Board of Building Standards

ELECTRICAL SAFETY INSPECTOR ADVISORY COMMITTEE
REQUEST FOR RECOMMENDATIONS

DATE: DECEMBER 08, 2023
TIME: 12:00 PM
LOCATION: NO MEETING THIS MONTH

Personnel Certification Applications

P-1 Cashwell, James - ESI
Certification ID: 9256
Current Certifications: None
Staff Notes: Appears to meet requirements: recommend approval.
ESIAC Recommendations:
Committee Recommendation:

Continuing Education Applications for Review

ER-1 2023 NEC Article 250 Grounding and Bonding (Institute for Professional Education)
All certifications (8 hours)
Staff Notes:
ESIAC Recommendation:
Committee Recommendation:

ER-2 2023 NEC Articles 230-242 (Institute for Professional Education)
All certifications (4 hours)
Staff Notes:
ESIAC Recommendation:
Committee Recommendation:

ER-3 2023 NEC Articles 230-300 (Institute for Professional Education)
All certifications (8 hours)
Staff Notes:
ESIAC Recommendation:
Committee Recommendation:

ER-4 2023 NEC Articles 230-314 (Institute for Professional Education)
All certifications (8 hours)
Staff Notes:
ESIAC Recommendation:
Committee Recommendation:

ER-5 2023 NEC Articles 90-200 (Institute for Professional Education)
All certifications (4 hours)
Staff Notes:
ESIAC Recommendation:
Committee Recommendation:

ER-6 2023 NEC Articles 90-210 (Institute for Professional Education)
All certifications (8 hours)
Staff Notes:
ESIAC Recommendation:
Committee Recommendation:

ER-7 2023 NEC Install Standards (Wink Electric)
All certifications (5 hours)
Staff Notes: There are no slides. Format includes traditional lecture, class discussion, sample illustrations, handouts, and use of code book.
ESIAC Recommendation:
Committee Recommendation:

ER-8 2023 NEC Updates (Wink Electric)
All certifications (5 hours)
Staff Notes: There are no slides for this course. Format includes traditional lecture, class discussion, sample illustrations, handouts, and using the code book.
ESIAC Recommendation:
Committee Recommendation:

ER-9 Electrical Safety Based on the 2023 NEC and NFPA 70E (Matthews Electrical Services)
All certifications (4 hours)
Staff Notes:
ESIAC Recommendation:
Committee Recommendation:

ER-10 NEC 2023 Load Calculations (Electrical League of Ohio)
All certifications (4 hours)
Staff Notes:
ESIAC Recommendation:
Committee Recommendation:

ER-11 Significant Changes to the 2023 NEC (Mansfield Area Electrical JATC)
All certifications (8 hours)
Staff Notes:
ESIAC Recommendation:
Committee Recommendation:

ER-12 Solar PV and the 2023 NEC Part 1 (Matthews Electrical Services)
All certifications (4 hours)
Staff Notes:
ESIAC Recommendation:
Committee Recommendation:

ER-13 Solar PV and the 2023 NEC Part 2 (Matthews Electrical Services)
All certifications (4 hours)
Staff Notes:
ESIAC Recommendation:
Committee Recommendation:

ER-14 2023 NEC Changes (Ohio Certificate Renewal)
All certifications (4 hours)
Staff Notes:
ESIAC Recommendation:
Committee Recommendation:

ER-15 Analysis of Changes to the 2023 NEC (IAEI Western)
All certifications (nine 2-hour sessions)
Staff Notes: "This course is based entirely on the 2023 Analysis powerpoint presentation distributed through the IAEI and consisting of 709 slides." Slides are not submitted except for six samples.
ESIAC Recommendation:
Committee Recommendation:

ER-16 Changes to the 2023 NEC Parts 1 and 2 (Master Electrical Contractors Association)
All certifications (5 hours each part)
Staff Notes: App and Outline will rotate right 45 degrees for viewing.
ESIAC Recommendation:
Committee Recommendation:

File Attachments for Item:

P-1 Cashwell, James - ESI

Certification ID: 9256

Current Certifications: None

Staff Notes: Appears to meet requirements: recommend approval.

ESIAC Recommendations:

Committee Recommendation:

Board of Building Standards Application for Interim Certification, Building Department Personnel

CASHWELL — *Last Name*

JAMES — *First Name*

BBS Certification ID

SECTION 1: CHECK INTERIM CERTIFICATION(S) BEING REQUESTED

☐ Building Official	☐ Master Plans Examiner	☐ Building Inspector	☑ Electrical Safety Inspector	☐ Fire Protection Inspector
☐ Building Plans Examiner	☐ Plumbing Plans Examiner	☐ Mechanical Plans Examiner	☐ Electrical Plans Examiner	☐ Fire Protection Plans Examiner
	☐ Plumbing Inspector	☐ Mechanical Inspector	☐ Non-Residential Industrial Unit Inspector	

SECTION 2: LIST ANY OHIO LICENSE, CERTIFICATE, OR REGISTRATION HELD

(Mark "T" If Trainee)

Description			Certificate Number	Date Received
Architectural Registration				
P.E. Registration				
Res	Non-Res			
☐	☐	Building Official Certification		
☐	☐	Plans Examiner Certification		
☐	☐	Building Inspector Certification		
☐	☐	Mechanical Inspector Certification		
Building Plans Examiner Certification				
Mechanical Plans Examiner Certification				
Fire Protection Plans Examiner Certification				
Electrical Plans Examiner Certification				
Plumbing Plans Examiner Certification				
Fire Protection Inspector Certification				
Electrical Safety Inspector Certification				
Plumbing Inspector Certification				
Fire Safety Inspector Certification				
Fire Protection System Designer Certification				
Medical Gas Piping Inspector Certification				

