCS	4/0	Cross	16 (20%)	N/A
S2	CCS	4/0	Cross	N/A	28 (35%)
C4	Copper	4/0	Straight	43 (54%)	45 (56%)
C5	Copper	4/0	Straight	37 (47%)	44 (55%)
S4	CCS	4/0	Straight	46 (58%)	55 (69%)
S5	CCS	4/0	Straight	70 (87%)	48 (60%)

Table A - 12. Loosening torque values for the LPS connector samples subjected to the 100 kA oscillatory impulse waveforms. The values in parentheses are the percent of the applied torque (80 in-lbs).

Sample Name	Conductor Materials	Conductor Size	Connector Type	Loosening Torque (in-lbs)	
				Supply Side or Outside Bolt	Return Side or Inside Bolt
C3	Copper	4/0	Cross	18 (22%)	N/A
S3	CCS	4/0	Cross	27 (33%)	N/A
C6	Copper	4/0	Straight	42 (52%)	45 (56%)
S6	CCS	4/0	Straight	60 (75%)	62 (77%)

Table A - 13. Transient voltage impulse peak values measured on a 8 AWG copper solid conductor wire.

Conductor Material	Conductor Size	Current Waveform		Voltage Response	
		Shape	Peak Current (kA)	Peak Voltage (kV)	Peak Voltage Filtered (kV)
Copper	8 AWG	10/350 unipolar	1.1	0.41	0.17
Copper	8 AWG	10/350 unipolar	5.3	2.0	0.80
Copper	8 AWG	10/350 unipolar	10.5	3.1	1.6
Copper	8 AWG	10/350 unipolar	21.0	6.5	3.4
Copper	8 AWG	10/350 unipolar	21.0	7.8	3.4
Copper	8 AWG	10/350 unipolar	21.0	5.4	3.4
Copper	8 AWG	10/350 unipolar	23.4	6.4	3.6

Table A - 14. Transient voltage impulse peak values measured on a 8 AWG CCS solid conductor wire.

Conductor Material	Conductor Size	Current Waveform		Voltage Response	
		Shape	Peak Current (kA)	Peak Voltage (kV)	Peak Voltage Filtered (kV)
CCS	8 AWG	10/350 unipolar	1.1	0.41	0.16
CCS	8 AWG	10/350 unipolar	5.2	1.6	0.78
CCS	8 AWG	10/350 unipolar	5.3	1.6	0.79
CCS	8 AWG	10/350 unipolar	10.3	3.8	1.6
CCS	8 AWG	10/350 unipolar	20.5	6.4	3.3
CCS	8 AWG	10/350 unipolar	20.5	7.5	3.4
CCS	8 AWG	10/350 unipolar	20.5	7.6	3.4
CCS	8 AWG	10/350 unipolar	20.3	6.3	3.4

Table A - 15. Transient voltage impulse peak values measured on a 4 AWG copper solid conductor wire.

Conductor Material	Conductor Size	Current Waveform		Voltage Response	
		Shape	Peak Current (kA)	Peak Voltage (kV)	Peak Voltage Filtered (kV)
Copper	4 AWG	10/350 unipolar	1.1	0.37	0.15
Copper	4 AWG	10/350 unipolar	5.3	1.6	0.78
Copper	4 AWG	10/350 unipolar	10.5	3.8	1.6
Copper	4 AWG	10/350 unipolar	20.7	7.3	3.4
Copper	4 AWG	10/350 unipolar	20.7	6.5	3.4
Copper	4 AWG	10/350 unipolar	20.7	6.1	3.4

Table A - 16. Transient voltage impulse peak values measured on a 4 AWG CCS solid conductor wire.

Conductor Material	Conductor Size	Current Waveform		Voltage Response	
		Shape	Peak Current (kA)	Peak Voltage (kV)	Peak Voltage Filtered (kV)
CCS	4 AWG	10/350 unipolar	1.1	0.36	0.14
CCS	4 AWG	10/350 unipolar	5.2	1.6	0.72
CCS	4 AWG	10/350 unipolar	10.5	3.6	1.5
CCS	4 AWG	10/350 unipolar	20.7	7.1	3.1
CCS	4 AWG	10/350 unipolar	20.7	6.8	3.1
CCS	4 AWG	10/350 unipolar	20.5	6.3	3.1

Table A - 17. Transient voltage impulse peak values measured on a 4/0 19 strand copper conductor.

Conductor Material	Conductor Size	Current Waveform		Voltage Response	
		Shape	Peak Current (kA)	Peak Voltage (kV)	Peak Voltage Filtered (kV)
Copper	4/0	10/350 unipolar	1.1	0.36	0.13
Copper	4/0	10/350 unipolar	5.3	1.7	0.69
Copper	4/0	10/350 unipolar	10.5	3.1	1.4
Copper	4/0	10/350 unipolar	20.5	4.8	2.9
Copper	4/0	10/350 unipolar	20.7	6.7	2.9
Copper	4/0	10/350 unipolar	20.7	6.8	2.9

Table A - 18. Transient voltage impulse peak values measured on a 4/0 19 strand CCS conductor.

Conductor Material	Conductor Size	Current Waveform		Voltage Response	
		Shape	Peak Current (kA)	Peak Voltage (kV)	Peak Voltage Filtered (kV)
CCS	4/0	10/350 unipolar	1.1	0.34	0.13
CCS	4/0	10/350 unipolar	5.3	1.4	0.64
CCS	4/0	10/350 unipolar	10.5	2.6	1.3
CCS	4/0	10/350 unipolar	20.7	6.5	2.8
CCS	4/0	10/350 unipolar	20.9	6.4	2.8
CCS	4/0	10/350 unipolar	20.5	5.6	2.8

Appendix B
Peter Lindahl, Ph.D., CFEI
Curriculum Vitae

Exponent®
Engineering & Scientific Consulting

Peter Lindahl, Ph.D., CFEI

Senior Managing Engineer | Electrical Engineering and Computer Science
Natick
+1-508-652-8578 | plindahl@exponent.com

Professional Profile

Dr. Lindahl's education and training is in electrical engineering with expertise in power systems, sensors and instrumentation, electromechanical machinery (motors and generators), electrochemical systems (e.g. batteries, fuel cells, and their associated electronics), renewable and distributed energy systems, industrial controllers such as variable speed motor drives, and consumer appliances and electronics. His professional activities involve, amongst others, conducting complex investigations related to product safety, reliability, failures, and standards compliance; advising clients and providing engineering services on matters concerning intellectual property; and developing condition monitoring and fault detection and isolation techniques.

Prior to Exponent, Dr. Lindahl was a postdoctoral associate at the Massachusetts Institute of Technology. While there, he conducted research and oversaw graduate student projects related to smart grid power management and control, condition monitoring in electrical and mechanical systems, and smart building technology development including capacitive occupancy sensing and HVAC performance tracking via smart meter measurements. He received his PhD from Montana State University for his work devising sensing methods and power control management schemes for solid oxide fuel cell systems.

Throughout his career, Dr. Lindahl has provided technical and scientific services to clients in a variety of industries including aerospace, construction, electrical power, oil and gas, automotive and marine transportation, and defense including the U.S. Navy, Coast Guard, Army, and Air Force. He's co-authored over two dozen research articles in high-impact academic journals and conference proceedings. His research work has also been featured in news outlets and engineering society magazines including MIT News, the SNAME Marine Technology Magazine, and the IEEE Instrumentation & Measurement Magazine.

Academic Credentials & Professional Honors

Ph.D., Engineering, Montana State University, 2013

M.S., Electrical Engineering, Montana State University, 2009

B.S., Electrical Engineering, Penn State University, 2003

Research Affiliate, Research Laboratory of Electronics, Massachusetts Institute of Technology

Licenses and Certifications

Professional Engineer Electrical, California, #25012

Certified Fire and Explosion Investigator (CFEI)

Academic Appointments

MIT - Massachusetts Institute of Technology, Research Laboratory of Electronics (RLE), Research Affiliate/Research Scientist

Postdoctoral Associate, Research Laboratory of Electronics, Massachusetts Institute of Technology, 2014 - 2019

Communication Lab Advisor, Electrical Engineering & Computer Science Department, Massachusetts Institute of Technology, 2015 - 2018

Assistant Teaching Professor & Research Engineer, Electrical & Computer Engineering Department, Montana State University, 2013 - 2014

Ph.D. Research Assistant, Electrical & Computer Engineering Department, Montana State University, 2009 - 2013

M.S. Research Assistant, Electrical & Computer Engineering Department, Montana State University, 2006 - 2009

Undergraduate Summer Researcher, Department of Physics, University of Maryland, Baltimore County, 2000 - 2002

Prior Experience

Assistant Project Engineer, Cianbro Corporation, Baltimore, MD 2006

Field Engineer & Electrical Estimator, Cianbro Corporation, Baltimore, MD, 2005-2006

Professional Affiliations

Senior Member, Institute of Electrical and Electronics Engineers (IEEE)

Member, Tau Beta Pi Engineering Honors Society

Publications

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Editorships & Editorial Review Boards

Technical Session Chair, 2017 IEEE Sensors Application Symposium

Peer Reviews

IEEE Transactions on Energy Conversion 2009–Present

IEEE Transactions on Instrumentation & Measurement 2010–Present

Energy Efficiency Oct. 2015–Present

IEEE Sensors Journal Jan. 2016–Present

IEEE Access March 2019–Present

Appendix C
Malima Wolf, Ph.D., CFEI
Curriculum Vitae

Exponent®
Engineering & Scientific Consulting

Malima Wolf, Ph.D., P.E., CFEI

Managing Engineer | Thermal Sciences
Natick
+1-508-652-8570 | mwolf@exponent.com

Professional Profile

Dr. Wolf specializes in heat transfer and thermodynamics. Her work at Exponent also includes investigating the origin and cause of fires and explosions.

She has conducted scene and laboratory inspections for incidents involving a variety of construction and consumer products, including water heaters, space heaters, gas piping, gasoline dispensing systems, and plumbing fittings. She has focused on incidents involving gas systems and gas appliances, including residential customer and distribution system incidents, and has worked with gas system models including Synergi.

Additionally, Dr. Wolf has broad experience in laboratory and field testing, including the design, construction, and instrumentation of customized experimental apparatus for project-specific problems. Examples include gasoline aging and gas can explosion testing. She also has extensive experience with polychlorinated biphenyl (PCB) -containing products including electrical equipment such as transformers and light ballasts.

Prior to joining Exponent, Dr. Wolf was a Senior Engineer at BlazeTech, Corp., focusing on heat transfer, fire, and safety related projects. She created analytical and numerical models for a variety of heat transfer and fluid projects including burn injury of human skin, thermal deflection, humid heat transfer, cavity formation, and composite degradation. Her experimental work there included the design and instrumentation of laboratory and field fire and heat transfer tests, and hyperspectral image analysis of material streams for separation. She designed and developed novel fire protection systems, including foaming fire suppression systems.

Dr. Wolf's academic work focused on energy use and environmental impact of manufacturing systems. As a researcher at Politecnico di Milano and ITIA-CNR and graduate student at MIT's Environmentally Benign Manufacturing Lab, she focused on the design of recycling systems as manufacturing systems, including performance analysis and facility design. She served as an environmental impact consultant on several research projects while at MIT, including tracking the environmental impact of waste after disposal and evaluating individual environmental impact based on personal lifestyle. Her research interests continue to include green manufacturing and the thermodynamics of materials systems including recycling systems. Also while at MIT, she designed testing apparatus and mechanical components including tooling for underwater robotics systems.

Academic Credentials & Professional Honors

Ph.D., Mechanical Engineering, Massachusetts Institute of Technology (MIT), 2011

M.S., Mechanical Engineering, Massachusetts Institute of Technology (MIT), 2006

B.S., Mathematics, Massachusetts Institute of Technology (MIT), 2004

B.S., Mechanical Engineering, Massachusetts Institute of Technology (MIT), 2003

Licenses and Certifications

Professional Engineer, Hawaii, #PE-20940

Professional Engineer Mechanical, Massachusetts, #52693

Professional Engineer, Oregon, #97257PE

Certified Fire and Explosion Investigator (CFEI)

PADI Certified Open Water Scuba Diver

Publications

Davies W, E Wikramanayake, M Wolf, A Hudgins. Transient Effects of Injecting Green Hydrogen into Natural Gas Pipelines. AIChE 10th International Congress on Sustainability Science & Engineering (ICOSSE2021), September 13-15, 2021.

Davies W, M Wolf, M Barry, S O’Hern, T Morse. The Effect of Valve Closure Time on Water Hammer. Proceedings of the ASME 2021 International Mechanical Engineering Congress and Exposition (IMECE2021), November 1-5, 2021.

Ibarreta AF, Colella F, Wolf MI, Yen, M, O'Hern SC, Myers TJ. Modeling of explosion venting fireballs. Proceedings, Mary K O'Connor Process Safety Symposium, College Station, TX, 2019.

Morse TL, Colella F, Wolf MI, Barry MT. Space Heater Fires and Fire Investigation, Proceedings, International Symposium on Fire Investigation Science and Technology, Itasca, IL, 2018.

Ibarreta AF, Colella F, Wolf MI, Vickery J, O’Hern SC, Myers TJ. Measuring leak flow rates in fire and explosion investigations. Proceedings, International Symposium on Fire Investigation Science and Technology, Itasca, IL 2018.

Ibarreta AF, Colella F, Wolf MI, O’Hern SC, Myers TJ. Modeling of explosion venting fireballs. Proceedings, 13th International Symposium on Hazards, Prevention, and Mitigation of Industrial Explosions (ISHPMIE), Kansas City, MO, 2018.

Wolf MI, Colledani M, Gershwin SB, Gutowski TG. A network flow model for the performance evaluation and design of material separation systems for recycling. IEEE Transactions on Automation Science and Engineering, 2013.

Phithakkitnukoon S, Wolf MI, Offenhuber D, Lee D, Biderman A, Ratti C. Tracking trash. IEEE Pervasive Computing, 2013.

Offenhuber D, Wolf MI, Ratti C. Trash Track - Active location sensing for evaluating e-waste transportation. Waste Management & Research, 2013.

Offenhuber D, Lee D, Wolf M, Phithakkitnukoon S, Biderman A, Ratti C. Putting matter in place: tradeoffs between recycling and distance in planning for waste disposal. Journal of the American Planning Association, 2012. JAPA Best Article of 2012

Boustani A, Girod L, Offenhuber D, Britter R, Wolf MI, Lee D, Miles S, Biderman A, Ratti C. Investigation of the waste-removal chain through pervasive computing. IBM Journal of Research and Development, 2011.

Presentations

Oakland County Association of Arson and Fire Investigators, Inc., “OCAAFII Quarterly Training: Recent Updates to NFPA 921, Spontaneous Combustion, and Residential Fuel Gas Explosions," November 17, 2020.

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Corrosion Testing of 40% Copper-Clad Steel (CCS) Conductors and Associated Connectors

Exponent®

Corrosion Testing of 40% Copper-Clad Steel (CCS) Conductors and Associated Connectors

Prepared For:

Copperweld Bimetallics, LLC.
Brentwood, TN 37027
For Use and Publication in the NFPA Standards Setting Process

Prepared By:

Vir Nirankari, Ph.D., P.E.
Managing Engineer, Materials and Corrosion Engineering

Noah Budiansky, Ph.D., P.E.
Senior Managing Engineer, Materials and Corrosion Engineering

Exponent, Inc.
1075 Worcester St.,
Natick, MA 01760

August 27, 2024

Table of Contents

Acronyms and Abbreviations

A	ampere, or amps
Ag	silver
AgCl	silver chloride
ASTM	ASTM International (formerly American Society for Testing and Materials)
AWG	American Wire Gauge
CCS	copper-clad steel
40% CCS	copper-clad steel conductors that are nominally 40% of the conductivity of the same-sized copper conductors at 60 Hz
CR	corrosion rate
Cu	copper
g	grams
in-lbs	inch-pounds
LPS	lightning protection system, or systems
M	molar, or moles per liter
mil	one-thousandth of an inch, or 0.001 inches
mm	millimeters
mpy	mils per year
NaCl	sodium chloride
NEC	National Electric Code
NFPA	National Fire Protection Association
wt	weight
μΩ	microohms

1.0 Executive Summary

1.1 Overview

1. Copper-clad steel (CCS, specifically 40% CCS)[1] was proposed as a material of use as a grounding electrode conductor (GEC) in the National Electric Code (NEC),[2] and as a down conductor for lightning protection system (LPS) in NFPA 780.[3]

2. At the request of Copperweld Bimetallics LLC, Exponent comparatively evaluated the corrosion resistance and reliability of both copper (Cu) and 40% CCS conductors when used in electrical connections.

1.2 Test Objectives

3. The objective of this testing was to comparatively evaluate the corrosion resistance and reliability of both Cu and CCS conductors when used in electrical connections, particularly in environments prone to salt exposure.

4. More specifically, the testing described in this report includes evaluating galvanic corrosion susceptibility of combinations of Cu and CCS conductors (using ASTM G71 as a guide),[4] and comparatively evaluating the reliability of Cu and CCS conductors used in electrical connections when subjected to an aggressive salt spray environment (through ASTM B117).[5]

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[1] In the context of this testing, 40% CCS refers to CCS conductors that are nominally 40% of the conductivity of the same-sized copper conductors at 60 Hz.
For the purposes of this report, CCS shall be used interchangeably with 40% CCS.

[2] The NEC is also known as the National Fire Protection Association (NFPA) 70.
A GEC is defined in the NEC as "[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*."
NEC 2023, §100.

[3] NFPA 780 is titled "Standard for the Installation of Lightning Protection Systems."
Exponent understands that these proposals were submitted through the NFPA's public input process.

[4] ASTM G71-81R24 is titled "Standard Guide for Conducting and Evaluating Galvanic Corrosion Tests in Electrolytes."

[5] ASTM B117-19 is titled "Standard Practice for Operating Salt Spray (Fog) Apparatus."

1.3 Findings

5. The results from this study indicate that, in a simulated seawater environment:

    5.a. The corrosion rate of uncoupled Cu, CCS, and steel were calculated to be approximately 8.3 mpy, 2.9 mpy, and 7.7 mpy, respectively; and

    5.b. The magnitude of galvanic effects appears to be a small fraction for Cu-Cu, CCS-CCS, and CCS-Cu couples, especially when compared to the more pronounced galvanic effect when Cu or CCS is coupled with steel.