Cashwell	James	
Last Name	*First Name*	*BBS Certification ID*

SECTION 3: EMPLOYMENT/EDUCATION

Formal Education	Date Graduated
Bellevue High School	8/83
Related Vocational or Technical Training	**Years' Experience**
ABC Electrical School Competed Electrical Apprenticeship	4
U.S. Military construction experience (MOS or other designation):	**Years' Experience**
Place of Employment:	**Years' Employed**
KenMarc Electric	9

SECTION 4: APPLICANTS REQUESTING MEDICAL GAS INSPECTOR CERTIFICATION

***Attach proof** of certification by an ASSE recognized third-party certifier in accordance with ASSE standard 6020.*

SECTION 5: OBC BUILDING INSPECTION EXPERIENCE PERFORMED FOR A BBS CERTIFIED BUILDING DEPARTMENT

BBS Certified Building Department	BBS Certified Position/Title	Duties	Date of Service, Length of Time (MM/DD/YY)

CASHWELL JAMES

Last Name *First Name* *BBS Certification ID*

SECTION 6: ELECTRICAL SAFETY INSPECTOR (ESI) - SPECIFIC EXPERIENCE QUALIFICATIONS

Applicants for Electrical Safety Inspector Only Must Complete This Item

Section 3783 of the Ohio Revised Code specifies that an applicant for a Certificate of Competency as an Electrical Safety Inspector must meet on of the following to qualify to take required examination. Please check the qualification that applies:

1. ☐ Have been a journeyman electrician or equivalent for four years, two of which were as an electrician foreman, and have had two years' experience as a building department electrical inspector trainee;
2. ☐ Have been a journeyman electrician or equivalent for four years and have had three years' experience as a building department electrical inspector trainee;
3. ☐ Have had for four years' experience as a building department electrical inspector trainee;
4. ☑ Have been a journeyman electrician or equivalent for six years;
5. ☐ Am a graduate electrical engineer and registered in the State of Ohio. Registration number: _____
6. ☐ Applicant authorizes all testing organizations including ICC to provide test results to the BBS.

SECTION 7: EXPERIENCE *(DO NOT SUBSTITUTE WITH OTHER RESUMES)*.

Refer to Experience Requirements Listed in O.A.C. 4101:7-3-01 and O.R.C. 3783

Below, list the specific projects you worked on, and the specific work you performed, your typical duties for each project, and dates of this work. You **must** demonstrate that you have the required number of months (years) of actual, practical experience for the certification requested (see matrix).

Provide letters from certified inspectors, employers, or contractors verifying your experience. Submit copies of any certificates, diplomas, or licenses. Remove all personal information.

SECTION 7 CONT.: EXPERIENCE

List Each Construction Project AND Specific Type of Work Performed	Name of Employer, Contact, Address, Telephone Number	Project Time: From_ To _ (MM/YY)
Example: *Children's Hospital, Toledo* *Structural steel work on addition*	*Homer Steel and Trade* *125 Anytown Street* *My City, OH, 45454* *(419)555-1212*	*July 2013-May 2014* *(10 months)*
ARCO, LATONIA KY. ELECTRICAL SERVICE TRANSFORMERS, ELECTRICAL PANELS, HVAC EQUIPMENT.	KENMARC ELECTRIC 1055 HEYWOOD ST. CINCINNATI, OH 45225	SEP. 14. 2023 PRESENT. 06/23 - 08/23
MERCY URGENT CARE (CHERRY GROVE) SERVICE EQUIPMENT, X-RAY EQUIPMENT, LAY OUT AND RUN EMT, LIGHTING, RECEPETACLES	KENMARC ELECTRIC 1055 HEYWOOD ST. CINCINNATI OH. 45225	
Total Experience on This Page (In Months):		4 months

CASHWELL
Last Name

JAMES
First Name

BBS Certification ID

List Each Construction Project AND Specific Type of Work Performed	Name of Employer, Contact, Address, Telephone Number	Project Time: From_ To _ (MM/YY)
The Childrens Home School UPGRADE SERVICE FIRE ALARM, R.T.U.'S lighting + Receptacle Power	KENMARC ELECTRIC 1055 Heywood St CINCINNATI, OH. 45225	05/19 - 11/19 6
Historic Homes in Ft. Thomas KY (Tower Park) UPGRADE All SERVICES REWIRE All Homes. outdoor lighting, NEW X-FORMERS.	KENMARC ELECTRIC 1055 Heywood St CINCINNATI, OH. 45225.	12/2017-12/2018 12
Bilstein of America UPGRADE SERVICE NEW MDP PANEL, INSTALLED BUS DUCT + BUSPLUGS FOR NEW MANUFACTURING EQUIPMENT. R.T.U's RAN EMT to Feed NEW MDP + BUS Duct	KENMARC ELECTRIC 1055 Heywood St CINCINNATI, OH. 45225	08/2015-2/2016 6
	Total Experience on This Page (In Months):	24 mouth.