6. The results from this study indicate that, from the salt spray testing, the weight loss was not significantly different between Cu and CCS connector samples, the contact resistance for the Cu connector samples was lower than the CCS connector samples (both before and after testing), the overall change in the mean contact resistance was similar for both Cu and CCS, and the relative change in the contact resistance was lower for CCS compared to Cu.

2.0 Testing Overview and Results

2.1 Galvanic Corrosion Testing

2.1.1 Testing Overview

7. "Galvanic corrosion" is an electrochemical process where accelerated corrosion occurs when two metals with different electrochemical potentials are in electrical contact and exposed in close proximity to the same environment or electrolyte (i.e., in ionic contact). The metal with a more negative potential (i.e., anode) tends to lose electrons or experiences accelerated oxidation (corrosion), while the metal with a more positive potential (i.e., cathode) gains electrons or is reduced (i.e., the corrosion rate is decreased).[6]

8. Galvanic corrosion testing measures the corrosion behavior of two materials in direct electrical contact in the same environment or electrolyte in close proximity to one another. The rate of corrosion is typically evaluated through weight loss measurements or by measuring the current between the two coupled materials. One standard typically used as a guide is ASTM Standard G71 (Standard Guide for Conducting and Evaluating Galvanic Corrosion Tests in Electrolytes).

9. To assess the effect of galvanic coupling, the corrosion rates of the galvanically coupled materials is compared with their uncoupled corrosion rates in the same environment.[7]

10. Test specimens were prepared from strands of 19-strand 4/0-AWG Cu and CCS conductors, along with a mild steel wire.[8] The strands/wires were approximately 3 mm in diameter and were cleaned from the as-received condition (i.e., were not polished) with Alconox to remove light surface residues and oils used during manufacturing.

11. An electrical wire was attached to each specimen to provide electrical contacts to the metal samples for electrochemical measurements. All electrical connections were masked

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[6] Jones, D. *Principles and Prevention of Corrosion*, 2nd Ed., 1996. §§ 1.5.2, 6; pp. 11-13, 168-169.

[7] ASM Handbook, Volume 13A, *Corrosion Fundamentals, Testing, and Protection*, 2003, PDF pp. 206-208.

[8] Testing with steel was conducted only to illustrate the galvanic behavior of materials considered to be dissimilar.

with a silicone-based sealant to insulate them from the test electrolyte. In addition, the cut end of each wire sample was masked to prevent any exposure of the steel core (in the case of the CCS) to the test solution. The coupled material combinations tested were Cu-Cu, CCS-CCS, CCS-Cu, Cu-Steel, and CCS-Steel (see Figure 1 for a representative photograph).

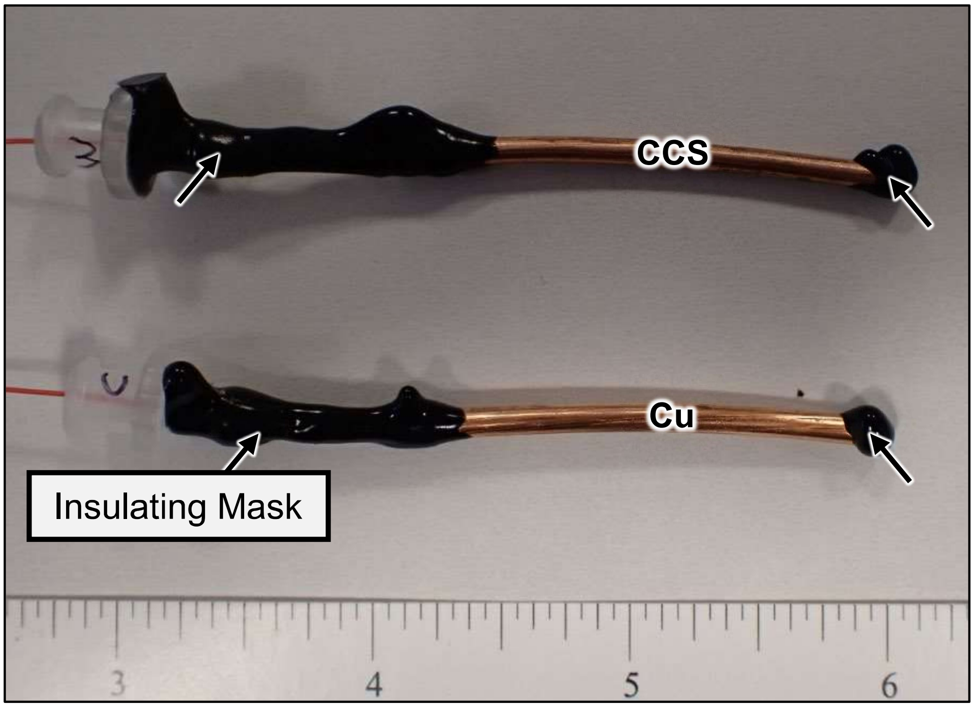

Figure 1. Photograph showing the CCS (top) and Cu (bottom) strands coupled for CCS-Cu galvanic corrosion testing. The insulating masks are noted with the black arrows.

12. While ASTM G71 notes that the test solution "*should closely approximate the service environment*,"[9] the test objective was to evaluate whether coupling (CCS and Cu) had the propensity to induce accelerated corrosion; thus, more severe conditions than the anticipated service environment were selected. The test environment was designed to evaluate whether the combination of CCS-Cu behaved similar to Cu-Cu / CCS-CCS couples.

12.a. Testing under more severe conditions allows evaluation of the galvanic couple behavior under "worst-case" scenarios in a relatively short period of time.

[9] ASTM G71-81R24, §5.1.1

12.b. Accordingly, results obtained from this testing should be interpreted with the explicit understanding that they represent performance under more severe conditions than is typical for these conductors.

13. Testing was conducted using 3.5 wt% sodium chloride (i.e., 0.6 M NaCl) solution. The test solution was sparged with air (to maintain a uniform oxygen concentration in the test solution) for a minimum of 1 hour prior to testing and continuously throughout the entire test duration. All testing was conducted at room temperature, which was measured to be between 19 °C and 22 °C. The pH of the solution was measured, but no pH range was specified. The pH was between approximately 6 and 7 pH units and was measured prior to and after each test.[10] A photograph showing the test cell is provided in Figure 2.

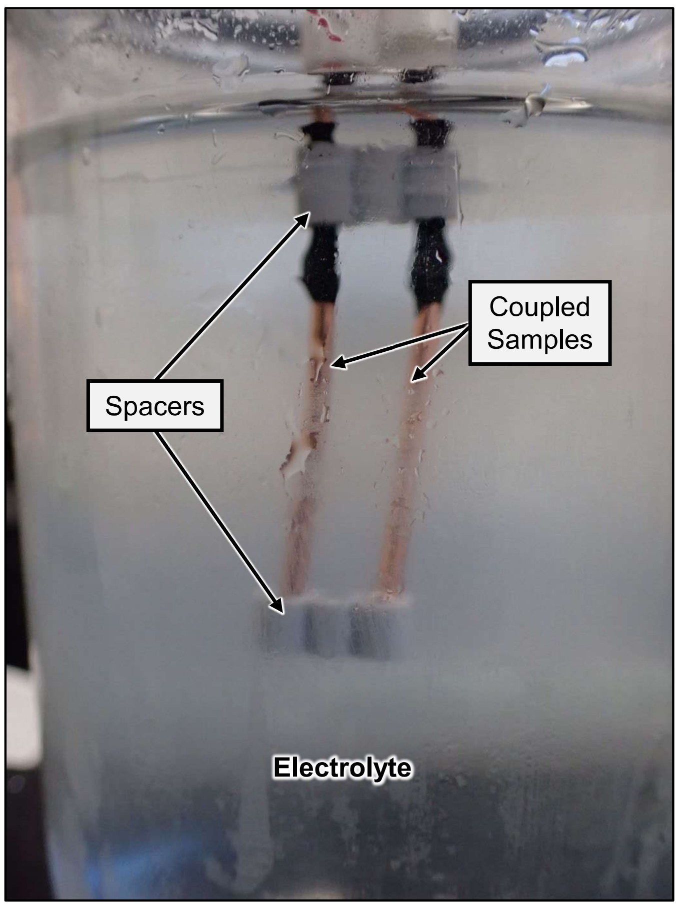

Figure 2. Photograph of a test cell for galvanic corrosion testing. The coupled samples were placed in an 0.6 M NaCl solution for 24 hours.

[10] Exponent notes that, that in some instance the test finished during non-business hours and was left for an extended period of time before the pH was measured.

14. Electrochemical galvanic corrosion susceptibility was evaluated by measuring the galvanic couple between the two electrodes utilizing zero-resistance-ammeter mode in a potentiostat. Gamry potentiostats were used for all testing. Silver-silver chloride (Ag-AgCl) reference electrodes were used for all testing, and the potential was converted to a saturated calomel scale for comparison to the corrosion literature. It was assumed that all measured galvanic current between the two electrodes was due to galvanic corrosion.

15. The test was conducted for a 24-hour period, with measurements of galvanic current and potentials recorded at 30-second intervals throughout the test duration. The corrosion current was determined by calculating the mean current from the last 15 minutes of testing.

16. All samples were prepared to achieve an approximately 1:1 surface area ratio. However, due to slight differences in diameter and masking area, an exact 1:1 ratio could not be achieved.

17. Uncoupled corrosion currents (which is directly related to the corrosion rate) were measured using ASTM G102 and ASTM G61 as guides.[11] Potentiodynamic corrosion testing was conducted after 24 hours of exposure time to the electrolyte (the same time used for galvanic corrosion testing) to evaluate the corrosion behavior of the uncoupled material.[12]

18. All testing was conducted in triplicate with the exception of testing Cu-Steel and CCS-Steel couples (which was conducted with single tests to illustrate the galvanic behavior of materials that are considered to be dissimilar). The results are provided in the following section.

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[11] ASTM G102 is titled "Standard Practice for Calculation of Corrosion Rates and Related Information from Electrochemical Measurements."
ASTM G61 is titled "Standard Test Method for Conducting Cyclic Potentiodynamic Polarization Measurements for Localized Corrosion Susceptibility of Iron-, Nickel-, or Cobalt-Based Alloys."

[12] The corrosion current was determined from the potentiodynamic curves using Tafel extrapolation technique, and the corrosion current was used to calculate the corrosion rate using Faraday's law. See ASTM G102 and ASTM G1 for further detail.

2.1.2 Testing Results

19. The coupled corrosion rate was calculated from the mean measured current from the last 15 minutes of the 24-hour exposure duration from each galvanic corrosion test. The mean of the three tests was calculated and is shown in Table 1.

19.a. The mean coupled corrosion rate for CCS-Cu was 0.23 mils per year (mpy).[13] The CCS acted as the anode in all of the tests conducted. Similarly, the mean coupled corrosion rate was 0.33 mpy and 0.17 mpy for Cu-Cu and CCS-CCS, respectively.

19.b. In contrast, when Cu or CCS is coupled to steel, the steel becomes the anode and Cu or CCS becomes the cathode. The coupled corrosion rate was calculated to be 26.30 mpy and 19.07 mpy when steel is coupled to Cu or CCS, respectively.[14]

20. For comparison, the corrosion rate of each material when uncoupled was calculated to elucidate the contribution of coupled (i.e., galvanic) corrosion rate to the total corrosion rate of Cu, CCS, and steel in a simulated seawater environment (0.6 M NaCl solution). This corrosion rate was calculated after 24 hours of exposure (to mimic the duration of the galvanic corrosion testing). The corrosion rate of Cu, CCS, and steel were calculated to be 8.35 mpy, 2.92 mpy, and 7.66 mpy, respectively.

21. The ratio of the coupled corrosion rate to the total corrosion rate was calculated to determine the galvanic contribution to the total corrosion rate. As shown in Table 1, the contribution of galvanic coupling to the total corrosion rate for Cu-Cu and CCS-CSS couples was found to contribute up to approximately 5.4% of the total current. Additionally, CCS-Cu coupling contributes approximately 7.3% of the total current. While this value is higher than coupling like-materials, CCS-Cu coupling nevertheless contributes only a small fraction of the total corrosion rate.

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13 A “mil” is one-thousandth of an inch, or 0.001 inches.

14 Exponent notes that these values were calculated from a single test and was conducted only to illustrate the behavior of dissimilar materials.

Table 1. Calculated mean corrosion rates (CRs) for uncoupled and coupled corrosion testing in 0.6 M NaCl solution (designed to simulate seawater) at room temperature.

	Uncoupled CR (mpy)[15]	Coupled CR (mpy)	Total CR (mpy)	Ratio of Coupled CR/Total CR (%)	Anode
Cu-Cu	8.35	0.33	8.68	3.79	Cu
CCS-CCS	2.92	0.17	3.09	5.36	CCS
CCS-Cu	2.92	0.23	3.15	7.33	CCS
Cu-Steel	7.66	26.30	33.95	77.45	Steel
CCS-Steel	7.66	19.07	26.72	71.35	Steel

21.a. This could be due to slight differences in composition, surface roughness, residual stresses/cold work, among others. Furthermore, as shown, even seemingly identical materials (i.e., Cu-Cu and CCS-CCS) can exhibit small galvanic effects due to subtle differences that can arise between samples.

21.b. For comparison, coupling contributes the majority of the corrosion when Cu/CCS is coupled to steel. Coupling contributes between approximately 71.4% and 77.5% of the total current for CCS-steel and Cu-steel, respectively.

21.c. Thus, the magnitude of the galvanic effects appears to be small fraction of the total corrosion of Cu-Cu, CCS-CCS, and CCS-Cu cases (with CCS-Cu being the highest), especially compared to the galvanic effect when Cu or CCS is coupled with steel.

2.2 Salt Spray Testing

2.2.1 Testing Overview

22. Salt spray testing (in accordance with the requirements of ASTM B117)[16] was performed to evaluate the comparative corrosion resistance and the contact resistance of the electrical connection assembly under aggressive salt spray (such as long-term exposure to marine environments) in a compressed timeframe.

[15] The uncoupled corrosion rate is the baseline corrosion rate of the anode in the galvanic couple.

[16] ASTM B117-19,"Standard Practice for Operating Salt Spray (Fog) Apparatus."

23. While salt spray testing can provide insights into corrosion behavior, Exponent understands that this test simulates a more severe environment than these conductors are expected to encounter in service, and the test results should be interpreted with this in mind.

24. The samples tested consisted of 19 strand 4/0-AWG Cu and CCS conductors terminated onto both straight and cross-connectors. All connections joined similar materials (either Cu-Cu, or CCS-CCS) and was tested in triplicate. Additionally, unconnected control samples (consisting of Cu/CCS conductors and straight/cross-connectors) were also tested and assembled only after salt spray testing. Prior to testing, the as-received samples were cleaned with acetone to remove any surface residues. Representative photographs of the connector samples before testing are shown in Figure 3.

Straight Connector

Cross Connector

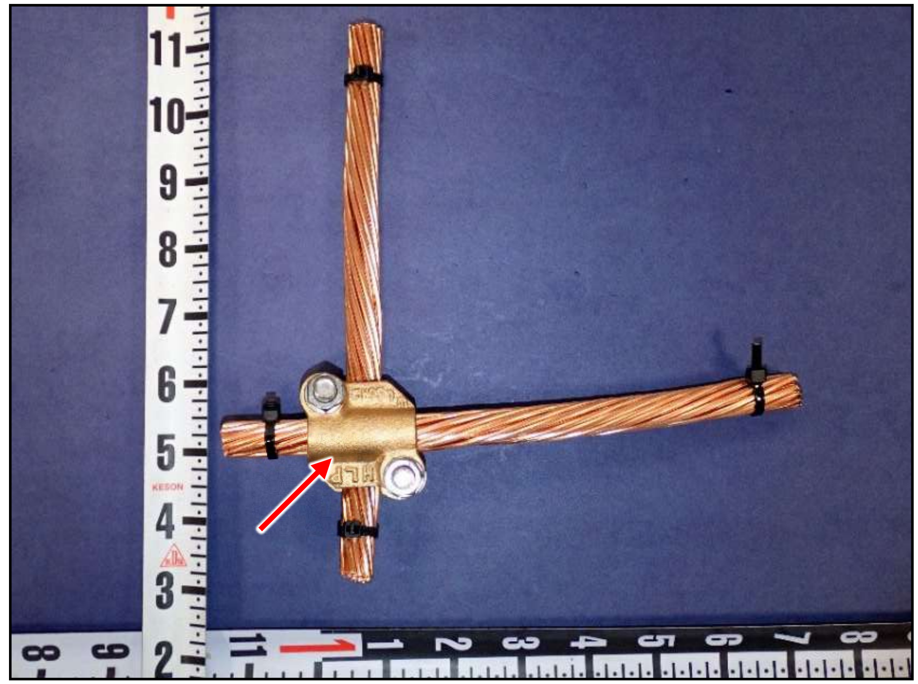

Figure 3. Representative photographs of the (left) straight connector and (right) cross-connector used for this testing. The connector is noted with the red arrow. The zip ties were removed for testing.

25. The connections were terminated to the appropriate tightening torque (by using a calibrated torque wrench) of 80 in-lbs as per the manufacturer's instructions. Contact resistance measurements and sample weight was measured before and after testing.

26. Samples were placed in a salt spray chamber configured to maintain conditions as outlined in ASTM B117 (i.e., 5% NaCl solution).[17] Samples were carefully spaced in the chamber to ensure both uniform exposure to the salt spray and to prevented dripping condensation.[18]

27. The samples were continuously exposed to salt spray for a duration of 200 hours, with the chamber operating uninterrupted during this period. Upon completion of the 200-hour exposure period, samples were carefully removed, rinsed, and dried for subsequent evaluation. The results are provided in the following section.

2.2.2 Testing Results

28. After completion of the salt spray testing, all samples exhibited evidence of visible corrosion. Representative photographs of the samples before and after testing are shown below in Figure 4, Figure 5, and Figure 6. Weight loss and contact resistance measurements are summarized below in Table 2 and Table 3.

[17] ASTM B117-19, §§ 10.1-10.2.

[18] Dripping condensation could result in non-uniform salt concentration and/or cross-contamination, which could lead to non-representative localized areas of accelerated corrosion.

Table 2. Weight Loss and Contact Resistance Measurements (Connector Samples)

Sample Type / ID		Sample Weight (g)			Contact Resistance (μΩ)		
		Before Testing	After Testing	Weight Loss	Before Testing	After Testing	Δ
Straight	**CCS 1**	414.4	410.9	3.5	46.6	58.1	11.5
Straight	**CCS 2**	407.5	405.5	2.0	42.1	55.2	13.1
Straight	**CCS 3**	414.8	412.5	2.3	53.2	62.1	8.9
Cross	**CCS 1**	518.8	517	1.8	68.1	63.9	-4.2
Cross	**CCS 2**	524.5	521.2	3.3	30.7	41.6	10.9
Cross	**CCS 3**	525.9	521.7	4.2	62.2	62.9	0.7
Straight	**Cu 1**	430.2	429.4	0.8	26.4	33.8	7.4
Straight	**Cu 2**	442.7	440.5	2.2	24.2	32.7	8.5
Straight	**Cu 3**	436	434.7	1.3	29.3	31.6	2.3
Cross	**Cu 1**	548	545.3	2.7	17.9	21.6	3.7
Cross	**Cu 2**	547.7	545.8	1.9	13.6	22.3	8.7
Cross	**Cu 3**	557.3	553.7	3.6	16.3	18.9	2.6

Table 3. Weight Loss and Contact Resistance Measurements (Control Samples)

Sample Type / ID		Sample Weight (g)[19]			Contact Resistance (μΩ)
		Before Testing	After Testing	Weight Loss	After Testing and Assembly
Straight	**CCS Ctrl**	581.2	579.2	2.0	174.8
Cross	**CCS Ctrl**	592.3	591.7	0.6	95.9
Straight	**Cu Ctrl**	557.7	556.6	1.1	181.1
Cross	**Cu Ctrl**	588.8	586.8	2.0	53.9

29. The mean weight loss for the Cu connector samples was 2.1 g ± 1.0 g, while the mean weight loss for the CCS connector samples was 2.9 g ± 1.0 g. Thus, the overall weight loss was not significantly different between materials. Moreover, the weight loss for the control samples was minimal (ranging from approximately 0.6 g to 2.0 g).

[19] The reported weight is the sum of the conductors and connector before assembling for contact resistance measurements.

30. The mean contact resistance for the Cu connector samples before and after testing was 21.3 μΩ ± 6.2 μΩ and 26.8 μΩ ± 6.6 μΩ, respectively, while the mean contact resistance for the CCS connector samples before and after testing 50.5 μΩ ± 13.7 μΩ and 57.3 μΩ ± 8.4 μΩ, respectively.

30.a. As shown by the data, the mean contact resistance of Cu samples is lower than CCS samples, and both Cu and CCS experienced an increase in contact resistance following salt spray testing. The increase in contact resistance is similar for both materials, with a difference in the mean contact resistance of approximately 5.5 μΩ and 6.8 μΩ for Cu and CCS, respectively. Further, the relative change in contact resistance was lower for CCS, with the relative change being approximately 13.5% for CCS and approximately 26.0% for Cu.

30.b. Moreover, the contact resistance for the control samples is notably higher than the connector samples, with the Cu and CCS straight connector samples showing similar contact resistance (approximately 174.8 μΩ and 181.1 μΩ, respectively), and the Cu cross-connector sample having a lower contact resistance than CCS cross-connector sample (approximately 53.9 μΩ and 95.9 μΩ, respectively). This suggests that the contact interfaces of the assembled samples were partially shielded from the salt spray.

31. Thus, the weight loss was not significantly different between Cu and CCS samples, the contact resistance for the Cu connectors was lower than the CCS (both before and after testing), the overall change in the mean contact resistance was similar for both Cu and CCS (at approximately 5.5 μΩ and 6.8 μΩ, respectively), and the relative change in the contact resistance was lower for CCS compared to Cu (at approximately 13.5% and 26.0%, respectively).

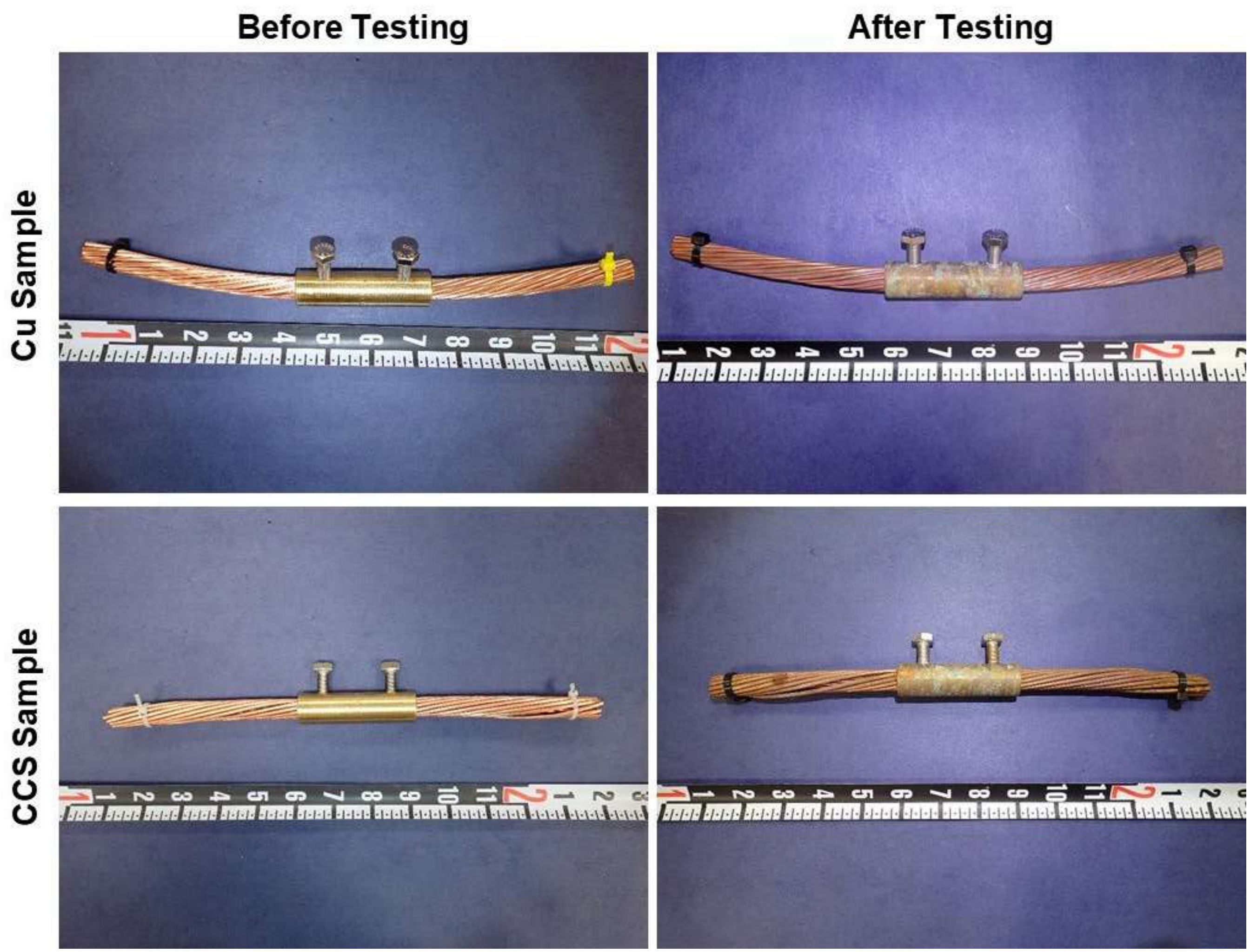

Figure 4. Representative photographs showing the straight connector samples before and after testing for Cu (top row) and CCS (bottom row). The zip ties were removed for testing.

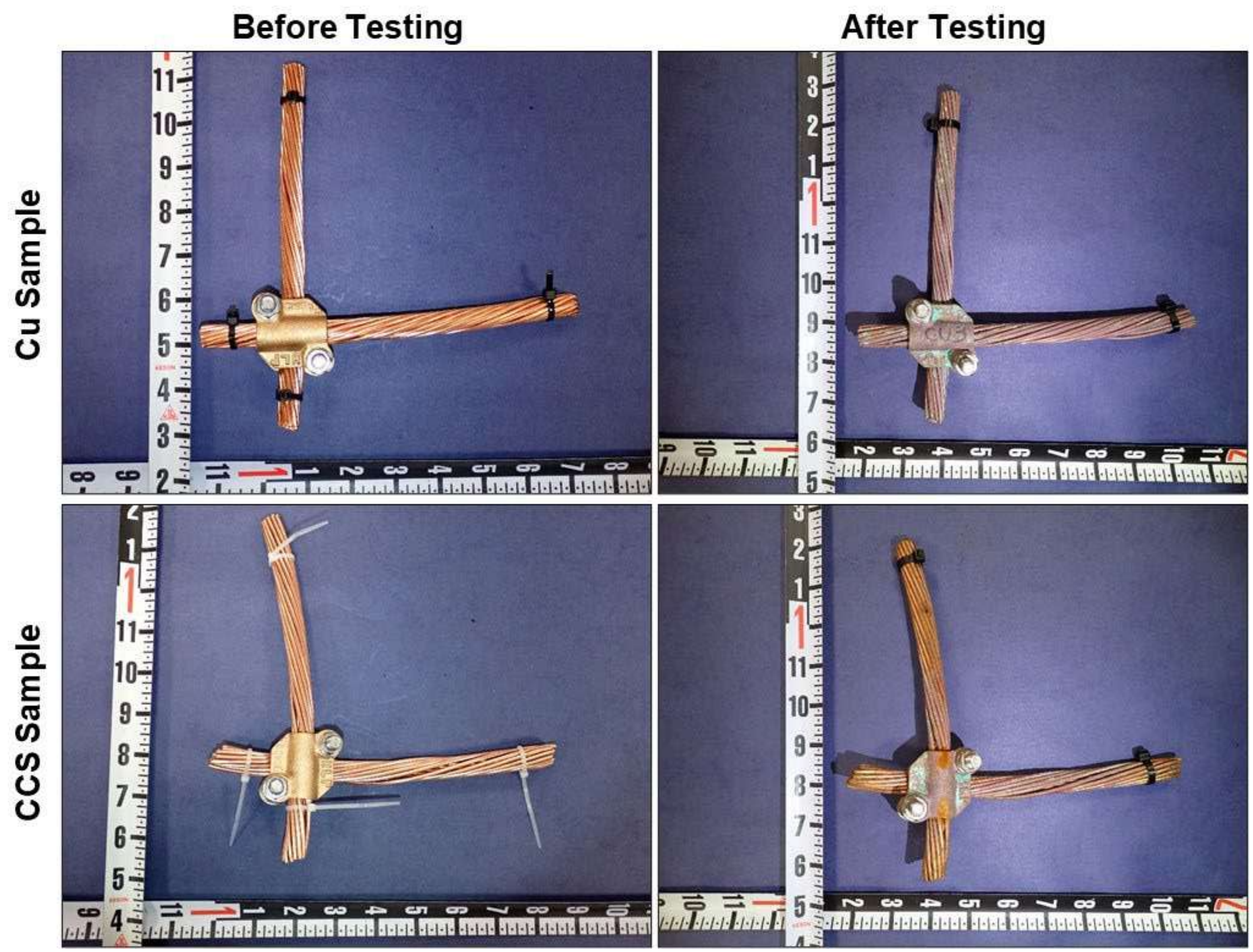

Figure 5. Representative photographs showing the cross-connector samples before and after testing for Cu (top row) and CCS (bottom row). The zip ties were removed for testing.

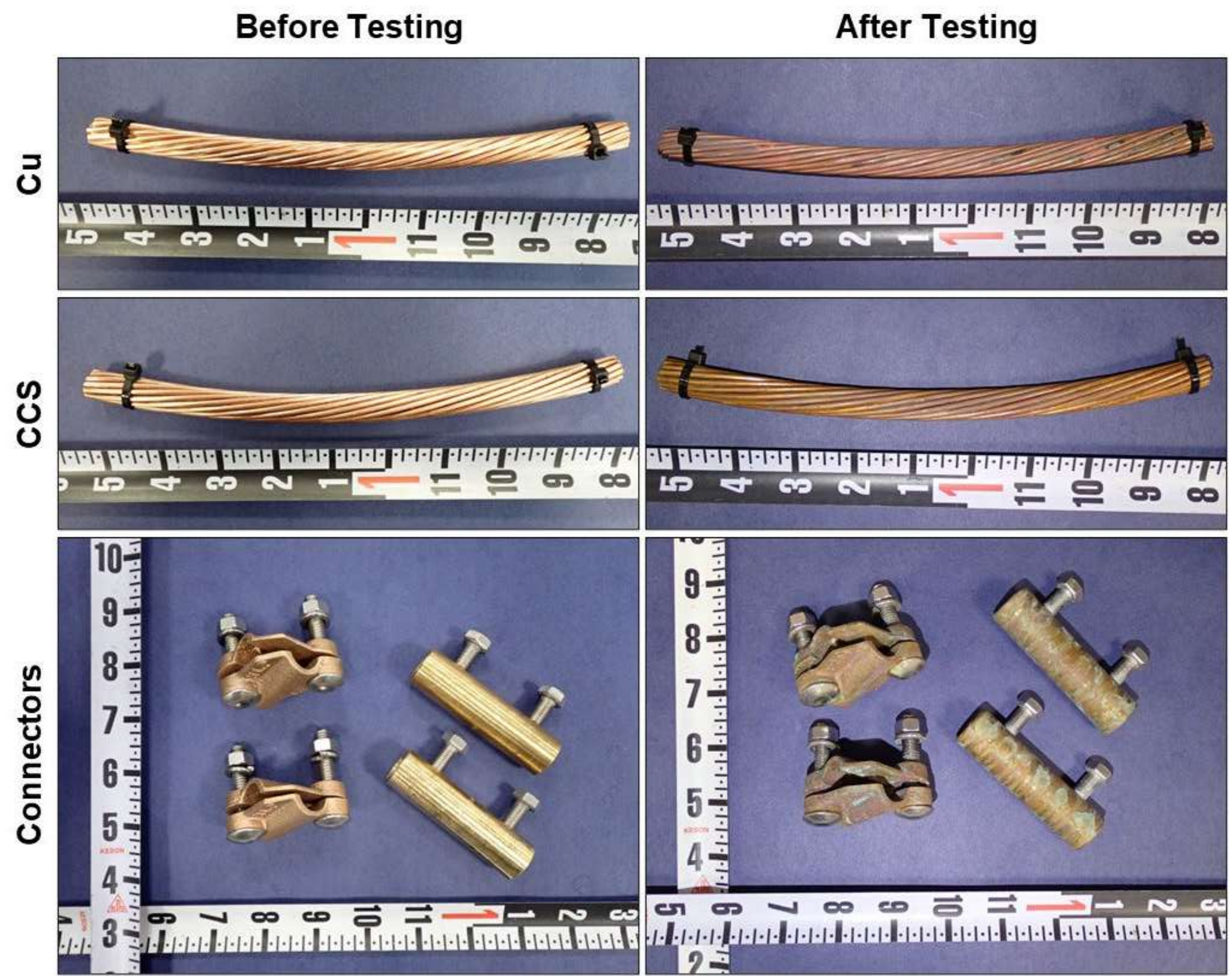

Figure 6. Representative photographs showing the unconnected control samples before and after testing for a Cu conductor (top row), a CCS conductor (middle row), and the straight / cross-connectors (bottom row). Samples were assembled after salt spray testing.

3.0 Limitations

32. This report includes results of work conducted at the request of Copperweld Bimetallics LLC.

33. The material contained herein is presented to a reasonable degree of scientific and engineering certainty and may not adequately address the needs of any or all users of this report. Any re-use of this report, or any of its contents, is made at the sole risk of the user. No guarantee or warranty as to future relevance is expressed or implied.

34. Exponent reserves the right to supplement this report and to expand or modify its contents based on review of additional material as it becomes available and/or through any additional work or review of additional work performed by others.

35. In the testing described above, we have relied on materials and information provided by Copperweld Bimetallics LLC. We cannot verify the correctness of this input and rely on Copperweld Bimetallics LLC for accuracy.

36. Although Exponent has exercised usual and customary care in preparing this summary presentation, the responsibility for the design, manufacture, and quality of their products remains fully with Copperweld Bimetallics LLC.

Appendix A
Vir Nirankari, Ph.D., P.E.
Curriculum Vitae

Exponent®
Engineering & Scientific Consulting

Vir Nirankari, Ph.D., P.E.

Managing Engineer | Materials and Corrosion Engineering
Natick
+1-508-652-8566 | vnirankari@exponent.com

Professional Profile

Dr. Nirankari's areas of expertise include failure analysis, metallurgy, fracture, welding, finite element modeling and materials characterization. He has conducted research and failure analysis of metals and welds involving both experimental and computational approaches.

Dr. Nirankari has applied his expertise to a range of engineering fields, including automotive, aerospace, consumer electronics and utilities. He also has experience with mechanical testing techniques, fractography, metallurgical and microstructural analysis, non-destructive evaluation, microscopy and computational mechanics.

Dr. Nirankari has extensive experience performing mechanical testing as well as microstructural analysis via optical microscopy, scanning electron microscopy (SEM), electron backscattered diffraction (EBSD), transmission electron microscopy (TEM) and energy dispersive X-ray spectroscopy (EDS). He is also skilled in computed tomography (CT). His computational expertise lies in use of finite element modeling. He has extensive experience with commercial finite element software (Abaqus) and computer aided design software (SolidWorks).

During his graduate study at the University of Michigan, Dr. Nirankari's research included the use of mechanical testing to understand the crack initiation and small crack propagation behavior of aluminum spot welds and finite element modeling to predict the weld lifetime. As an undergraduate, Dr. Nirankari's research focused on improving the efficacy of plasma sprayed thermal barrier coatings for turbine blades.

Academic Credentials & Professional Honors

Ph.D., Materials Science and Engineering, University of Michigan, Ann Arbor, 2017

B.S., Mechanical Engineering, Boston University, 2010

Licenses and Certifications

Professional Engineer Metallurgical, California, #2039

SOLIDWORKS Certificate in Mechanical Design

Prior Experience

Graduate Student Research Assistance, University of Michigan, 2011-2017

Professional Affiliations

American Welding Society (AWS) D10 Committee on Piping and Tubing:

AWS D10V Subcommittee on Tubular Steel Vehicle Structure

AWS D10 Committee on Piping and Tubing: AWS D10H Subcommittee on Aluminum Piping

AWS D8 Committee on Automotive Welding: AWS D8D Subcommittee on Automotive Resistance Spot Welding

International Organization for Standardization (ISO): ISO/TC 44/SC6, Resistance welding and allied mechanical joining

Publications

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Editorships & Editorial Review Boards

Journal of Failure Analysis and Prevention (Associate Editor)

Peer Reviews

International Journal of Fatigue

Journal of Failure Analysis and Prevention

Appendix B
Noah Budiansky, Ph.D., P.E.
Curriculum Vitae

Exponent® Engineering & Scientific Consulting

Noah Budiansky, Ph.D., P.E.