Board of Building Standards Application for Interim Certification, Building Department Personnel

CASHWELL — *Last Name*

JAMES — *First Name*

BBS Certification ID

List Each Construction Project AND Specific Type of Work Performed	Name of Employer, Contact, Address, Telephone Number	Project Time: From_ To _ (MM/YY)
Jeff Wyler Corporate Installed EV charging stations. upgraded service FIRE ALARM. Additon to existing Building.	KENMARC ELECTRIC 1055 HEYWOOD ST. CINCINNATI, OH. 45225	02/23 - 06/23 4
	KENMARC ELECTRIC 1055 HEYWOOD ST. CINCINNATI, OH. 45225	10/22 - 02/23 4
MERCY URGENT CARE (milford) SERVICE EQUIPMENT, X-RAY EQUIPMENT, CAY OUT JOB FOR MYSELF AND APPRENTICES Duct Smoke detectors. LOW VOLTAGE lighting CONTROLS.	KENMARC ELECTRIC 1055 HEYWOOD ST. CINCINNATI, OH 45225	05/22 - 10/22 5
	KENMARC ELECTRIC 1055 HEYWOOD ST. CINCINNATI, OH 45225	12/21 - 3/22 3
MIDWEST FILTRATION NEW SERVICE for Addition, TRANSFORMER PANELS, CHARGING STATIONS ELECTRIC FORK LIFTS, FIRE ALARM, OUTSIDE LIGHTING DOCK LEVELERS.		
MAKETEWAH COUNTRY CLUB RENOVATED KITCHEN FIRE ALARM, EGRESS lighting, SERVICE UPGRADE		
	Total Experience on This Page (In Months):	16 MONTH.

CASHWELL
Last Name

JAMES
First Name

BBS Certification ID

List Each Construction Project AND Specific Type of Work Performed	Name of Employer, Contact, Address, Telephone Number	Project Time: From_ To_ (MM/YY)
H+M (Clothing Store) Liberty Center Installed X-formers Panels, Elevator Equipment, Fire Alarm motor starters Layout Electrical Room	KENMARC Electric 1055 Heywood St. Cincinnati, OH. 45225	01/16 - 04/16 4
Sharefax Credit Union Fire Alarm, Lighting Controls, Recps. Service, X-Former	KENMARC Electric 1055 Heywood St. Cincinnati, OH. 45225	11/20 - 6/21 7
Harbor Freight Underground P.V.C. for new service, and Pole lights. Rough-in-masonry. Build service. Fire Alarm lighting controls,	KENMARC Electric 1055 Heywood St. Cincinnati, OH. 45225	04/16 - 08/16 4
Victoria's Secret New service, MDP R.T.U.S, Fire Alarm	KENMARC Electric Cincinnati, OH. 45225	04/14 - 7/14 3
	Total Experience on This Page (In Months):	18 months.

Cashwell
Last Name

James
First Name

BBS Certification ID

List Each Construction Project AND Specific Type of Work Performed	Name of Employer, Contact, Address, Telephone Number	Project Time: From_ To _ (MM/YY)
Fedex (CVG Airport) Install MDP & Sub Panels. 480v & 208v 3 Phase, Backup Generator. Install EMT, PVC, Rigid Conduit Branch circuits.	KENMARC Electric 1055 Heywood St Cincinnati, OH. 45225	07/19 - 02/20 6
Silverlake Temporary power RTU, Fire Alarm Install EMT for Branch circuits.	KENMARC ELECTRIC 1055 Heywood St. Cincinnati, OH. 45225	08/18 - 07/19 11
Petco Install PVC for service Pullwire for SERICE Install and wire X-former and all Panels. Fire Alarm	KENMARC ELECTRIC 1055 Heywood St. Cincinnati, OH. 45225	08/17 - 09/17 1
H&M (clothing Store) Installed-all-X-Formers Panels. wired All X-formers & Panels Elevator equipment	KENMARC ELECTRIC 1055 Heywood St. Cincinnati, OH. 45225	10/15 - 01/16 3
	Total Experience on This Page (In Months):	21 month.

Board of Building Standards Application for Interim Certification, Building Department Personnel

Cashwell	James	
Last Name	*First Name*	*BBS Certification ID*

List Each Construction Project AND Specific Type of Work Performed	Name of Employer, Contact, Address, Telephone Number	Project Time: From_ To _ (MM/YY)
Zotefoams office Remodel Relocate existing MDP, Run new EMT for new MDP in addition. Build new service	Kenmarc Electric 1055 Heywood St. Cincinnati, OH. 45225	02/2019 08/2019 6
	Total Experience on This Page (In Months):	

CASHWELL — *Last Name*

JAMES — *First Name*

BBS Certification ID

SECTION 8: PERSONAL HISTORY

1. Have you ever been convicted of any felony, or any crime involving moral turpitude? ☐ Yes ☑ No

   If you answered "Yes" please explain below:

2. Have you served in the U.S. armed services? (If No, skip question 3) ☑ Yes ☐ No
3. If YES, were you discharged under honorable conditions? ☑ Yes ☐ No

   If you answered "No" please explain below:

SECTION 9: CERTIFICATION

I certify the information contained in this application is true and complete, and I understand that providing false information may be grounds for not granting certification or for immediate termination of certification at any point in the future, if granted. I authorize the investigation of all statements contained herein and release all parties from all liability for any damage that may result from furnishing the same to Ohio Board of Building Standards. Falsification is a violation of section 2921.13 of the Ohio Revised Code and is punishable as a misdemeanor of the first degree.

Signature of Applicant: James R. Cashwell

Subscribed and duly sworn before me according to law, by the above named applicant this day 15 of November in the year 2023 at Permit Central, County of Clermont and State of Ohio.