Senior Managing Engineer | Materials and Corrosion Engineering
Natick
+1-508-652-8516 | nbudiansky@exponent.com

Professional Profile

Dr. Budiansky's expertise is in metallurgy and corrosion science and engineering. He specializes in failure analysis, material degradation, failure prevention, material selection, material characterization, and laboratory testing in the areas of implantable medical devices, portable electronic devices and consumer appliances, gas pipelines and water distribution, chemical processing and food production, paints and coatings, mechanical fasteners, and building and structures.

Dr. Budiansky has conducted research and corrosion failure analyses involving uniform corrosion, localized corrosion, stress corrosion cracking, hydrogen embrittlement, fretting corrosion, formicary corrosion, graphitic corrosion, and galvanic corrosion.

Dr. Budiansky has extensive experience solving complex corrosion problems using AC and DC electrochemical techniques, accelerated exposure techniques (environmental exposure and accelerated environments), material characterization techniques (microscopy and elemental analysis), metallographic examination, fractography, on-site investigations, and failure analysis.

Academic Credentials & Professional Honors

Ph.D., Materials Science and Engineering, University of Virginia, 2007

M.S., Materials Science and Engineering, University of Virginia, 2003

B.S., Environmental Sciences, University of Massachusetts, Amherst, 1997

Marcel Pourbaix Second Place Prize for Best Poster in Corrosion Science "Material Parameters Associated With Cooperative Spreading Of Localized Corrosion on Heterogeneous Materials," CORROSION/06 Conference Student Poster Session, National Association of Corrosion Engineers, San Diego, CA, 2006

Electrochemical Society Corrosion Division Student Travel Grant for the 3rd International Symposium on Pits and Pores: Formation, Properties and Significance for Advanced Materials, The Electrochemical Society, Honolulu, HI, 2004

Marcel Pourbaix First Place Prize for Best Poster in Corrosion Science, "Origins of Persistent Interactions Among Localized Corrosion Sites Investigated Using Experimental Electrode Arrays," CORROSION/02 Conference Student Poster Session, National Association of Corrosion Engineers, Denver, CO, 2002

Licenses and Certifications

Professional Engineer, New York, #099471

NACE - Certified Coating Inspector Level 1 Certification

NACE Certified Corrosion Technician

Prior Experience

Senior Research Technician, W.R. Grace Construction Products Division, 1997-2000

Geotechnical Laboratory Technician, American Reclamation Inc./Materials Technology Center, 1995-1997

Professional Affiliations

ASM International

- Chairperson Central Massachusetts Chapter, 2013-2014
- Vice Chairperson Central Massachusetts Chapter, 2012-2013

Electrochemical Society (active member)

National Association of Corrosion Engineers (active member)

Patents

Patent 6,277,191: Air Entrainment with Polyoxyalkylene Copolymers for Concrete Treated With Oxyalkylene SRA, August 21, 2001

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Brody v Simpson Development Corp. et al.. United States District Court for the District of Vermont. State of Vermont. Civil Action No. 2:05-cv-293, October 2007.

The Deacons of First Baptist Church in Dorchester v Boston Water and Sewer Commission and P. Gioioso & Sons, Inc.. Commonwealth of Massachusetts. Civil Action No. 07-2974-B, 2011.

Whirlpool v ZIM. Chicago, IL. Deposition (10/21/2011) and Arbitration (11/14/2011).

New Bern v R.H. Shepard. Commonwealth of Massachusetts, Civil Action No. BRCV2008-00510-A. Deposition (11/2012).

Debra Harris and Barbara Stark v Nordyne, LLC. United States District Court in and For the Southern District of Florida Miami Division.Case No. 1:14-cv-21884-BB. Deposition (12/1/2015).

CORROSION ON BURIED COPPER CLAD STEEL

Cece Syarif
Global Application Engineer
&
Anthony Hale
Manager, Utility Products, North America

COPPERWELD

254 Cotton Mill Rd, Fayetteville, TN 37334. Tel. (931) 433 – 7177

July 26, 2011

This paper compiles several studies and analysis regarding the corrosion performance of buried Copperweld® Copper-Clad-Steel (CCS) conductors. These range from the early 1900's with the invention of Copperweld® through the present day with studies performed by independent parties as well as Copperweld Company in-house testing. The purpose is to present the available information so that prospective users of Copperweld® CCS wire and strand can evaluate the corrosion resistance and expected performance within their specific application and area. Copperweld uses oxygen free copper in the manufacture of Copperweld® wire and strand. The copper surface of CCS is expected to oxidize and turn color ranging from green (patination) to brown and black the same as any solid copper wire or strand when exposed to environmental stimuli. Corrosion on exposed steel at the cut tip or end of the wire is also expected. The question to be answered is if the corrosion on either material or the interface between the copper and steel (galvanic reaction) will result in degradation of the wire as to make it unsuitable for use as a grounding conductor.

The oldest known underground corrosion study of bimetallic material was performed in the early 1900s[1]. This study focused on the corrosion behavior of Copperweld® CCS underground rod as well as other materials such as Copper and galvanized steel ground rod. The National Bureau of Standards (NBS) conducted an extensive underground corrosion study that involves 36,500 specimens which include 333 varieties of ferrous, nonferrous, and protective coating materials buried in 128 test locations throughout U.S in 1910 - 1955.

The study summarizes the service life of a ground rod as following:

10 mils copper coating – acceptable for service life up to 40 years

13 mils copper coating – acceptable for service life up to 50 years

Similarly, the Naval Civil Engineering Laboratory in collaboration with the National Association of Corrosion Engineers conducted a 7-year program of testing metal rods for electrical grounding to determine the galvanic corrosion effect. The three metals tested were stainless clad steel, copper-bonded steel (CCS), and galvanized steel. The result on the ⅝" CCS ground rod was as expected. The copper surface of the CCS was virtually free of corrosion and the steel core has corroded at the tip approximately 2 inches down the length of the rod.

Copperweld Corporation is the inventor and sole manufacturer of Copperweld® Copper-bonded ground rods and Copperweld® wire and strand since 1915. The corrosion behavior of a Copperweld® ground rod is similar to the corrosion on Copperweld® wire and strand conductor. Both materials consist of copper permanently bonded to a steel core. All Copperweld® 40% CCS has a copper thickness of 10% of the overall diameter. For example, Copperweld® 4THOUGHT™ has a configuration of 19 strands of 0.1055 inch wires. It means that each strand has a copper thickness of 10.55 mils. Based on the NBS study, 4THOUGHT™ will have at least a minimum service life of 40 years.

Copperweld has also conducted a 5-year study of buried bare 21% conductivity (copper thickness is 3% of the diameter) Copperweld® CCS in 10 different soil conditions in association with Southwest Research Institute[2]. The study reported 100% surface oxidation and various degrees of deterioration of the steel core as expected after 5 years. The exposed steel on the tip of the wire rusted and formed “scab”, as shown in Figure 1. The rust appeared to “seal-off” the un-oxidized material from the corrosive medium. The maximum depth of corrosion was 70% of the wire diameter.

Figure 1: Example of Underground Corrosion of Copper Clad Steel

Although the copper surface oxidation was heavy, the samples showed no signs of pits or holes in the copper cladding. The copper thickness of a severely oxidized 5-year sample showed no discernable difference when compared to an un-oxidized control sample that was not subjected to the corrosive environment. The mechanical and resistance testing

254 Cotton Mill Rd, Fayetteville, TN 37334. Tel. (931) 433 – 7177

resulted in negligible differences between 5-year samples and the control samples. Thus, the oxidation had no discernable impact on the strength or electrical performance of the wire.

An accelerated corrosion study based on ASTM B117 was conducted on bare CCS and solid Copper wires to evaluate copper surface corrosion. The wires were exposed to salt fog spray for 504 hours. As a result, corrosion on the CCS copper surface showed no significant difference as compared to the corrosion of copper wire.

(a) Copper Clad Steel (b) Copper

Figure 2: Patination of Copper Surface after 504 hours exposure to Salt Fog Spray

In February 2011, three separate sample strands of Copper Clad Steel were un-earthed and cut out from a substation built in Louisville, KY. The conductors were 40% conductivity, Low Carbon Steel, Dead Soft Annealed, 7 No. 5 (231,613 circular mil) and were installed in 1962.

Table 1: Physical properties of the three strands of Copperweld® conductor that had been buried underground for 48 years in a Kentucky substation

			Strand 1	Strand 2	Strand 3
Conductor Type			40% Low Carbon Annealed		
Conductor Size			7 No. 5		
Cross Section Area		*in²*	0.1819	0.1819	0.1819
Diameter of Single end		*inch*	0.1819	0.1819	0.1819
Diameter of Conductor		*inch*	0.5457	0.5457	0.5457
Copper Thickness	Min	*inch*	0.0142	0.0114	0.0134
	Max	*inch*	0.0213	0.0209	0.01975
% Concentricity			83.30%	77.30%	83.90%
Depth of corrosion	Min	*inch*	0.004	0.028	0.111
	Max	*inch*	0.781	0.859	0.484

The 1962 conductors were manufactured by Copperweld with a nominal copper thickness of 10% of its diameter. Figure 3 shows the copper thickness ranges from 11.4 – 21.3 mils and the concentricity of the conductor averaged at 81.5%. Current manufacturing improvements yield concentricity of copper thickness above 85%.

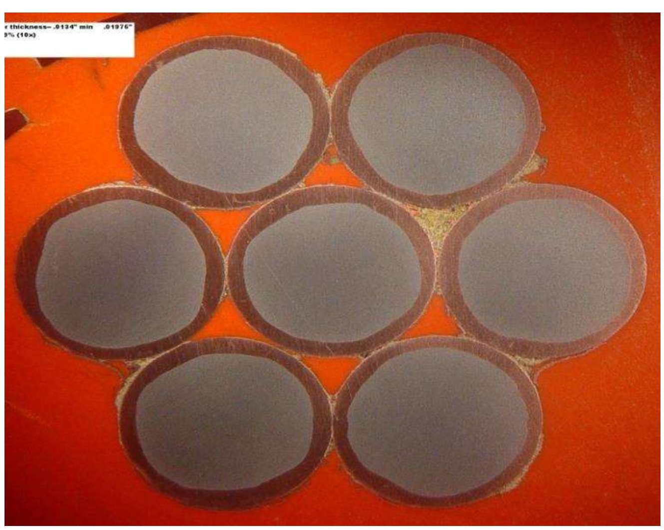

Figure 3: Copperweld® 40% LC DSA 7 No. 5 manufactured in 1962

Figure 4a shows no visible corrosion observed other than oxidation and patination on the copper surface. At the ends of the wires, the corrosion occurred in the form of steel rust. The maximum depth of the corrosion is 0.859 inch with an average of 0.382 inch, as shown in Figure 4b.

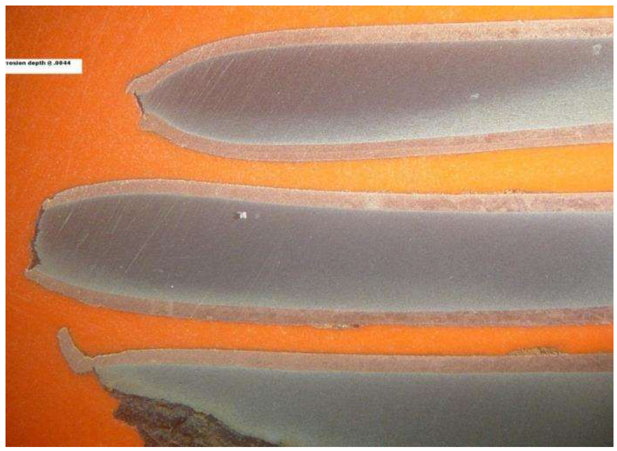

Figure 4a: There is no visible corrosion between the copper and steel on all wires obtained from the substation in Kentucky.

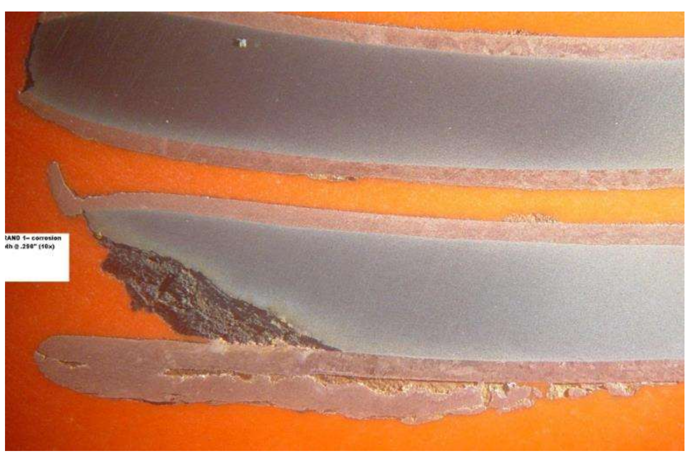

Figure 4b: Corrosion occurred at the ends of the wires. Maximum penetration depth is 0.859 inch.

From all the corrosion studies above, there have not been reported or observed any galvanic corrosion at the interface of copper and steel. The process of cladding for

Copperweld® ensures a metallurgical bond between the two metals. That metallurgical bond prevents any moisture from penetrating between the two metals precluding the corrosion process. Any propagation of corrosion on an area of exposed steel averages two times the diameter of the wire then stops. The corrosion rate of the copper surface is equivalent to that observed on standard solid copper wire and strand. Based on the results of these studies, it can be summarized that CCS can be expected to have a 50 plus year service life as buried grounding conductors.

REFERENCES:

1. Rempe, Chris. 7 July 2003. "A Technical Report on the Service Life of Ground Rod Electrodes".
2. Fox, Dustin, Belado, Chris, and Brossia, Sean. 23 September 2009. "The Effect of Corrosion on Tracer Wire with a Copper Clad Steel Center Conductor".

Public Comment No. 293-NFPA 70-2024 [Section No. 680.26(B)(2)]

(2) Perimeter Surfaces.

Bonding to perimeter surfaces shall be provided as specified in 680.26(B)(2)(a), 680.26(B)(2)(b), and 680.26(B)(2)(c). The perimeter surface shall include unpaved surfaces, concrete, masonry pavers, and other types of paving. The perimeter surface to be bonded shall extend 900 mm (3 ft) horizontally beyond the inside walls of the pool at a height between 900 mm (3 ft) above and 900 mm (3 ft) below the maximum water level. Perimeter surfaces separated from the pool by a permanent wall or building 1.5 m (5 ft) in height or more shall require equipotential bonding only on the pool side of the permanent wall or building.

For conductive pool shells where bonding to perimeter surfaces is required, bonding shall be attached to the pool structural reinforcing steel or copper conductor grid at a minimum of four points uniformly spaced around the perimeter of the pool. If the bonded perimeter surface does not surround the entire pool, bonding shall be attached to the pool reinforcing structural steel or copper or 40% copper-clad steel conductor grid at a minimum of four uniformly spaced points along the bonded perimeter surface.

For nonconductive pool shells, where bonding to the perimeter surfaces is required, bonding at four points shall not be required. The perimeter bonding shall be attached to the 8 AWG copper or 40% copper-clad steel equipotential bonding conductor and, if present, to any conductive support structure for the pool.

> Informational Note: Because the perimeter surface can incorporate various types of materials at various locations and elevations above and below maximum water level, the perimeter surface required to be bonded might not surround the entire pool. The 8 AWG copper or 40% copper-clad steel equipotential bonding conductor can encircle the entire pool to facilitate connection of bonded parts.

(a) *Conductive Paved Portions of Perimeter Surfaces.* Conductive paved portions of perimeter surfaces shall be bonded to one or more of the following:

(2) Unencapsulated structural reinforcing steel in accordance with 680.26(B)(1)(a)

~~Copper~~

(1) A conductor grid made of copper or 40% copper-clad steel

(2) Unencapsulated steel structural welded wire reinforcement bonded together by steel tie wires or the equivalent, fully embedded within the pavement unless pavement will not allow for embedding

If structural reinforcing steel is absent or encapsulated in a nonconductive compound, or if embedding is not possible, unencapsulated welded wire steel reinforcement or a ~~copper~~ conductor grid ~~shall~~ made with 8 AWG copper or 40% copper-clad steel shall be provided and secured directly under the paving not more than 150 mm (6 in.) below finished grade.

Where not fully embedded in concrete, ~~copper~~ the conductor grid and unencapsulated steel structural welded wire used for equipotential bonding shall be listed for corrosion resistance and mechanical performance. This listing requirement shall become effective January 1, 2029. The ~~copper~~ conductor grid or unencapsulated steel structural welded wire reinforcement shall also meet the following:

(1) ~~Copper~~ The conductor grid is constructed of 8 AWG solid bare copper or 40% copper-clad steel and arranged in accordance with 680.26(B)(1)(b)(3).

(2) Structural steel welded wire reinforcement is minimum ASTM 6 × 6-W2.0 × W2.0 or minimum No. 3 rebar constructed in a 300 mm (12 in.) grid.

(3) ~~Copper~~ The conductor grid and steel structural welded wire reinforcement follows the contour of the perimeter surface extending not less than 900 mm (3 ft) horizontally beyond the inside walls of the pool.

Informational Note No. 1: Performance of the equipotential bonding system at the perimeter surface is improved as the distance between the bonding means and finished grade is minimized, either by embedding within, or by direct contact with the underside of, the finished pavement.

Informational Note No. 2: See ASTM A615/A615M, *Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement;* A1064/A1064M, *Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete;* A1022/A1022M, *Standard Specification for Deformed and Plain Stainless Steel Wire and Welded Wire for Concrete Reinforcement;* A1060A/A1060M, *Standard Specification for Zinc-Coated (Galvanized) Steel Welded Wire Reinforcement, Plain and Deformed, for Concrete;* and ACI Standard ACI 318, *Building Code Requirements for Structural Concrete,* for examples of standards currently used in the listing of reinforcing steel bars and steel welded wire reinforcement.

(c) *Unpaved Portions of Perimeter Surfaces.* Unpaved portions of perimeter surfaces shall be bonded with any of the following methods:

(4) A

~~copper~~

(1) conductor(s) shall meet the following:

- (5) At least one minimum 8 AWG bare solid copper or 40% copper-clad steel conductor is provided, including the 8 AWG copper or 40% copper-clad steel equipotential bonding conductor, if available.
- (6) The conductor(s) follows the contour of the perimeter surface.
- (7) The conductor(s) is 450 mm to 600 mm (18 in. to 24 in.) from the inside walls of the pool.
- (8) The conductor(s) is under the unpaved portion of the perimeter surface 100 mm to 150 mm (4 in. to 6 in.) below finished grade.
- (9) The conductor(s) is installed only in perimeter surfaces not intended to have direct access to swimmers in the pool.

(2) A copper or 40% copper-clad steel conductor grid or unencapsulated steel structural welded wire reinforcement used for equipotential bonding of unpaved portions of perimeter surfaces shall meet the following:

- (10) It is installed in accordance with 680.26(B)(2)(a) .
- (11) It is located within an unpaved surface(s) between 100 mm to 150 mm (4 in. to 6 in.) below finished grade.

(I) *Nonconductive Perimeter Surfaces.* Equipotential bonding shall not be required for nonconductive portions of perimeter surfaces that are separated from earth or raised on nonconducting supports. Equipotential bonding shall not be required for any perimeter surface that is electrically separated from the pool structure and raised on nonconductive supports above an equipotentially bonded surface.

Informational Note: Nonconductive materials include, but are not limited to, wood, plastic, wood-plastic composites, fiberglass, and fiberglass composites.

Statement of Problem and Substantiation for Public Comment

Please refer to Public Comment No. 292-NFPA 70-2024 Section No. 680.26(B)(1)

Related Item

- PI 2020

Submitter Information Verification

Submitter Full Name: Peter Graser

Organization: Copperweld Bimetallics, LLC.

Affiliation: ABA

Street Address:

City:

State:

Zip:

Submittal Date: Sat Jul 27 17:18:08 EDT 2024

Committee: NEC-P17

Public Comment No. 291-NFPA 70-2024 [Section No. 680.26(B) [Excluding any Sub-Sections]]

The parts specified in 680.26(B)(1) through 680.26(B)(7) shall be bonded together using one or more of the following:

(1) Solid copper <u>or 40% copper-clad steel</u> conductors, as follows:

a. Are insulated, covered, or bare, not smaller than 8 AWG

b. Are not required to be extended or attached to remote panelboard enclosures, service equipment, or electrodes

c. Are permitted to encircle the pool to facilitate bonding connections to portions of the perimeter covered in 680.26(B)(2)(a) and 680.26(B)(2)(b) that are not contiguous

(2) Rigid metal conduit of brass or other identified corrosion-resistant metal

(3) Structural reinforcing steel

(4) Steel structural welded wire reinforcement (e.g., welded wire mesh, welded wire fabric)

Connections to bonded parts shall be made in accordance with 250.8 and 680.7(C).

Statement of Problem and Substantiation for Public Comment

Please refer to Public Comment No. 292-NFPA 70-2024 Section No. 680.26(B)(1)

<u>Related Item</u>

- PI 2018

Submitter Information Verification

Submitter Full Name: Peter Graser
Organization: Copperweld Bimetallics, LLC.
Affiliation: ABA
Street Address:
City:
State:
Zip:

Submittal Date: Sat Jul 27 17:10:55 EDT 2024
Committee: NEC-P17

Public Comment No. 23-NFPA 70-2024 [Section No. 680.29]

~~**680.29** Portable Signs.~~

~~Portable electric signs shall not be placed within pools or within 1.5 m (5 ft) measured horizontally from the inside walls of a pool.~~

Statement of Problem and Substantiation for Public Comment

Delete this section and move to new 680.22(D). 680.22 Lighting, Receptacles and Equipment contains requirements for electrical receptacles and devices including luminaires, lighting outlets, ceiling-suspended fans, switching devices, other outlets, and other equipment, which are located in proximity to pools. FR 9129 added a similar provision for electric signs, which would be more appropriately included in the text of 680.22 under 2.1.4.1 of the Style Manual, as it is also electrical equipment in proximity to a pool. The revised language submitted simply moves the intact language of the new 680.29 and relocates as 680.22(D). See also accompanying Public Comment 22-NFPA 70-2024.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 22-NFPA 70-2024 [New Section after 680.22(C)]	Move item from new 680.29 to new 680.22(D)

Related Item

- FR 9129-NFPA 70-2024

Submitter Information Verification

Submitter Full Name:	E. P. Hamilton
Organization:	E. P. Hamilton & Associates, I
Affiliation:	self
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Wed Jul 10 11:30:39 EDT 2024
Committee:	NEC-P17

Public Comment No. 389-NFPA 70-2024 [Section No. 680.29]

~~**680.29** Portable Signs.~~

~~Portable electric signs shall not be placed within pools or within 1.5 m (5 ft) measured horizontally from the inside walls of a pool.~~

Statement of Problem and Substantiation for Public Comment

This subject matter is already addressed in 680.22, which applies to ALL equipment, not just portable electric signs. Placing the sign within 5' violates 680.22(E).

Related Item

- FR 9129

Submitter Information Verification

Submitter Full Name:	Ryan Jackson
Organization:	Self-employed
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Tue Jul 30 14:19:19 EDT 2024
Committee:	NEC-P17

Public Comment No. 694-NFPA 70-2024 [Section No. 680.32]

680.32 Ground-Fault Circuit-Interrupter (GFCI) and Special Purpose Ground-Fault Circuit-Interrupter (SPGFCI) Protection.

All electrical equipment, including power-supply cords, used with storable pools shall have GFCI protection complying with 680.5(B) or SPGFCI protection complying with 680.5(C), as applicable.

All receptacles located within 6.0 m (20 ft) of the inside walls of a storable pool, storable spa, or storable hot tub shall have GFCI protection complying with 680.5(B) or SPGFCI protection complying with 680.5(C), as applicable, if any of the following conditions exist:

(1) If supplied by branch circuits rated 150 volts or less to ground and 60 amperes or less, single-phase

(2) If supplied by branch circuits rated 150 volts or less to ground and 100 amperes or less, 3-phase

(3) If supplied by branch circuits exceeding 150 volts to ground but not exceeding 480 volts phase-to-phase and 100 amperes or less

In determining these dimensions, the distance to be measured shall be the shortest path the supply cord of an appliance connected to the receptacle would follow without piercing a floor, wall, ceiling, doorway with hinged or sliding door, window opening, or other effective permanent barrier.

Additional Proposed Changes

File Name	Description	Approved
CN_394.pdf		

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 394 appeared in the First Draft Report on First Revision No. 9143.

The panel should consider revising the requirement here to point to the general rule in 680.5 (First Revision 9045) instead of repeating the details in this section. The Correlating Committee notes that the definition for SPGFCI in Article 100 has been revised.

Related Item

• First Revision No. 9143

Submitter Information Verification

Submitter Full Name: CC Notes

Organization: NEC Correlating Committee

Street Address:

City:

State:

Zip:

Submittal Date: Fri Aug 02 11:26:05 EDT 2024

Committee: NEC-P17

Correlating Committee Note No. 394-NFPA 70-2024 [Section No. 680.32]

Submitter Information Verification

Committee: NEC-AAC
Submittal Date: Fri May 10 12:14:57 EDT 2024

Committee Statement

Committee Statement: The panel should consider revising the requirement here to point to the general rule in 680.5 (First Revision 9045) instead of repeating the details in this section. The Correlating Committee notes that the definition for SPGFCI in Article 100 has been revised.

First Revision No. 9143-NFPA 70-2024 [Section No. 680.32]

Ballot Results

✔ **This item has passed ballot**

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

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.
Bowmer, Trevor N.
Hickman, Palmer L.
Holub, Richard A.
Jackson, Peter D.
Kendall, David H.
Manche, Alan
Osborne, Robert D.
Porter, Christine T.
Schultheis, Timothy James
Williams, David A.

Public Comment No. 820-NFPA 70-2024 [Section No. 680.32]

680.32 Ground-Fault Circuit-Interrupter (GFCI) and Special Purpose Ground-Fault Circuit-Interrupter (SPGFCI) Protection.

All electrical equipment, including power-supply cords, used with storable pools shall have GFCI protection ~~complying with 680.5(B)~~ - or SPGFCI protection complying with 680.5~~(C)~~ , as applicable.

All receptacles located within 6.0 m (20 ft) of the inside walls of a storable pool, storable spa, or storable hot tub shall have GFCI protection ~~complying with 680.5(B)~~ - or SPGFCI protection complying with 680.5~~(C)~~ , _ as applicable~~, if any of the following conditions exist:~~

(1) ~~If supplied by branch circuits rated 150 volts or less to ground and 60 amperes or less, single-phase~~

(2) ~~If supplied by branch circuits rated 150 volts or less to ground and 100 amperes or less, 3-phase~~

(3) ~~If supplied by branch circuits exceeding 150 volts to ground but not exceeding 480 volts phase-to-phase and 100 amperes or less~~

.

In determining these dimensions, the distance to be measured shall be the shortest path the supply cord of an appliance connected to the receptacle would follow without piercing a floor, wall, ceiling, doorway with hinged or sliding door, window opening, or other effective permanent barrier.

Statement of Problem and Substantiation for Public Comment

This comment simplifies the text by removing unnecessary words.

Related Item

• FR 9143

Submitter Information Verification

Submitter Full Name: Ryan Jackson
Organization: Self-employed
Street Address:
City:
State:
Zip:

Submittal Date: Mon Aug 05 17:33:32 EDT 2024
Committee: NEC-P17

Public Comment No. 277-NFPA 70-2024 [Section No. 680.42(B)]

(B) Bonding.

Bonding by metal-to-metal mounting on a common frame or base shall be permitted. The metal bands or hoops used to secure wooden staves shall not be required to be bonded as required in 680.26.

Equipotential bonding of perimeter surfaces in accordance with 680.26(B)(2) shall not be required to be provided for spas and hot tubs where all of the following conditions apply:

(1) The spa or hot tub shall be listed, labeled, and identified as a self-contained spa for aboveground use.

(2) The spa or hot tub shall not be identified as suitable only for indoor use.

(3) The installation shall be in accordance with the manufacturer’s instructions and shall be located on or above grade.

(4) The top rim of the spa or hot tub shall be at least ~~710 mm~~ 900 mm (~~28 in~~ 36 in .) above and 900 mm (36 in) below all perimeter surfaces that are within ~~760 mm~~ 900 mm (~~30 in~~ 36 in .), measured horizontally from the spa or hot tub. The height of nonconductive external steps for entry to or exit from the self-contained spa shall not be used to reduce or increase this rim height measurement.

Informational Note: See ANSI/UL 1563, *Standard for Electric Spas, Equipment Assemblies, and Associated Equipment,* for information regarding listing requirements for self-contained spas and hot tubs.

Statement of Problem and Substantiation for Public Comment

The measurement in 680.42(B)(4) should align with the measurements in 680.26(B)(2). It doesn't make sense to require bonding for hot tubs where the top rim is less than 28 inches and refer back to 680.26 which says 36 inches.

Related Item

- 1st stage 680.26

Submitter Information Verification

Submitter Full Name: MARK RHOTON

Organization: Frederick County Government

Affiliation: I'm the Chief Electrical Inspector Frederick County Maryland

Street Address:

City:

State:

Zip:

Submittal Date: Sat Jul 27 09:44:45 EDT 2024

Committee: NEC-P17

Public Comment No. 695-NFPA 70-2024 [Section No. 680.43(A)(2)]

(2) Ground-Fault Circuit-Interrupter (GFCI) and Special Purpose Ground-Fault Circuit-Interrupter (SPGFCI) Protection for Receptacles, General.

All receptacles located within 3.0 m (10 ft) of the inside walls of a spa or hot tub shall have GFCI protection complying with 680.5(B) or SPGFCI protection complying with 680.5(C), as applicable, if any of the following conditions exist:

(1) If supplied by branch circuits rated 150 volts or less to ground and 60 amperes or less, single-phase

(2) If supplied by branch circuits rated 150 volts or less to ground and 100 amperes or less, 3-phase

(3) If supplied by branch circuits exceeding 150 volts to ground but not exceeding 480 volts phase-to-phase and 100 amperes or less

Additional Proposed Changes

File Name	Description	Approved
CN_395.pdf		

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 395 appeared in the First Draft Report on First Revision No. 9160.

CMP 17 should consider revising the requirement here to refer to the general rule in 680.5 (First Revision 9045) instead of repeating the details in this section. The Correlating Committee notes that the definition for SPGFCI in Article 100 has been revised.

Related Item

• First Revision No. 9160

Submitter Information Verification

Submitter Full Name: CC Notes

Organization: NEC Correlating Committee

Street Address:

City:

State:

Zip:

Submittal Date: Fri Aug 02 11:27:22 EDT 2024

Committee: NEC-P17

Correlating Committee Note No. 395-NFPA 70-2024 [Section No. 680.43(A)(2)]

Submitter Information Verification

Committee: NEC-AAC

Submittal Date: Fri May 10 12:16:29 EDT 2024

Committee Statement

Committee Statement: CMP 17 should consider revising the requirement here to refer to the general rule in 680.5 (First Revision 9045) instead of repeating the details in this section. The Correlating Committee notes that the definition for SPGFCI in Article 100 has been revised.

First Revision No. 9160-NFPA 70-2024 [Section No. 680.43(A)(2)]

Ballot Results

✔ **This item has passed ballot**

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

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.
Bowmer, Trevor N.
Hickman, Palmer L.
Holub, Richard A.
Jackson, Peter D.
Kendall, David H.
Manche, Alan
Osborne, Robert D.
Porter, Christine T.
Schultheis, Timothy James
Williams, David A.

Public Comment No. 821-NFPA 70-2024 [Section No. 680.43(A)(2)]

(2) Ground-Fault Circuit-Interrupter (GFCI) and Special Purpose Ground-Fault Circuit-Interrupter (SPGFCI) Protection for Receptacles, General.

All receptacles located within 3.0 m (10 ft) of the inside walls of a spa or hot tub shall have ~~GFCI protection complying with 680.5(B) or~~ GFCI or SPGFCI protection complying with 680.5~~(C)~~ , as applicable~~, if any of the following conditions exist:~~

(1) ~~If supplied by branch circuits rated 150 volts or less to ground and 60 amperes or less, single-phase~~

(2) ~~If supplied by branch circuits rated 150 volts or less to ground and 100 amperes or less, 3-phase~~

(3) ~~If supplied by branch circuits exceeding 150 volts to ground but not exceeding 480 volts phase-to-phase and 100 amperes or less~~

.

Statement of Problem and Substantiation for Public Comment

This simplifies the text by removing unnecessary words.

Related Item

- FR 9160

Submitter Information Verification

Submitter Full Name: Ryan Jackson
Organization: Self-employed
Street Address:
City:
State:
Zip:

Submittal Date: Mon Aug 05 17:38:02 EDT 2024
Committee: NEC-P17

Public Comment No. 145-NFPA 70-2024 [Section No. 680.45(C)]

(C) Heaters.

Heaters used with permanently installed immersion pools shall comply with either 680.45(C)(1) or 680.45(C)(2).

(1) Permanently Installed Heaters — ~~Hard Wired~~ Permanently Connected .

Permanently installed heaters rated 120 volts through 250 volts nominal that are built-in or permanently attached as an integral part of permanently installed immersion pools shall ~~meet~~ comply with the following:

(1) ~~Heaters shall be~~ Be identified for swimming pool and spa use.

(2) ~~Heaters shall be grounded and bonded.~~
~~Heaters shall have~~

(3) Be connected to an EGC.

(4) Have GFCI protection complying with 680.5(B) or SPGFCI protection complying with 680.5(C), as applicable.

(2) Permanently Installed Heaters — Cord- and Plug-Connected.

Permanently installed immersion heaters rated nominal 120 volts, 20 amperes or less, or nominal 250 volts, 30 amperes or less, single-phase, shallcomply with the following:

(1) ~~Heaters shall be~~ Be permitted to be cord- and plug-connected.

(2) ~~Heaters shall meet~~ Meet the following:

a. The cord shall not be shorter than 1.83 m (6 ft) and not longer than 4.6 m (15 ft).

b. If GFCI is provided as an integral part of the cord assembly, it shall be located at the attachment plug or in the power-supply cord within 300 mm (12 in) of the attachment plug.

c. ~~Heaters shall have~~ Have GFCI protection complying with 680.5(B) or SPGFCI protection complying with 680.5(C), as applicable.

d. ~~Heaters shall be~~ Be provided with means for grounding all non-current-carrying metal parts.

(3) Storable and Portable Heaters.

Cord-connected storable or portable heaters rated 120 volts nominal and 20 amperes or less, or 250 volts nominal and 30 amperes or less, single-phase, ~~used with but~~ not permanently installed or attached as an integral part of permanently installed immersion pools, shall ~~meet~~ comply with the following:

(a) ~~Heaters shall be~~ Be identified for swimming pool and spa use.

(b) ~~Heaters shall be~~ Be cord- andplug-connected with a cord not shorter than 1.83 m (6 ft) and not longer than 4.6 m (15 ft).

(c) ~~Heaters shall have GFCI protection complying with~~ Have GFCI protection in accordance with 680.5(B) or SPGFCI protection complying with 680.5(C), as applicable.

(d) If GFCI is provided as an integral part of the cord assembly, it shall be located at the attachment plug or in the power-supply cord within 300 mm (12 in.) of the attachment plug.

Additional Proposed Changes

File Name	Description	Approved
680.45C_re-write.docx	680.45(C) revisions	

Statement of Problem and Substantiation for Public Comment

This PC proposes the following:
(1) The title of (C)(1) is revised to "permanently connected" to correlate with many other locations in the Code where “permanently connected” is used: 551.46(A)(2), 552.44(A), 422.31, 210.50(B), 210.6(B), 220.82(B), 393.10.
(2) At various locations "meet the following" is changed to "comply with the following" to comply with the NEC Style Manual and correlate with (C)(2).
(3) (C)(1)(2) is revised from "grounded and boned" to "connected to an EGC" to correlate the language with Article 250 and other sections in Article 680.
(4) The list items are revised to delete redundant language as the parent language already mentions heaters and the mandatory “shall” requirement.
(5) The parent language at (C)(3) is revised to delete the unnecessary and possibly confusing term "used with but" for clarity.

NOTE: A word doc with track changes is attached to this PC

Related Item

• FR 9247

Submitter Information Verification

Submitter Full Name: Vincent Della Croce

Organization: Siemens

Street Address:

City:

State:

Zip:

Submittal Date: Mon Jul 22 11:52:27 EDT 2024

Committee: NEC-P17

(C) Heaters.

Heaters used with permanently installed immersion pools shall comply with either 680.45(C)(1) or 680.45(C)(2).