Notary Public: Alex Wakefield Exp 8/23/28

ALEXANDRIA WAKEFIELD NOTARY PUBLIC, STATE OF OHIO

File Attachments for Item:

ER-1 2023 NEC Article 250 Grounding and Bonding (Institute for Professional Education)

All certifications (8 hours)

Staff Notes:

ESIAC Recommendation:

Committee Recommendation:

Mike DeWine, Governor
Jon Husted, Lt. Governor
Sheri Maxfield, Director

Board of Building Standards

Application for Continuing Education Course Approval

Provider Information:

Name: Paul R. Fussner BBS # 504
Organization: Institute for professional Education
Address: 30508 Ronald Drive, Willowick, Ohio 44095
E-mail: pfussner@paulfussner.onmicrosoft.com Telephone: 216-299-9367
Website: www.ohiocodeclass.org/
Conference Sponsor (if applicable) Elaine's Educational Services, LLC Conference Email: vfussner1955@gmail.com

Check here if Course Renewal: _____ Prior course number _____ *(i.e. BBS2018-429)*
Renewals will only be granted for identical content and certifications, within the current code cycle.
Attach a copy of prior course approval letter for confirmation. No further information is required.

New Course Information:

Course title: 2023 National Electrical Code Artical 250 Understanding Grounding and Bonding
Course instructor: Paul R. Fussner BBS # 504
Course description: An in depth study of Article 250 Understanding Grounding and Bonding, Power Point Slide Presentation with questions and answers to allow students to better understand and interpret the requirements for establishing a grounding electrode system. (10) minute break per hour and (1) hour break for lunch.
Instructional hours per session: eight hour Number of Sessions: one day session
Course Date(s) and Location: See attached proposed 2023 schedule (subject to change throughout the year)

Special Content:

Code Administration: ____
Existing Buildings: ____
Electrical Instruction: X
Plumbing Instruction: ____

Conference Course: Course will be offered live and Virtual on line Zoom
Conference Name: Understanding Grouding and Bonding
Conference location: See attached proposed Schedule

Course to be offered online? yes **On Demand** ____ **Webinar** Virtual Zoom Session
Course Website: WWW.ohiocodeclass.org/
Detail online course participation confirmation method *(i.e. test, quizlets, participant activity confirmation)*:
Each student logs in with course link provided after verification of certifications and photo ID , this information reviewed again during sign in or log in on the day of the course

Course applicable for the following certifications

Residential Certifications Only: ____ Commercial Certifications: ____
Administrative Course, All Certifications: X

Application materials included:

X Course Outline or Course Learning Objectives Power Point Presentation
X Presentation Materials/Slides Presented from Power Point Presentation
X Assessment Materials (for online courses) Zoom Live Presentation
____ Presenter Bio

Please submit application and materials in .pdf format to: michael.lane@com.ohio.gov or BBS@com.ohio.gov

RECEIVED
NOV 27 2023
BOARD OF BUILDING STANDARDS

Paul Robert Fussner, dba

THE INSTITUTE FOR PROFESSIONAL EDUCATION

30508 Ronald Drive
Willowick, Ohio 44095-4341
pfussner@paulfussner.onmicrosoft.com

November 21.2023

Ohio Board of Building Standards
6606 Tussing Rd
Reynoldsburg, Ohio 43068-9009

REGARDING: Course Syllabus Electrical Contractor. 8-Hour Study of 2023 National Electrical Code Changes Article 250 Understanding Grounding and Bonding

In-person student classes utilize the normal sign-in method of showing a picture ID and state license before signing the OCILB registration sheet, sign-in begins 30 minutes before the session start time.

Classes are to be held online: **Utilizing Zoom Meetings Software**

Computer sign-in and registration(s) begin 30 minutes before the session, utilizing the Zoom login link assigned to each student who has pre-registered by mail or online. Students may log in with a computer, tablet, or smartphone.

Session Schedule

8:00	**am**	**Beginning of PowerPoint presentation and review of:**
		Article 250 of the 2023 National Electrical Code
8:50	**am**	**Ten-minute break.**
		50 minutes per hour of study of the PowerPoint presentation.
12:00	**pm**	**Students will be given a one-hour break for lunch**
1:50	**pm**	**Ten-minute break.**
		50 minutes per hour of study of the PowerPoint presentation
5:00	**pm**	**Student dismissal**

Note: **All eight-hour sessions begin promptly at 8:00 am**

Paul Robert Fussner, dba
The Institute for Professional Education
30508 Ronald Drive
Willowick, Ohio 44095-4341
pfussner@paulfussner.onmicrosoft.com

INSTRUCTOR QUALIFICATIONS:

- State Certified Electrical Safety Inspector #504
- State Certified Building Inspector #504
- Building Official #504
- Residential Building Official #504
- Board of Building Standards Instructor, Electrical Safety Inspector Re-certification, established in 1999.
- OCILB Instructor, state-licensed, electrical, plumbing, HVAC, and Hydronics contractors continuing education courses, established in 1999.

50 years of experience in the building and electrical trades, as Founder and President of the Gibson Robert Company, Inc. I expedited all new work including researching and ordering the proper electrical equipment required for a safe, efficient installation, while meeting the requirements of The NFPA 70 Electrical Code, The B.O.C.A. Code, and The Ohio Building Code.

29 years of experience as a State Certified Electrical Safety Inspector, 24 years experience as a State Certified Building Inspector with 12 years of departmental management experience.

14 years as Building Official #504

Former Chairman, Western Reserve Chapter International Association of Electrical Inspectors. Two years as Education Chairman, Western Reserve Chapter of the IAEI.

Owner of The Institute for Professional Education, a State of Ohio Training Agency for the Mandatory Continuing Education Credits for Electrical Safety Inspectors and State Licensed Electrical Contractors. Accredited by the Ohio Board of Building Standards and the Ohio Construction industry licensing board. established 1999.

2024 IN-PERSON and ONLINE ZOOM SESSION(S) SCHEDULE for all OCILB. Contractors and BBS Certifications

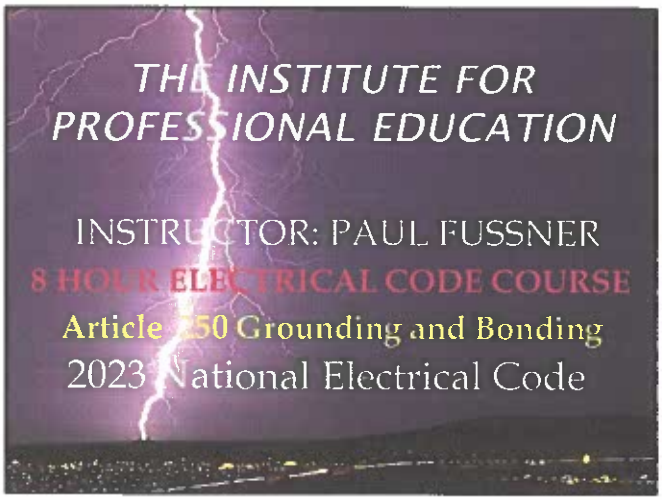
TO REGISTER FOR A CLASS, VISIT OUR WEB PAGE:

WWW.OHIOCODECLASS.ORG / OR CALL 216-299-9367

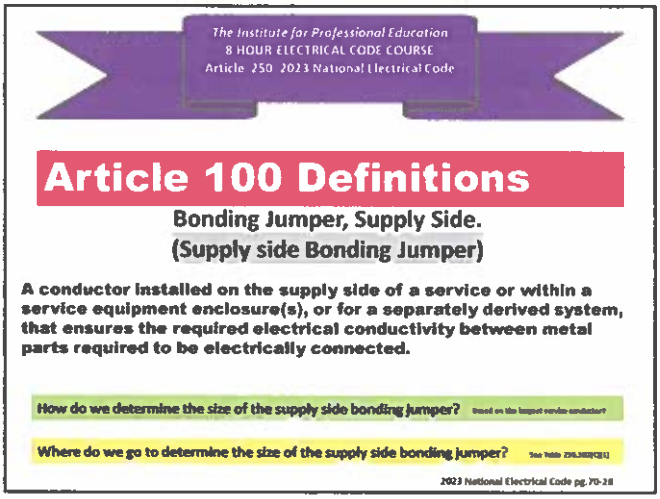
January 13	**8-Hr Online Virtual Zoom Session** 2023 NEC Article 250 Understanding Grounding and Bonding	**Course # 3750064**
February 17	**4-hr Online Virtual Zoom Session** 7:45 am-12:00 pm 2023 NEC Articles 90-200	**Course # 3750066**
	4-Hr Online Virtual Zoom Session 1:00 pm - 5:00 pm 2023 NEC Articles 230-242	**Course # 3750060**
	2-Hr Online Virtual Zoom Session 5:00 pm - 7:00 pm 2019 RCO Chapter 113 Existing	**Course # 3750061**
March 23	**8-Hr Online Virtual Zoom Session** 2023 National Electrical Code Article's 230 – 314	**Course # 3750062**
April 27	**4-Hr Online Virtual Zoom Session** 7:45 am-12:00 pm 2023 NEC Articles 90-200	**Course # 3750066**
	4-Hr Online Virtual Zoom Session 1:00 pm - 5:00 pm 2023 NEC Articles 230-242	**Course # 3750060**
	2-Hr Online Virtual Zoom Session 5:00 pm - 7:00 pm 2019 RCO Chapter 3401.1(2)(1)	**Course # 3750065**
May 18	**8-Hr Online Virtual Zoom Session** 2023 National Electrical Code Article's 90 – 210	**Course # 3750063**
June 17	8-Hr Live in-person session 2023 NEC Article 250 Understanding Grounding and Bonding	**Course # 3750064**
	Location: Grace Church 36300 Ridge Rd, Willoughby, Ohio 44094 **Rear Lower Level Entrance**	
July 27	**8-Hr Online Virtual Zoom Session** 2023 National Electrical Code Article's 230 – 314	**Course # 3750062**
August 14	4-Hr Weekday **Virtual Zoom Session** 7:45 am-12:00 pm 2023 NEC Articles 90-200	Course # 3750066
August 21	4-Hr Weekday **Virtual Zoom Session** 7:45 am-12:00 pm 2023 NEC Articles 230-242	Course # 3750060
September 7	4-Hr Live in Person Session 7:45 am-12:00 pm 2023 NEC Articles 90-200	**Course # 3750066**
	4-Hr Live in Person Session 1:00 pm - 5:00 pm 2023 NEC Articles 230-242	**Course # 3750060**
	2-Hr Live in Person Session 5:00 pm - 7:00 pm 2019 RCO Chapter 113 Existing	**Course # 3750061**
	Location: Cretan Party Center 13853 W. 168th Street & Lorain Rd, Cleveland, Ohio 44111	
October 19	4-Hr Live in Person Session 7:45 am-12:00 pm 2023 NEC Articles 90-200	**Course # 3750066**
	4-Hr Live in Person Session 1:00 pm - 5:00 pm 2023 NEC Articles 230-242	**Course # 3750060**
	2-Hr Live in Person Session 5:00 pm - 7:00 pm 2019 RCO Chapter 3401.1(2)(1)	**Course # 3750065**
	Location: Huntsburg Civic Center 12396 Madison Rd. (Rt,528 & 322) Middlefield, Ohio 44062 Use the rear entrance	
November 16	**8-Hr Online Virtual Zoom Session** 2023 National Electrical Code Article 250 Grounding and Bonding	**Course # 3750064**
December 7	4-Hr Live in Person Session 7:45 am-12:00 pm 2023 NEC Articles 90-200	**Course # 3750066**
	4-Hr Live in Person Session 1:00 pm - 5:00 pm 2023 NEC Articles 230-242	**Course # 3750060**
	2-Hr Live in Person Session 5:00 pm - 7:00 pm 2019 RCO Chapter 113 Existing	**Course # 3750061**