(1) Permanently Installed Heaters — ~~Hard Wired~~Permanently Connected.

Permanently installed heaters rated 120 volts through 250 volts nominal that are built-in or permanently attached as an integral part of permanently installed immersion pools shall ~~meet~~ comply with the following:

(1) ~~Heaters shall b~~Be identified for swimming pool and spa use.
(2) ~~Heaters shall b~~Be ~~grounded and bonded~~ connected to an EGC.
(3) ~~Heaters shall h~~Have GFCI protection complying with 680.5(B) or SPGFCI protection complying with 680.5(C), as applicable.

(2) Permanently Installed Heaters — Cord- and Plug-Connected.

Permanently installed immersion heaters rated nominal 120 volts, 20 amperes or less, or nominal 250 volts, 30 amperes or less, single-phase, shall comply with the following:

(1) ~~Heaters shall b~~Be permitted to be cord- and plug-connected.
(2) ~~Heaters shall m~~Meet the following:
(a) The cord shall not be shorter than 1.83 m (6 ft) and not longer than 4.6 m (15 ft).
(b) If GFCI is provided as an integral part of the cord assembly, it shall be located at the attachment plug or in the power-supply cord within 300 mm (12 in) of the attachment plug.
(c) ~~Heaters shall h~~Have GFCI protection complying with 680.5(B) or SPGFCI protection complying with 680.5(C), as applicable.
(d) ~~Heaters shall b~~Be provided with means for grounding all non-current-carrying metal parts.

(3) Storable and Portable Heaters.

Cord-connected storable or portable heaters rated 120 volts nominal and 20 amperes or less, or 250 volts nominal and 30 amperes or less, single-phase, ~~used with but~~ not permanently installed or attached as an integral part of permanently installed immersion pools, shall ~~meet~~ comply with the following:

(a) ~~Heaters shall b~~Be identified for swimming pool and spa use.
(b) ~~Heaters shall b~~Be cord- andplug-connected with a cord not shorter than 1.83 m (6 ft) and not longer than 4.6 m (15 ft).
(c) ~~Heaters shall h~~Have GFCI protection ~~complying~~ in accordance with 680.5(B) or SPGFCI protection complying with 680.5(C), as applicable.
(d) If GFCI is provided as an integral part of the cord assembly, it shall be located at the attachment plug or in the power-supply cord within 300 mm (12 in.) of the attachment plug.

Commented [DCV(USES1]: Revised to correlate with many other locations in the Code where "permanently connected" is used: 551.46(A)(2), 552.44(A), 422.31, 210.50(B), 210.6(B), 220.82(B), 393.10

Commented [DCV(USES2]: Revised to comply with the NEC Style Manual and correlate with (C)(2)

Commented [DCV(USES3]: Revise to delete redundant language. The parent language already mentions heaters and the mandatory "shall"

Commented [DCV(USES4]: Revised to correlate the language with Article 250 and other sections in Article 680

Commented [DCV(USES5]: Revise to delete redundant language. The parent language already mentions heaters and the mandatory "shall"

Commented [DCV(USES6]: Revised to delete unnecessary and possibly confusing language

Commented [DCV(USES7]: Revised to comply with the NEC Style Manual and correlate with (C)(2)

Commented [DCV(USES8]: Revise to delete redundant language. The parent language already mentions heaters and the mandatory "shall"

Commented [DCV(USES9]: Revised to comply with the NEC Style Manual

Public Comment No. 691-NFPA 70-2024 [Section No. 680.45(C)]

(C) Heaters.

Heaters used with permanently installed immersion pools shall comply with either 680.45(C)(1) or 680.45(C)(2).

(1) Permanently Installed Heaters — Hard Wired.

Permanently installed heaters rated 120 volts through 250 volts nominal that are built-in or permanently attached as an integral part of permanently installed immersion pools shall meet the following:

(1) Heaters shall be identified for swimming pool and spa use.

(2) Heaters shall be grounded and bonded.

(3) Heaters shall have GFCI protection complying with 680.5(B) or SPGFCI protection complying with 680.5(C), as applicable.

(2) Permanently Installed Heaters — Cord- and Plug-Connected.

Permanently installed immersion heaters rated nominal 120 volts, 20 amperes or less, or nominal 250 volts, 30 amperes or less, single-phase, shallcomply with the following:

(1) Heaters shall be permitted to be cord- and plug-connected.

(2) Heaters shall meet the following:

a. The cord shall not be shorter than 1.83 m (6 ft) and not longer than 4.6 m (15 ft).

b. If GFCI is provided as an integral part of the cord assembly, it shall be located at the attachment plug or in the power-supply cord within 300 mm (12 in) of the attachment plug.

c. Heaters shall have GFCI protection complying with 680.5(B) or SPGFCI protection complying with 680.5(C), as applicable.

d. Heaters shall be provided with means for grounding all non-current-carrying metal parts.

(3) Storable and Portable Heaters.

Cord-connected storable or portable heaters rated 120 volts nominal and 20 amperes or less, or 250 volts nominal and 30 amperes or less, single-phase, used with but not permanently installed or attached as an integral part of permanently installed immersion pools, shall meet the following:

(a) Heaters shall be identified for swimming pool and spa use.

(b) Heaters shall be cord- andplug-connected with a cord not shorter than 1.83 m (6 ft) and not longer than 4.6 m (15 ft).

(c) Heaters shall have GFCI protection complying with 680.5(B) or SPGFCI protection complying with 680.5(C), as applicable.

(d) If GFCI is provided as an integral part of the cord assembly, it shall be located at the attachment plug or in the power-supply cord within 300 mm (12 in.) of the attachment plug.

Additional Proposed Changes

File Name	Description	Approved
CN_396.pdf		

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 396 appeared in the First Draft Report on First Revision No. 9247.

CMP 17 should consider revising the charging language to describe under what conditions a storable or portable heater described in 680.45(C)(3) could be applied.

Related Item

• First Revision No. 9247

Submitter Information Verification

Submitter Full Name: CC Notes
Organization: NEC Correlating Committee
Street Address:
City:
State:
Zip:
Submittal Date: Fri Aug 02 11:22:05 EDT 2024
Committee: NEC-P17

Correlating Committee Note No. 396-NFPA 70-2024 [Section No. 680.45(C)]

Submitter Information Verification

Committee: NEC-AAC
Submittal Date: Fri May 10 12:19:08 EDT 2024

Committee Statement

Committee Statement: CMP 17 should consider revising the charging language to describe under what conditions a storable or portable heater described in 680.45(C)(3) could be applied.

FR-9247-NFPA 70-2024

Ballot Results

✔ **This item has passed ballot**

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

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.
Bowmer, Trevor N.
Hickman, Palmer L.
Holub, Richard A.
Jackson, Peter D.
Kendall, David H.
Manche, Alan
Osborne, Robert D.
Porter, Christine T.
Schultheis, Timothy James
Williams, David A.

Public Comment No. 833-NFPA 70-2024 [Section No. 680.45(C)]

(C) Heaters.

~~Heaters~~ Permanently installed heaters used with permanently installed immersion pools shall comply with either 680.45(C)(1) or 680.45(C)(2). Storable and portable heaters shall comply with 680.45(C)(3).

(1) Permanently Installed Heaters — ~~Hard Wired~~ Other Than Cord-and-Plug-Connected .

Permanently installed heaters rated 120 volts through 250 volts nominal that are built-in or permanently attached as an integral part of permanently installed immersion pools shall ~~meet~~ comply with the following:

(1) Heaters shall be identified for swimming pool and spa use.

(2) Heaters shall be ~~grounded and bonded~~ connected to an equipment grounding conductor .

(3) ~~Heaters shall have GFCI protection complying with 680.5(B)~~ The outlet shall be provided with GFCI or SPGFCI protection ~~complying~~ , as applicable, in accordance with 680.5~~(C) , as applicable~~ .

(2) Permanently Installed Heaters — Cord- and Plug-Connected.

Permanently installed immersion heaters rated nominal 120 volts, 20 amperes or less, or nominal 250 volts, 30 amperes or less, single-phase, ~~shallcomply~~ shall comply with the following:

(1) ~~Heaters shall be permitted to be cord- and plug-connected.~~
~~Heaters shall meet the following:~~

(2) ~~The cord shall not be shorter than 1.83 m (6 ft) and not longer than 4.6 m (15 ft).~~

(3) ~~If~~
~~GFCI~~

(4) ~~GFCI protection is provided as an integral part of the cord assembly, it shall be located at the attachment plug or in the power-supply cord within 300 mm (12 in) of the attachment plug.~~
~~Heaters shall have GFCI protection complying with 680.5(B)~~

(5) ~~The outlet shall be provided with GFCI - or SPGFCI protection~~
~~complying~~

(6) ~~, as applicable, in accordance with 680.5~~
~~(C), as applicable~~

(7) ~~-~~

(8) ~~Heaters shall be provided with means for~~
~~grounding~~

(9) ~~connecting all normally non-current-carrying metal parts to an equipment grounding conductor .~~

(3) Storable and Portable Heaters.

Cord-and-plug- connected storable or portable heaters rated 120 volts nominal and 20 amperes or less, or 250 volts nominal and 30 amperes or less, single-phase, ~~used with but~~ that are not permanently installed or attached as an integral part of permanently installed immersion pools, shall ~~meet~~ comply with the following:
(1) Heaters shall be identified for swimming pool and spa use.

~~Heaters shall be cord- andplug-connected with a cord~~
(2) The cord shall not shorter than 1.83 m (6 ft) and not longer than 4.6 m (15 ft).

~~Heaters shall have GFCI protection complying with 680.5(B) or SPGFCI protection complying~~
(3) The outlet shall be provided with GFCI or SPGFCI protection, as applicable, in accordance with 680.5 .

(

~~C), as applicable.~~
4) If GFCI protection is provided as an integral part of the cord assembly, it shall be located at the attachment plug or in the power-supply cord within 300 mm (12 in.) of the attachment plug.

Statement of Problem and Substantiation for Public Comment

These revisions are editorial in nature and are made for consistency with other code sections and to utilize proper terminology.

Related Item

- FR 9247

Submitter Information Verification

Submitter Full Name:	Ryan Jackson
Organization:	Self-employed
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Tue Aug 06 11:20:11 EDT 2024
Committee:	NEC-P17

Public Comment No. 690-NFPA 70-2024 [Section No. 680.58]

680.58 Ground-Fault Circuit-Interrupter (GFCI) and Special Purpose Ground-Fault Circuit-Interrupter (SPGFCI) Protection for Adjacent Receptacle Outlets.

All receptacles located within 6.0 m (20 ft) of a fountain edge shall have GFCI protection complying with 680.5(B) or SPGFCI protection complying with 680.5(C), as applicable, if any of the following conditions exist:

(1) If supplied by branch circuits rated 150 volts or less to ground, and 60 amperes or less, single-phase

(2) If supplied by branch circuits rated 150 volts or less to ground and 100 amperes or less, 3-phase

(3) If supplied by branch circuits exceeding 150 volts to ground but not exceeding 480 volts phase-to-phase and 100 amperes or less

Additional Proposed Changes

File Name	Description	Approved
CN_397.pdf		

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 397 appeared in the First Draft Report on First Revision No. 9181.

CMP 17 should consider revising the requirement here to refer to the general rule in 680.5 (First Revision 9045) instead of repeating the details in this section. The Correlating Committee notes that the definition for SPGFCI in Article 100 has been revised.

Related Item

• First Revision No. 9181

Submitter Information Verification

Submitter Full Name: CC Notes
Organization: NEC Correlating Committee
Street Address:
City:
State:
Zip:
Submittal Date: Fri Aug 02 11:20:56 EDT 2024
Committee: NEC-P17

Correlating Committee Note No. 397-NFPA 70-2024 [Section No. 680.58]

Submitter Information Verification

Committee: NEC-AAC

Submittal Date: Fri May 10 12:20:06 EDT 2024

Committee Statement and Meeting Notes

Committee Statement: CMP 17 should consider revising the requirement here to refer to the general rule in 680.5 (First Revision 9045) instead of repeating the details in this section. The Correlating Committee notes that the definition for SPGFCI in Article 100 has been revised.

First Revision No. 9181-NFPA 70-2024 [Section No. 680.58]

Ballot Results

✔ **This item has passed ballot**

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

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.

Bowmer, Trevor N.

Hickman, Palmer L.

Holub, Richard A.

Jackson, Peter D.

Kendall, David H.

Manche, Alan

Osborne, Robert D.

Porter, Christine T.

Schultheis, Timothy James

Williams, David A.

Public Comment No. 834-NFPA 70-2024 [Section No. 680.58]

680.58 Ground-Fault Circuit-Interrupter (GFCI) and Special Purpose Ground-Fault Circuit-Interrupter (SPGFCI) Protection for Adjacent Receptacle Outlets.

All receptacles located within 6.0 m (20 ft) of a fountain edge shall have GFCI protection ~~complying with 680.5(B)~~ - or SPGFCI protection- ~~complying~~ , as applicable. in accordance with 680.5~~(C)~~ ~~, as applicable, if any of the following conditions exist:~~

(1) ~~If supplied by branch circuits rated 150 volts or less to ground, and 60 amperes or less, single-phase~~

(2) ~~If supplied by branch circuits rated 150 volts or less to ground and 100 amperes or less, 3-phase~~

(3) ~~If supplied by branch circuits exceeding 150 volts to ground but not exceeding 480 volts phase-to-phase and 100 amperes or less~~

.

Statement of Problem and Substantiation for Public Comment

Simplification of the text.

Related Item

• FR 9181 •

Submitter Information Verification

Submitter Full Name: Ryan Jackson
Organization: Self-employed
Street Address:
City:
State:
Zip:

Submittal Date: Tue Aug 06 11:59:00 EDT 2024
Committee: NEC-P17

Public Comment No. 143-NFPA 70-2024 [Section No. 680.71]

680.71 Branch Circuit.

Hydromassage bathtubs and their associated electrical components shall be ~~on an individual~~ supplied by a minimum of one individual branch circuit(s).

Statement of Problem and Substantiation for Public Comment

This PC proposes to revise the requirement to recognize that more than one individual branch circuit can supply a hydromassage bathtub, which is permitted by their product standard. UL 1795 for Hydromassage Bathtubs permits up to 3 sources of supply to feed a hydromassage tub and its equipment, and the instructions are required to specify when more than one supply is required.

Related Item

- FR 9190

Submitter Information Verification

Submitter Full Name: Vincent Della Croce

Organization: Siemens

Street Address:

City:

State:

Zip:

Submittal Date: Mon Jul 22 11:05:02 EDT 2024

Committee: NEC-P17

Public Comment No. 835-NFPA 70-2024 [Section No. 680.71]

680.71 Branch Circuit.

~~Hydromassage~~ Branch circuits supplying hydromassage bathtubs and their associated electrical components shall ~~be on an individual branch circuit(s)~~ serve no other loads .

Statement of Problem and Substantiation for Public Comment

An individual branch circuit cannot serve multiple loads, so how does it serve the hydromassage tub AND it associated electrical components? If the intent is that the circuit not serve any loads that are not related to the tub, the language I submitted should be accepted. Similar requirements can be found throughout the code when this prediciment comes up, such as 760.41(B) for fire alarms.

Related Item

- FR 9190

Submitter Information Verification

Submitter Full Name: Ryan Jackson
Organization: Self-employed
Street Address:
City:
State:
Zip:
Submittal Date: Tue Aug 06 12:03:19 EDT 2024
Committee: NEC-P17

Public Comment No. 687-NFPA 70-2024 [Section No. 680.75]

680.75 GFCI Protection.

(A) General.

Hydromassage bathtubs and their associated electrical components shall be protected by a readily accessible GFCI.

(B) Receptacles.

All 125-volt, single-phase receptacles not exceeding 30 amperes and located within 1.83 m (6 ft) measured horizontally of the inside walls of a hydromassage tub shall be GFCI protected.

Additional Proposed Changes

File Name	Description	Approved
CN_390.pdf		

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 390 appeared in the First Draft Report on First Revision No. 9190.

The Correlating Committee directs CMP 17 to identify the specific modifications to the requirements of 210.8 made in this requirement. If there are no modifications to the general requirement in Chapter 2, it is not necessary to restate the requirement in accordance with NEC Style Manual Section 4.1.1.

Related Item

• First Revision No. 9190

Submitter Information Verification

Submitter Full Name: CC Notes

Organization: NEC Correlating Committee

Street Address:

City:

State:

Zip:

Submittal Date: Fri Aug 02 11:17:00 EDT 2024

Committee: NEC-P17

Correlating Committee Note No. 390-NFPA 70-2024 [Section No. 680.75]

Submitter Information Verification

Committee: NEC-AAC

Submittal Date: Fri May 10 11:40:56 EDT 2024

Committee Statement and Meeting Notes

Committee Statement: The Correlating Committee directs CMP 17 to identify the specific modifications to the requirements of 210.8 made in this requirement. If there are no modifications to the general requirement in Chapter 2, it is not necessary to restate the requirement in accordance with NEC Style Manual Section 4.1.1.

First Revision No. 9190-NFPA 70-2024 [Detail]

Ballot Results

✔ **This item has passed ballot**

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

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.

Bowmer, Trevor N.

Hickman, Palmer L.

Holub, Richard A.

Jackson, Peter D.

Kendall, David H.

Manche, Alan

Osborne, Robert D.

Porter, Christine T.

Schultheis, Timothy James

Williams, David A.

Public Comment No. 1735-NFPA 70-2024 [Sections Part VI., 426.50, 426.51]

Add new part VI and renumber existing Part VI to Part VII and renumber sections.

Part VI Conductive Pavement Heating Systems

426.60 General . Except as modified in this Part, conductive pavement heating systems shall comply with Parts I, II and VII of Article 426 and the following additional requirements.

426.62 Listing . A conductive pavement heating system shall be listed as a conductive pavement heating system.

426.64 Engineered Design . The engineering design shall comply with all the following.

(A) Site Specific Design . Conductive pavement heating systems shall be designed and specified for specific installation site applications within the limits of the listing and manufacturer's installation instructions.

(B) Professional Engineer Required . The design engineer shall be a licensed professional electrical engineer retained by the system owner or installer.

(C) Documentation . Documentation of the engineered design of the conductive pavement heating system shall be stamped and provided to the Authority Having Jurisdiction. The design specifications, installation instructions, mixture specifications, and required conductivity test report requirements shall be provided to the Authority Having Jurisdiction.