Fee Scheule

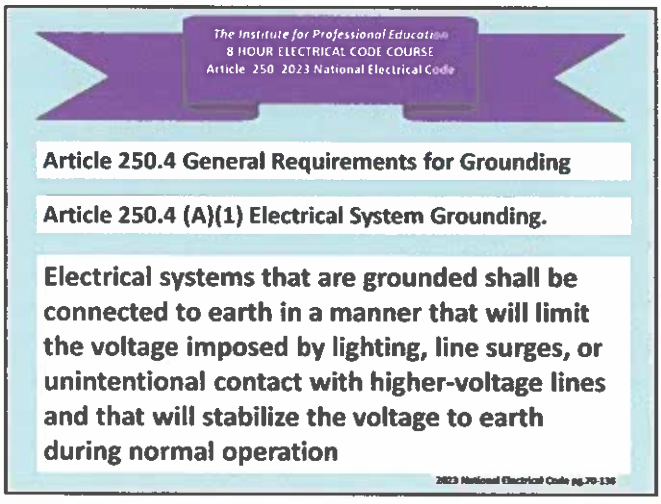
Ten Hours of Education	**$200.00**
Eight Hours of Education	**$180.00**
Four Hours of Education	**$ 90.00**
Two Hours of Education	**$ 50.00**


THE INSTITUTE FOR PROFESSIONAL EDUCATION
INSTRUCTOR: PAUL FUSSNER
8 HOUR ELECTRICAL CODE COURSE
Article 250 Grounding and Bonding
2023 National Electrical Code

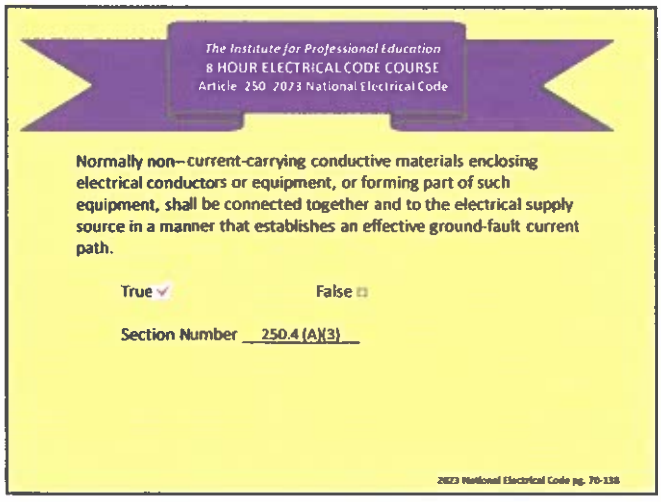
1


The Institute for Professional Education
8 HOUR ELECTRICAL CODE COURSE
Article 250 2023 National Electrical Code
Article 100 Definitions
Bonding Jumper, Supply Side.
(Supply side Bonding Jumper)
A conductor installed on the supply side of a service or within a service equipment enclosure(s), or for a separately derived system, that ensures the required electrical conductivity between metal parts required to be electrically connected.
How do we determine the size of the supply side bonding jumper?
Where do we go to determine the size of the supply side bonding jumper?
2023 National Electrical Code pg. 70-28

2


The Institute for Professional Education
8 HOUR ELECTRICAL CODE COURSE
Article 250 2023 National Electrical Code
Article 250.4 General Requirements for Grounding
Article 250.4 (A)(1) Electrical System Grounding.
Electrical systems that are grounded shall be connected to earth in a manner that will limit the voltage imposed by lighting, line surges, or unintentional contact with higher-voltage lines and that will stabilize the voltage to earth during normal operation
2023 National Electrical Code pg.70-136

3


The Institute for Professional Education
8 HOUR ELECTRICAL CODE COURSE
Article 250 2023 National Electrical Code
Normally non-current-carrying conductive materials enclosing electrical conductors or equipment, or forming part of such equipment, shall be connected together and to the electrical supply source in a manner that establishes an effective ground-fault current path.
True
False
Section Number 250.4 (A)(3)
2023 National Electrical Code pg. 70-138

4

Slide 7

PF2 Why are we not allowed to solder a grounding connection?
Paul Fussner, 4/9/2017

The Institute for Professional Education
8 HOUR ELECTRICAL CODE COURSE
Article 250 2023 National Electrical Code

Article 250.4 (A)(5) Effective Ground-Fault Current Path

△ **Electrical equipment and wiring and other electrically conductive material likely to become energized shall be installed in a manner that creates a low-impedance circuit facilitating the operation of the overcurrent device or ground detector for high-impedance ground systems. It shall be capable of safely carrying the maximum ground-fault current likely to be imposed on it from any point on the wiring system where a ground fault occurs to the electrical supply source. The earth shall not be considered as an effective ground-fault current path.**

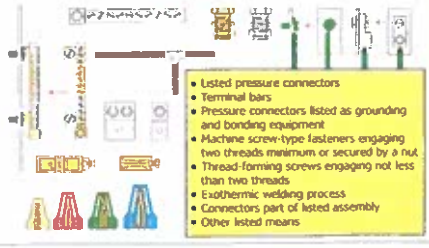
2023 National Electrical Code pg.70-138

5

The Institute for Professional
8 HOUR ELECTRICAL CODE COURSE
Article 250 2023 National Electrical Code

250.8 Grounding and Bonding Connections

(A) Permitted Methods. Equipment grounding conductors, grounding electrode conductors, and bonding jumpers shall be connected by one or more of the following means:



- Listed pressure connectors
- Terminal bars
- Pressure connectors listed as grounding and bonding equipment
- Machine screw-type fasteners engaging two threads minimum or secured by a nut
- Thread-forming screws engaging not less than two threads
- Exothermic welding process
- Connectors part of listed assembly
- Other listed means

6

PF2

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Article 250 2023 National Electrical Code

(4) Connection devices or fittings that depend solely on solder shall not be used for grounding.

True ✓ **False ☐**

Section Number 250.8 (B)

Why aren't we permitted to depend solely on solder for connecting grounding terminations?

2023 National Electrical Code pg.70-139

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(5) Alternating-current systems shall be grounded in accordance with section _____ (A), (B), (C), (D), unless permitted elsewhere in this *code*. Other systems shall be permitted to be grounded. If such systems are grounded, they shall comply with the applicable provisions of article?

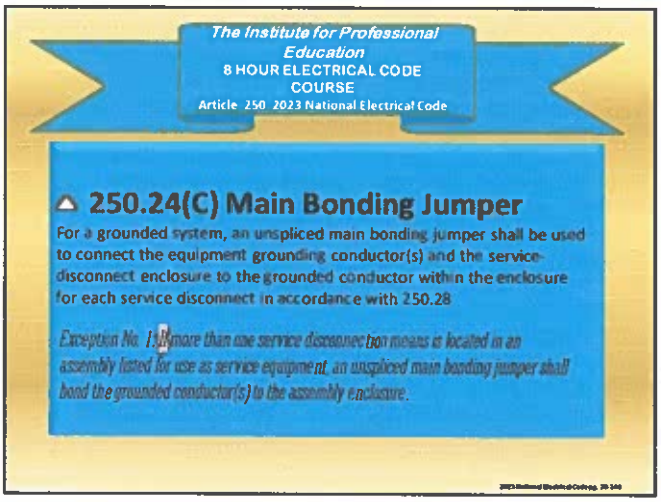
Answer 1 250.20 (A) (B) (C), (D)

Answer 2 250

Section Number 250.20

2023 National Electrical Code pg 70-139

8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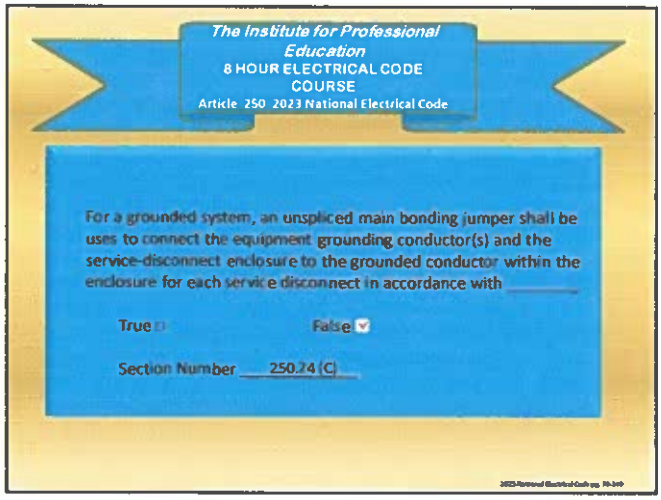
Article 250 2023 National Electrical Code
250.24(C) Main Bonding Jumper
For a grounded system, an unspliced main bonding jumper shall be used to connect the equipment grounding conductor(s) and the service-disconnect enclosure to the grounded conductor within the enclosure for each service disconnect in accordance with 250.28
Exception No. 1: Where more than one service disconnection means is located in an assembly listed for use as service equipment, an unspliced main bonding jumper shall bond the grounded conductor(s) to the assembly enclosure.

13


The Institute for Professional Education
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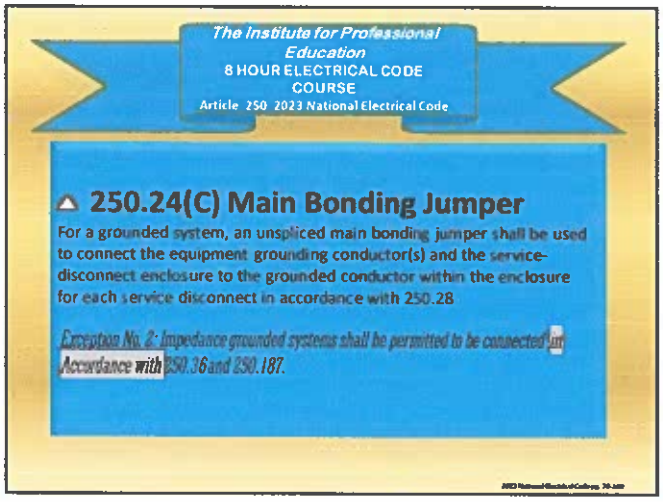
For a grounded system, an unspliced main bonding jumper shall be uses to connect the equipment grounding conductor(s) and the service-disconnect enclosure to the grounded conductor within the enclosure for each service disconnect in accordance with _____
True
False
Section Number 250.24 (C)

14


The Institute for Professional Education
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Article 250 2023 National Electrical Code
250.24(C) Main Bonding Jumper
For a grounded system, an unspliced main bonding jumper shall be used to connect the equipment grounding conductor(s) and the service-disconnect enclosure to the grounded conductor within the enclosure for each service disconnect in accordance with 250.28
Exception No. 2: Impedance grounded systems shall be permitted to be connected in accordance with 250.36 and 250.187.