(D) Additional Design Information . Additional stamped independent engineering reports detailing compliance of the design with applicable electrical standards and industry practice shall be provided upon request of the Authority Having Jurisdiction.

(E) Conformance Documentation . Conformance documentation shall include details of conformance of the design with the applicable parts of Article 426.

426.66 Installation. The conductive pavement heating system shall be installed in accordance with the following.

(A) Engineering Supervision . Conductive pavement heating systems shall be installed under design engineering supervision and in accordance with the manufacturer's instructions.

(B) Documentation . The engineer shall provide documentation of the testing of the conductive pavement mixture, and commissioning of the system to the Authority Having Jurisdiction.

(C) Specifications . Conductive pavement heating systems shall be installed in accordance with the installation instructions and conductive pavement mixture specifications.

426. 68 Overtemperature Protection . The conductive pavement system shall have monitoring for surface temperatures and have overtemperature protection set not greater than 15 ° C (60 ° F). An overtemperature condition shall cause the power to the electrodes to be deenergized.

426.70 Conductive Pavement Heating System

(A) Electrode Encasement . Embedded electrodes shall be encased by not less than 50 mm (2 in.) of conductive pavement on all sides of the electrode.

(B) Support and Securement . Electrodes and supply conductors within the conductive pavement shall be supported and secured in place by nonmetallic frames or spreaders or other approved means while the conductive pavement is installed.

(C) Expansion and Contraction . Electrodes and supply conductors shall not be installed where they bridge expansion joints unless provisions are made for expansion, contraction or other movement.

(D) Flexural Capability . Where installed on flexible structures, the electrodes and associated equipment shall have a flexural capability that is compatible with the movement of the structure.

426.72 Electrode Power Supply. The operating voltage of the conductive pavement system electrodes shall not exceed 30 volts ac or 60 volts dc.

426.74 Ungrounded System. The power supply to the electrodes shall be an ungrounded system from an isolation transformer.

426.76- Wiring Methods

A) Electrode Supply Conductors . The power supply conductors shall comply with the following requirements:

(1) The power supply conductors to the electrodes encased for any part in the conductive pavement shall be type USE-2 copper.

(2) The electrode power supply conductors shall have not less than 300 mm (12 in.) provided within junction boxes.

(3) The power supply conductors from the control panel to a junction box shall be permitted to be any type suitable for a wet location. These conductors shall be protected from exposure to direct contact with the conductive pavement material.

(4) The power supply conductors shall be directly buried or shall be installed in nonmetallic raceway(s) suitable for the temperature and environment.

(B) Sensor and Control Conductors. Sensor and control conductors shall be installed in accordance with the following:

(1) Nonmetallic raceways suitable for the temperature and environment shall be used for all sensor and control conductors installed in the conductive pavement.

(2) Sensor and control conductors installed above the conductive pavement shall be installed in nonmetallic raceways for any penetration through the conductive pavement.

(3) Ferrous and nonferrous metal raceways, boxes, fittings, supports, and support hardware shall be permitted to be installed above the conductive pavement in areas subject to severe corrosive influences, where made of material suitable for the condition, or where provided with corrosion protection identified as suitable for the condition.

(4) Metal raceways installed above the conductive pavement shall not have any contact with the conductive pavement.

(C) Other Electrical Equipment . Electrical equipment, other than electrode supply conductors and sensor and control conductors, installed above the conductive pavement, such as area lighting, shall be installed in accordance with the following:

(1) All penetrations through the conductive pavement shall be nonmetallic raceways suitable for the temperature and environment

(2) Ferrous and nonferrous metal raceways, boxes, fittings, supports, and support hardware shall be permitted to be installed above the conductive pavement in areas subject to severe corrosive influences, where made of material suitable for the condition, or where provided with corrosion protection identified as suitable for the condition.

(3)Metal raceways installed above the conductive pavement shall not have any contact with the conductive pavement.

426.78 Electrical Connection.

(A) Electrode Connections . Electrical connections to the electrodes within the conductive pavement shall comply with one of the following:

(1) Be connected by exothermic welding

(2) Be of the irreversible crimp-type terminal complying with the following:

(a) Connectors shall be listed for direct burial or concrete encasement.

(b) Connectors shall be installed with stainless steel bolts, washers and nuts.

(B) Circuit Connections . Splices and terminations, other than at the electrode end, shall be installed in a box or fitting in accordance with 110.14 and 300.15.

426.80 GFCI Protection . GFCI protection shall be provided for all 125-volt 15- and 20-amp single phase branch circuits supplying equipment installed on the conductive pavement.

426.82 Conductive Pavement Material Testing . The conductive pavement material mixture and testing shall comply with the following:

(A) Have a wet resistance test conducted on the conductive pavement as it is installed, and the test report shall be provided to the Authority Having Jurisdiction.

(B) The wet resistance test results shall be within the specified limits of the engineering design.

(C) Final approval for the installation shall not be granted until all material test reports have been provided and reviewed.

426.84 Equipment Mounting . Structures or equipment mounted onto the conductive pavement surface shall be mounted with nonmetallic anchors into the conductive pavement surface. No metallic anchors or penetrations shall be permitted in the conductive pavement.

Sections Part VI., 426.50, 426.51

Part ~~VI~~ VII . Control and Protection

426.~~50~~ 90 Disconnecting Means.

(A) Disconnection.

All fixed outdoor deicing and snow-melting equipment shall be provided with a means for simultaneous disconnection from all ungrounded conductors. Where readily accessible to the user of the equipment, the branch-circuit switch or circuit breaker shall be permitted to serve as the disconnecting means. The disconnecting means shall be the indicating type and be lockable open in accordance with 110.25.

(B) Cord-and-Plug-Connected Equipment.

The factory-installed attachment plug of cord-and-plug-connected equipment rated 20 amperes or less and 150 volts or less to ground shall be permitted to be the disconnecting means.

426.~~51~~ 92 Controllers.

(A) Temperature Controller with “Off” Position.

Temperature-controlled switching devices that indicate an “off” position and that interrupt line current shall open all ungrounded conductors when the control device is in the “off” position. These devices shall not be permitted to serve as disconnecting means unless they are lockable open in accordance with 110.25.

(B) Temperature Controller Without “Off” Position.

Temperature-controlled switching devices that do not have an “off” position shall not be required to open all ungrounded conductors. These devices shall not be permitted to serve as disconnecting means.

(C) Remote Temperature Controller.

Remote-controlled temperature-actuated devices shall not be required to meet the requirements of 426.51(A). These devices shall not be permitted to serve as disconnecting means.

(D) Combined Switching Devices.

Switching devices consisting of combined temperature-actuated devices and manually controlled switches that serve both as the controller and disconnecting means shall comply with all of the following conditions:

(1) Open all ungrounded conductors when manually placed in the “off” position

(2) Be so designed that the circuit cannot be energized automatically if the device has been manually placed in the “off” position

(3) Be lockable open in accordance with 110.25

Additional Proposed Changes

File Name	Description	Approved
PC_1735_Doc_Part_VI_Conductive_Pavement_Heating_Systems.docx	Clean word file of proposed changes due to Terra issues with text changes.	
Conductive_Concrete_an_Electrifying_Idea_.pdf	Conductive Concrete article downloaded from Internet. URL https://engineering.unl.edu/faculty/cv/V50I06P46.pdf	

Statement of Problem and Substantiation for Public Comment

Introduction

The development of a conductive concrete heating system continues from the Iowa State University Department of Civil, Construction and Environmental Engineering with several pilot installations. Since the first draft meetings in January 2024, additional research, laboratory testing and pilot site installations have been installed to find the optimal design with a low voltage, 30 volts ac or less, power supply. This ongoing research required new configurations for the electrode spacing as well as changes to the carbon fiber content in the concrete mix.

Testing in concert with UL of existing pilot installations set up for 208, 120, and 240 volts determined that the wet surface voltage and resultant body current exceeded acceptable safe values and present potential shock hazards where bare hands or feet were in contact with the surface. This along with the panel committee input statement determined the design change to the lower voltage.

Recent testing of a sample slab operating with a 24-volt RMS supply measured with the test point right above the electrodes, which should be the maximum value, found surface voltages to be approximately 16 volts RMS. The same result was found for both solid (undamaged) and where deep cuts in the concrete, to the electrode depth, has been made to simulate cracks.

The Need for NEC Requirements

The present NEC requirements do not address this new technology. Because this technology is very different than present systems covered by Article 426 a new Part VI was proposed along with other changes specific to the conductive pavement applications. The text in the public comment has revised what was proposed to include only requirements relative to the electrical system and address the panel input and continued research activities.

As this effort to provide NEC requirements has been underway, information has become available that some engineering companies are designing heated pavement systems for applications in cold weather areas with supply voltages to the electrodes of 480 volts. Without some requirements from the NEC, it is very difficult for jurisdictions to deal with these potentially unsafe installations.

National Need

A quick survey of other state and federal agencies has determined interest in this technology as well as integration into similar research projects these states are already undertaking. Some of those agencies or states expressing specific interest include:
Federal Aviation Administration
State of Alaska DOT
State of California DOT
State of Iowa DOT (lead on the present project with Iowa State University)
State of Missouri DOT
State of New Jersey DOT (similar project underway with Rowan University)
State of New York DOT
State of Texas DOT
State of Nebraska Department of Road (pilot project, see attached article) and Kansas City, Nebraska (similar project for bus stop with University of Nebraska – Lincoln)
This topic has also been a topic of presentations for several years at the American Association of State Highway and Transportation Officials (AASHTO) meeting with representation for all 50 states and US territories.

Proposed NEC Sections Technical Discussion

A new definition for Conductive Pavement Heating System has been proposed in a separate comment, PC 1733, to be added in Article 100 for this new technology. This comment recommended the definition to be under the purview of CMP-17 and applicable to Article 426 only.

The scope of Article 426 has been modified in a separate comment, PC 1734, to accommodate this technology and provide coverage for this system in the scope of Article 426.

No changes are proposed to Parts II through V of Article 426 as these parts are specific with different concepts and unrelated technologies. Due to the unique nature of this technology, it was determined a whole new part is needed, therefore the creation of the new Part VI and renumbering of the existing Part VI to Part VII. This is consistent with other parts in Article 426 that address specific types of equipment or systems.

New Part VI

The new part is recommended to become Part VI and the existing Part VI to be renumbered to Part VII with applicable renumbering of the two remaining affected sections. This public comment includes the applicable section numbering changes to the new Part VII, as revised by the panel in the first draft, and verified renumbering in cross references. No other changes in Part VII are intended from this comment.

A general requirement is included to clarify which previous parts of Article 426 are to be included for installations of conductive pavement heating systems. One item to note from Part II is 426.13 which requires signage alerting anyone approaching the conductive pavement that there is this system present. Some designs being considered include a light, to supplement this sign, signifying the system is energized and operating when illuminated.

The first draft established a general listing requirement for snow melting and deicing equipment in 426.2. To ensure this technology is properly covered by listing, an additional requirement is put in to require this system to be “listed as a conductive pavement heating system”. This is to ensure certain equipment listings, such as the main control panel, are not confused as covering the entire system.

The Iowa Department of Transportation has engaged UL Solutions in a preliminary investigation toward developing the listing requirements, and that project is ongoing. The UL project is being conducted in parallel and coordinated with the proposed changes to the NEC as this Code cycle progresses. Part of the UL efforts will be ensuring the listing requirements align with these code requirements.

The following key elements are included in the new requirements in Part VI

Each system will be unique to a site and will be required to be designed and specification from a registered professional engineer. Similar requirements for these kinds of unique systems are already included elsewhere in code.

The installation will require oversight by the design engineer with some documentation requirements being made available to the Authority Having Jurisdiction. This is similar to existing NEC requirements found in 371.14 and 691.6. Having the design professional for the custom design of each system with the standardized specification and listing by a recognized testing laboratory provides the Authority Having Jurisdiction with a solid body of information to assist in the approval of the installation. This aspect was strongly recommended by the AHJs that are part of the Iowa DOT team working on this project.

There are clear documentation requirements for the initial design through the final commissioning to be provided to the Authority Having Jurisdiction for review and approval. The manufacturer’s instructions, which will be part of the listing, and the specifications for the pavement batch mixing are required for the AHJ to evaluate conformance of the installation. One of these reports would be the “wet” and “cured” testing results for the resistance or conductivity of the conductive pavement materials.

The primary hazards identified are potential shock and thermal burn hazards. The shock hazard is being mitigated by now requiring the supply voltage not exceed 30 volts RMS or 60 Volts dc. The power supply is also required to be an isolation transformer and the system to be ungrounded. This will address concerns for stray currents through the earth or effects on other facilities. These requirements are consistent with other NEC requirements. Since the system is now low voltage from an isolation transformer and to be an ungrounded system, only GFCI protection for 125 volt 15- and 20-amp branch circuits supplying equipment installed on the conductive pavement is required.

The other hazard is from a surface becoming excessively hot. The level of heat required is only to melt snow or prevent icing, which is at a temperature of about 40°F per the research completed. The temperature limits set in the proposed requirements are 15°C or 60°F which are well below the 50°C or 122°F allowed in many UL standards for contact without burns.

Installation requirements have been revised to include a minimum electrode encasement in the conductive pavement. Installation also includes wiring methods addressing the power supply to the electrodes, wiring to control and sensor equipment embedded in or in support of the system, and wiring methods for other electrical equipment that may be installed on the conductive pavement. Requirements are established for the proper connection devices of the supply conductors to the electrodes and for the mounting of any equipment to structures onto the conductive pavement.

No special grounding and bonding are required under the revised requirements and all the requirements from Article 250 would apply as provided through 90.3.

Related Public Comments for This Document

Related Comment	Relationship
Public Comment No. 1733-NFPA 70-2024 [New Definition after Definition: Concealed Knob-and-Tube Wi...]	
Public Comment No. 1734-NFPA 70-2024 [Section No. 426.1]	

Related Item

- PI 4168 and CI 8998

Submitter Information Verification

Submitter Full Name: Charles Mello
Organization: Cdcmello Consulting Llc
Affiliation: State of Iowa Department of Transportation
Street Address:
City:
State:
Zip:
Submittal Date: Mon Aug 26 20:11:24 EDT 2024
Committee: NEC-P17

Attachment to Public Comment No. 1735

See following link for article titled “Conductive Concrete – an Electrifying Idea”

https://engineering.unl.edu/faculty/cv/V50I06P46.pdf

Part VI Conductive Pavement Heating Systems

426.60 General. Except as modified in this Part, conductive pavement heating systems shall comply with Parts I, II and VII of Article 426 and the following additional requirements.

426.62 Listing. A conductive pavement heating system shall be listed as a conductive pavement heating system.

426.64 Engineered Design. The engineering design shall comply with all the following.

(A) Site Specific Design. Conductive pavement heating systems shall be designed and specified for specific installation site applications within the limits of the listing and manufacturer's installation instructions.

(B) Professional Engineer Required. The design engineer shall be a licensed professional electrical engineer retained by the system owner or installer.

(C) Documentation. Documentation of the engineered design of the conductive pavement heating system shall be stamped and provided to the Authority Having Jurisdiction. The design specifications, installation instructions, mixture specifications, and required conductivity test report requirements shall be provided to the Authority Having Jurisdiction.

(D) Additional Design Information. Additional stamped independent engineering reports detailing compliance of the design with applicable electrical standards and industry practice shall be provided upon request of the Authority Having Jurisdiction.

(E) Conformance Documentation. Conformance documentation shall include details of conformance of the design with the applicable parts of Article 426.

426.66 Installation. The conductive pavement heating system shall be installed in accordance with the following.

(A) Engineering Supervision. Conductive pavement heating systems shall be installed under design engineering supervision and in accordance with the manufacturer's instructions.

(B) Documentation. The engineer shall provide documentation of the testing of the conductive pavement mixture, and commissioning of the system to the Authority Having Jurisdiction.

(C) Specifications. Conductive pavement heating systems shall be installed in accordance with the installation instructions and conductive pavement mixture specifications.

426. 68 Overtemperature Protection. The conductive pavement system shall have monitoring for surface temperatures and have overtemperature protection set not greater than 15°C (60°F). An overtemperature condition shall cause the power to the electrodes to be deenergized.

426.70 Conductive Pavement Heating System

(A) Electrode Encasement. Embedded electrodes shall be encased by not less than 50 mm (2 in.) of conductive pavement on all sides of the electrode.

(B) Support and Securement. Electrodes and supply conductors within the conductive pavement shall be supported and secured in place by nonmetallic frames or spreaders or other approved means while the conductive pavement is installed.

(C) Expansion and Contraction. Electrodes and supply conductors shall not be installed where they bridge expansion joints unless provisions are made for expansion, contraction or other movement.

(**D) Flexural Capability**. Where installed on flexible structures, the electrodes and associated equipment shall have a flexural capability that is compatible with the movement of the structure.

426.72 Electrode Power Supply. The operating voltage of the conductive pavement system electrodes shall not exceed 30 volts ac or 60 volts dc.

426.74 Ungrounded System. The power supply to the electrodes shall be an ungrounded system from an isolation transformer.

426.76- Wiring Methods

A) Electrode Supply Conductors. The power supply conductors shall comply with the following requirements:

(1) The power supply conductors to the electrodes encased for any part in the conductive pavement shall be type USE-2 copper.

(2) The electrode power supply conductors shall have not less than 300 mm (12 in.) provided within junction boxes.

(3) The power supply conductors from the control panel to a junction box shall be permitted to be any type suitable for a wet location. These conductors shall be protected from exposure to direct contact with the conductive pavement material.

(4) The power supply conductors shall be directly buried or shall be installed in nonmetallic raceway(s) suitable for the temperature and environment.

(B) Sensor and Control Conductors. Sensor and control conductors shall be installed in accordance with the following:

(1) Nonmetallic raceways suitable for the temperature and environment shall be used for all sensor and control conductors installed in the conductive pavement.

(2) Sensor and control conductors installed above the conductive pavement shall be installed in nonmetallic raceways for any penetration through the conductive pavement.

(3) Ferrous and nonferrous metal raceways, boxes, fittings, supports, and support hardware shall be permitted to be installed above the conductive pavement in areas subject to severe corrosive influences, where made of material suitable for the condition, or where provided with corrosion protection identified as suitable for the condition.

(4) Metal raceways installed above the conductive pavement shall not have any contact with the conductive pavement.

(C) Other Electrical Equipment. Electrical equipment, other than electrode supply conductors and sensor and control conductors, installed above the conductive pavement, such as area lighting, shall be installed in accordance with the following:

(1) All penetrations through the conductive pavement shall be nonmetallic raceways suitable for the temperature and environment

(2) Ferrous and nonferrous metal raceways, boxes, fittings, supports, and support hardware shall be permitted to be installed above the conductive pavement in areas subject to severe corrosive influences, where made of material suitable for the condition, or where provided with corrosion protection identified as suitable for the condition.

(3)Metal raceways installed above the conductive pavement shall not have any contact with the conductive pavement.

426.78 Electrical Connection.

(A) Electrode Connections. Electrical connections to the electrodes within the conductive pavement shall comply with one of the following:

(1) Be connected by exothermic welding

(2) Be of the irreversible crimp-type terminal complying with the following:

(a) Connectors shall be listed for direct burial or concrete encasement.

(b) Connectors shall be installed with stainless steel bolts, washers and nuts.

(B) Circuit Connections. Splices and terminations, other than at the electrode end, shall be installed in a box or fitting in accordance with 110.14 and 300.15.

426.80 GFCI Protection. GFCI protection shall be provided for all 125-volt 15- and 20-amp single phase branch circuits supplying equipment installed on the conductive pavement.

426.82 Conductive Pavement Material Testing. The conductive pavement material mixture and testing shall comply with the following:

(A)   Have a wet resistance test conducted on the conductive pavement as it is installed, and the test report shall be provided to the Authority Having Jurisdiction.

(B) The wet resistance test results shall be within the specified limits of the engineering design.

(C) Final approval for the installation shall not be granted until all material test reports have been provided and reviewed.

426.84 Equipment Mounting. Structures or equipment mounted onto the conductive pavement surface shall be mounted with nonmetallic anchors into the conductive pavement surface. No metallic anchors or penetrations shall be permitted in the conductive pavement.

Part ~~VI~~ VII. Control and Protection

426.~~50~~90 Disconnecting Means.

(A) Disconnection. All fixed outdoor deicing and snow-melting equipment shall be provided with a means for simultaneous disconnection from all ungrounded conductors. Where readily accessible to the user of the equipment, the branch-circuit switch or circuit breaker shall be permitted to serve as the disconnecting means. The disconnecting means shall be the indicating type and be lockable open in accordance with 110.25.

(B) Cord-and-Plug-Connected Equipment. The factory-installed attachment plug of cord-and-plug-connected equipment rated 20 amperes or less and 150 volts or less to ground shall be permitted to be the disconnecting means.

426.~~51~~92 Controllers.

(A) Temperature Controller with “Off” Position. Temperature-controlled switching devices that indicate an “off” position and that interrupt line current shall open all ungrounded conductors when the control device is in the “off” position. These devices shall not be permitted to serve as the disconnecting means unless they are lockable open in accordance with 110.25.

(B) Temperature Controller Without “Off” Position. Temperature controlled switching devices that do not have an “off” position shall not be required to open all ungrounded conductors. These devices shall not be permitted to serve as disconnecting means.

(C) Remote Temperature Controller. Remote controlled temperature-actuated devices shall not be required to meet the requirements of 426.~~51~~92(A). These devices shall not be permitted to serve as disconnecting means.

(D) Combined Switching Devices. Switching devices consisting of combined temperature-actuated devices and manually controlled switches that serve both as the controller and the disconnecting means shall comply with all of the following conditions:

(1) Open all ungrounded conductors when manually placed in the “off” position

(2) Be so designed that the circuit cannot be energized automatically if the device has been manually placed in the “off” position

(3) Be lockable open in accordance with 110.25

Substantiation

Introduction

The development of a conductive concrete heating system continues from the Iowa State University Department of Civil, Construction and Environmental Engineering with several pilot installations. Since the first draft meetings in January 2024, additional research, laboratory testing and pilot site installations have been installed to find the optimal design with a low voltage, 30 volts ac or less, power supply. This ongoing research required new configurations for the electrode spacing as well as changes to the carbon fiber content in the concrete mix.

Testing in concert with UL of existing pilot installations set up for 208, 120, and 240 volts determined that the wet surface voltage and resultant body current exceeded acceptable safe values and present potential shock hazards where bare hands or feet were in contact with the surface. This along with the panel committee input statement determined the design change to the lower voltage.

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The Need for NEC Requirements

The present NEC requirements do not address this new technology. Because this technology is very different than present systems covered by Article 426 a new Part VI was proposed along with other changes specific to the conductive pavement applications. The text in the public comment has revised what was proposed to include only requirements relative to the electrical system and address the panel input and continued research activities.

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Federal Aviation Administration

State of Alaska DOT

State of California DOT

State of Iowa DOT (lead on the present project with Iowa State University)

State of Missouri DOT

State of New Jersey DOT (similar project underway with Rowan University)

State of New York DOT

State of Texas DOT

State of Nebraska Department of Road (pilot project, see attached article) and Kansas City, Nebraska (similar project for bus stop with University of Nebraska – Lincoln, see attached article)

This topic has also been a topic of presentations for several years at the American Association of State Highway and Transportation Officials (AASHTO) meeting with representation for all 50 states and US territories.

Proposed NEC Sections Technical Discussion

A new definition for Conductive Pavement Heating System has been proposed in a separate comment, PC 1733, to be added in Article 100 for this new technology. This comment recommended the definition to be under the purview of CMP-17 and applicable to Article 426 only.

The scope of Article 426 has been modified in a separate comment, PC 1734, to accommodate this technology and provide coverage for this system in the scope of Article 426.

No changes are proposed to Parts II through V of Article 426 as these parts are specific with different concepts and unrelated technologies. Due to the unique nature of this technology, it was determined a whole new part is needed, therefore the creation of the new Part VI and renumbering of the existing Part VI to Part VII. This is consistent with other parts in Article 426 that address specific types of equipment or systems.

New Part VI

The new part is recommended to become Part VI and the existing Part VI to be renumbered to Part VII with applicable renumbering of the two remaining affected sections. This public comment includes the applicable section numbering changes to the new Part VII, as revised by the panel in the first draft, and verified renumbering in cross references. No other changes in Part VII are intended from this comment.

A general requirement is included to clarify which previous parts of Article 426 are to be included for installations of conductive pavement heating systems. One item to note from Part II is 426.13 which requires signage alerting anyone approaching the conductive pavement that there is this system present. Some designs being considered include a light, to supplement this sign, signifying the system is energized and operating when illuminated.

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The following key elements are included in the new requirements in Part VI

Each system will be unique to a site and will be required to be designed and specification from a registered professional engineer. Similar requirements for these kinds of unique systems are already included elsewhere in code.

The installation will require oversight by the design engineer with some documentation requirements being made available to the Authority Having Jurisdiction. This is similar to existing NEC requirements found in 371.14 and 691.6. Having the design professional for the custom design of each system with the standardized specification and listing by a recognized testing laboratory provides the Authority Having Jurisdiction with a solid body of information to assist in the approval of the installation. This aspect was strongly recommended by the AHJs that are part of the Iowa DOT team working on this project.

There are clear documentation requirements for the initial design through the final commissioning to be provided to the Authority Having Jurisdiction for review and approval. The manufacturer’s instructions, which will be part of the listing, and the specifications for the pavement batch mixing are required for the AHJ to evaluate conformance of the installation. One of these reports would be the “wet” and “cured” testing results for the resistance or conductivity of the conductive pavement materials.

The primary hazards identified are potential shock and thermal burn hazards. The shock hazard is being mitigated by now requiring the supply voltage not exceed 30 volts RMS or 60 Volts dc. The power supply is also required to be an isolation transformer and the system to be ungrounded. This will address concerns for stray currents through the earth or effects on other facilities. These requirements are consistent with other NEC requirements. Since the system is now low voltage from an isolation transformer and to be an ungrounded system, only GFCI protection for 125 volt 15- and 20-amp branch circuits supplying equipment installed on the conductive pavement is required.

The other hazard is from a surface becoming excessively hot. The level of heat required is only to melt snow or prevent icing, which is at a temperature of about 40°F per the research completed. The temperature limits set in the proposed requirements are 15°C or 60°F which are well below the 50°C or 122°F allowed in many UL standards for contact without burns.

Installation requirements have been revised to include a minimum electrode encasement in the conductive pavement. Installation also includes wiring methods addressing the power supply to the electrodes, wiring to control and sensor equipment embedded in or in support of the system, and wiring methods for other electrical equipment that may be installed on the conductive pavement. Requirements are established for the proper connection devices of the supply conductors to the electrodes and for the mounting of any equipment to structures onto the conductive pavement.

No special grounding and bonding are required under the revised requirements and all the requirements from Article 250 would apply as provided through 90.3.

Public Comment No. 327
Assigned to CMP - 1 Referred to CMPs 2 - 17

Public Comment No. 327-NFPA 70-2024 [Global Input]

CMP 1 has deleted the definition for "In Sight From", and the requirements that were part of that definition are now located in 110.29. This global Correlating Committee Note directs all CMP's to review occurrences of the phrase "in sight from", "within sight from", and "within sight" and consider whether references to 110.29 or 110.39 should be included.

Additional Proposed Changes

File Name	Description	Approved
CN_26.pdf	NEC_CN26	✓

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 26 appeared in the First Draft Report on First Revision No. 9187.

CMP 1 has deleted the definition for "In Sight From", and the requirements that were part of that definition are now located in 110.29. This global Correlating Committee Note directs all CMP's to review occurrences of the phrase "in sight from", "within sight from", and "within sight" and consider whether references to 110.29 or 110.39 should be included.

Related Item

• First Revision No. 9187

Submitter Information Verification

Submitter Full Name: CC Notes
Organization: NEC Correlating Committee
Street Address:
City:
State:
Zip:

Submittal Date: Mon Jul 29 17:05:29 EDT 2024
Committee: NEC-P01

Correlating Committee Note No. 26-NFPA 70-2024 [Global Input]

Submitter Information Verification

Committee: NEC-AAC

Submittal Date: Tue May 07 14:23:07 EDT 2024

Committee Statement and Meeting Notes

Committee Statement: CMP 1 has deleted the definition for “In Sight From”, and the requirements that were part of that definition are now located in 110.29. This global Correlating Committee Note directs all CMP’s to review occurrences of the phrase “in sight from”, “within sight from”, and “within sight” and consider whether references to 110.29 or 110.39 should be included.

First Revision No. 9187-NFPA 70-2024 [Section No. 225.41]

Ballot Results

✔ **This item has passed ballot**

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

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.
Bowmer, Trevor N.
Hickman, Palmer L.
Holub, Richard A.
Jackson, Peter D.
Kendall, David H.
Manche, Alan
Osborne, Robert D.
Porter, Christine T.
Schultheis, Timothy James
Williams, David A.

Public Comment No. 443
Assigned to CMP-5, Referred to CMPs 1 - 18

Public Comment No. 443-NFPA 70-2024 [Global Input]

The Correlating Committee directs all Code-Making Panels to verify cross-references to Article 200 are accurate due to the renumbering of the article.

Additional Proposed Changes

File Name	Description	Approved
CN_84.pdf		✓

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 84 appeared in the First Draft Report.

The Correlating Committee directs all Code-Making Panels to verify cross-references to Article 200 are accurate due to the renumbering of the article.

Related Item

- Correlating Committee Note No. 84

Submitter Information Verification

Submitter Full Name: CC Notes
Organization: NEC Correlating Committee
Street Address:
City:
State:
Zip:

Submittal Date: Tue Jul 30 17:35:49 EDT 2024
Committee: NEC-P05

Correlating Committee Note No. 84-NFPA 70-2024 [Global Input]

Submitter Information Verification

Committee: NEC-AAC

Submittal Date: Wed May 08 08:49:53 EDT 2024

Committee Statement

Committee Statement: The Correlating Committee directs all Code-Making Panels to verify cross-references to Article 200 are accurate due to the renumbering of the article.

Ballot Results

✔ **This item has passed ballot**

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

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.
Bowmer, Trevor N.
Hickman, Palmer L.
Holub, Richard A.
Jackson, Peter D.
Kendall, David H.
Manche, Alan
Osborne, Robert D.
Porter, Christine T.
Schultheis, Timothy James
Williams, David A.

Public Comment No. 504
Assigned to CMP-18, Referred to CMPs 1 - 17

Public Comment No. 504-NFPA 70-2024 [Global Input]

The Correlating Committee directs the CMPs to review the revision of the title of Article406 (Wiring Devices) and the new definition for the term "wiring device" in Article 100 forcorrelation of existing terminology using the newly define term in their articles.

Additional Proposed Changes

File Name	Description	Approved
CN_157.pdf		✓

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 157 appeared in the First Draft Report on First Revision No. 7965.

The Correlating Committee directs the CMPs to review the revision of the title of Article 406 (Wiring Devices) and the new definition for the term "wiring device" in Article 100 for correlation of existing terminology using the newly define term in their articles.

Related Item

- First Revision No. 7965

Submitter Information Verification

Submitter Full Name: CC Notes
Organization: NEC Correlating Committee
Street Address:
City:
State:
Zip:

Submittal Date: Tue Jul 30 22:29:14 EDT 2024
Committee: NEC-P18

Correlating Committee Note No. 157-NFPA 70-2024 [Global Input]

Submitter Information Verification

Committee: NEC-AAC

Submittal Date: Thu May 09 08:59:03 EDT 2024

Committee Statement and Meeting Notes

Committee Statement: The Correlating Committee directs the CMPs to review the revision of the title of Article 406 (Wiring Devices) and the new definition for the term "wiring device" in Article 100 for correlation of existing terminology using the newly define term in their articles.

First Revision No. 7965-NFPA 70-2024 [New Definition after Definition: Wireways, Nonmetallic. (No...]

Ballot Results

✔ **This item has passed ballot**

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

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.
Bowmer, Trevor N.
Hickman, Palmer L.
Holub, Richard A.
Jackson, Peter D.
Kendall, David H.
Manche, Alan
Osborne, Robert D.
Porter, Christine T.
Schultheis, Timothy James
Williams, David A.

Public Comment No. 527
Assigned to CMP- 2, Referred to CMPs 1 - 18

Public Comment No. 527-NFPA 70-2024 [Global Input]

The CMPs are directed to review references to Article 220 in the articles under their purview and make necessary revisions based on Article 220 being relocated to Article120.

Additional Proposed Changes

File Name	Description	Approved
CN_212.pdf		✓

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 212 appeared in the First Draft Report.

The CMPs are directed to review references to Article 220 in the articles under their purview and make necessary revisions based on Article 220 being relocated to Article 120.

Related Item

- Correlating Committee Note No. 212

Submitter Information Verification

Submitter Full Name: CC Notes
Organization: NEC Correlating Committee
Street Address:
City:
State:
Zip:
Submittal Date: Tue Jul 30 23:08:41 EDT 2024
Committee: NEC-P02

Correlating Committee Note No. 212-NFPA 70-2024 [Global Input]

Submitter Information Verification

Committee: NEC-AAC

Submittal Date: Thu May 09 11:53:08 EDT 2024

Committee Statement and Meeting Notes

Committee Statement: The CMPs are directed to review references to Article 220 in the articles under their purview and make necessary revisions based on Article 220 being relocated to Article 120.

Ballot Results

✔ **This item has passed ballot**

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

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.

Bowmer, Trevor N.

Hickman, Palmer L.

Holub, Richard A.

Jackson, Peter D.

Kendall, David H.

Manche, Alan

Osborne, Robert D.

Porter, Christine T.

Schultheis, Timothy James

Williams, David A.

Public Comment No. 542
Assigned to CMP-3, Referred to CMPs 1 - 18

Public Comment No. 542-NFPA 70-2024 [Global Input]

The Correlating Committee directs the CMPs to review all references to requirements in Chapters 7 & 8 for accuracy in light of the relocation of requirements occurring in the First Draft.

Additional Proposed Changes

File Name	Description	Approved
CN_401.pdf		✓

Statement of Problem and Substantiation for Public Comment

NOTE: The following CC Note No. 401 appeared in the First Draft Report.

The Correlating Committee directs the CMPs to review all references to requirements in Chapters 7 & 8 for accuracy in light of the relocation of requirements occurring in the First Draft.

Related Item

- Correlating Committee Note No. 401

Submitter Information Verification

Submitter Full Name: CC Notes
Organization: NEC Correlating Committee
Street Address:
City:
State:
Zip:

Submittal Date: Tue Jul 30 23:39:04 EDT 2024
Committee: NEC-P03

Correlating Committee Note No. 401-NFPA 70-2024 [Global Input]

Submitter Information Verification

Committee: NEC-AAC
Submittal Date: Fri May 10 12:35:51 EDT 2024

Committee Statement

Committee Statement: The Correlating Committee directs the CMPs to review all references to requirements in Chapters 7 & 8 for accuracy in light of the relocation of requirements occurring in the First Draft.

Ballot Results

✔ **This item has passed ballot**

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

Not Returned

McDaniel, Roger D.

Affirmative All

Ayer, Lawrence S.

Bowmer, Trevor N.

Hickman, Palmer L.

Holub, Richard A.

Jackson, Peter D.

Kendall, David H.

Manche, Alan

Osborne, Robert D.

Porter, Christine T.

Schultheis, Timothy James

Williams, David A.

Public Comment No. 649
Assigned to CMP-1, Referred to CMPs 2 - 18

Public Comment No. 649-NFPA 70-2024 [Global Input]

Delete the words, "to be installed" everywhere they appear in the First Draft.

Statement of Problem and Substantiation for Public Comment

The term "to be installed" is always redundant. 90.2(C) says, "This code covers the installation and removal of electrical conductors, equipment, and raceways...". Every requirement of the NEC is about installation or removal (and requirements about removal are a very small minority). "Shall be permitted" and "shall not be permitted," as applied to equipment, mean that the subject equipment either is or is not allowed to be installed.
The new First Draft restrictions on reconditioned equipment seem to have overlooked the scope and purpose of the NEC. Adding the superfluous term "to be installed" also does not conform to 3.1.1, 3.1.2, and 3.5.1.1 of the NEC Style Manual.

Related Item

- FR-9197
- FR-9236
- FR-7868
- PI-3713
- FR-8938
- FR-7970
- FR-8831
- FR-8941
- FR-8944
- FR-8947
- FR-7925
- FR-7585
- FR-8136
- FR-8148
- FR-8984
- FR-8293
- FR-8362
- FR-8348
- FR-8360
- FR-7614
- FR-7658
- FR-7734
- FR-7746
- FR-8150
- FR-7717

Submitter Information Verification

Submitter Full Name: William Fiske
Organization: Intertek Testing Services
Street Address:
City:
State:
Zip:

Submittal Date: Fri Aug 02 09:19:44 EDT 2024
Committee: NEC-P01