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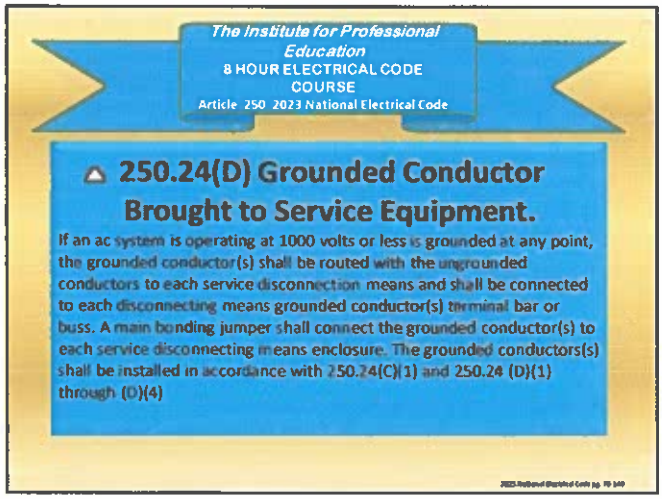
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Article 250 2023 National Electrical Code
250.24(D) Grounded Conductor Brought to Service Equipment.
If an ac system is operating at 1000 volts or less is grounded at any point, the grounded conductor(s) shall be routed with the ungrounded conductors to each service disconnection means and shall be connected to each disconnecting means grounded conductor(s) terminal bar or buss. A main bonding jumper shall connect the grounded conductor(s) to each service disconnecting means enclosure. The grounded conductors(s) shall be installed in accordance with 250.24(C)(1) and 250.24 (D)(1) through (D)(4)

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△ Article 250.12 Clean Surfaces

Nonconductive coating (such as paint, lacquer, and enamel) on equipment to be grounded or bonded shall be removed from threads and other contact surfaces to ensure good electrical continuity or shall be connected by means of fittings designed to make such removal unnecessary.

9

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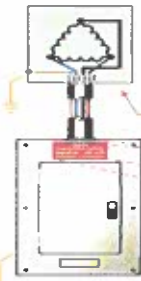
250.21(C) Marking – Ungrounded Systems



Ungrounded systems shall be legibly marked "Caution Ungrounded System Operating ____ Volts Between Conductors" at the source or first disconnecting means of the system.

The marking shall be of sufficient durability to withstand the environment involved.

Ungrounded three-phase, three-wire delta system

Marking requirements are required for ungrounded systems to indicate an ungrounded system

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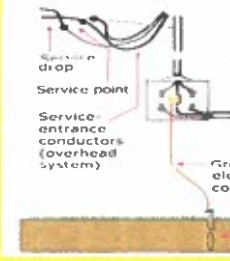
250.24(A)(1) System Grounding Connections



The grounding electrode conductor connection shall be made at any accessible point from the load end of the overhead service conductors, service drop, underground service conductors, or service lateral to and including the terminal or bus to which the grounded service conductor is connected at the service disconnecting means.

Service disconnect

Grounding electrode conductor connection permitted at either location

Does this picture as presented violate the requirements for grounding of service equipment ?

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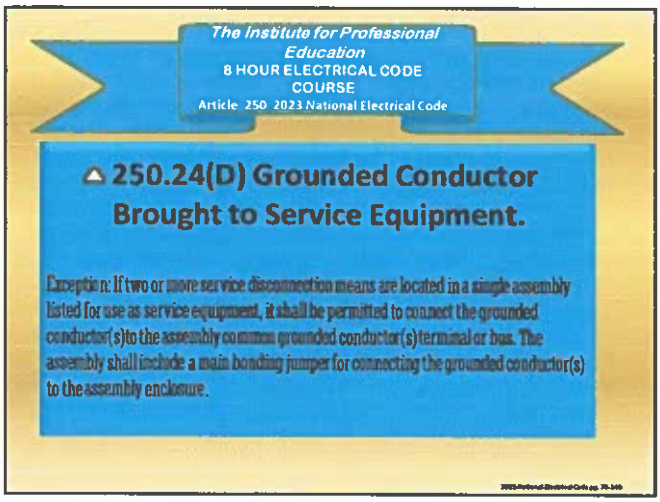
N Article 250.24 (B) Load-Side Grounding Connections

A grounded conductor shall not be connected to normally non-current carrying metal parts of equipment, to equipment grounding conductor(s), or be reconnected to ground on the load side of the service disconnecting means except as otherwise permitted elsewhere in this article.

12


The Institute for Professional Education
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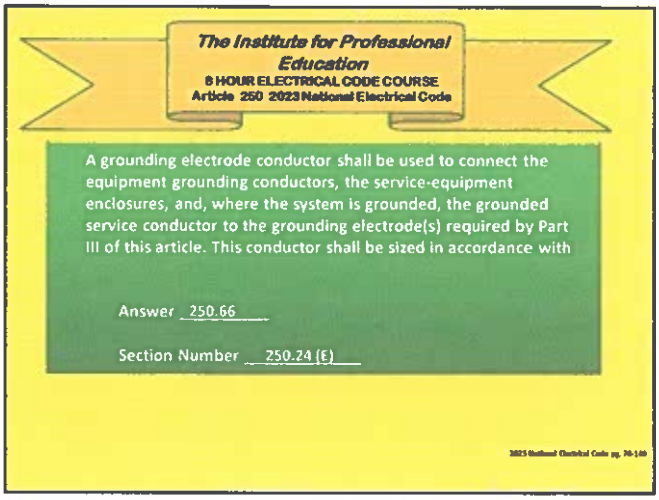
Article 250 2023 National Electrical Code
▲ 250.24(D) Grounded Conductor Brought to Service Equipment.
Exception: If two or more service disconnection means are located in a single assembly listed for use as service equipment, it shall be permitted to connect the grounded conductor(s) to the assembly common grounded conductor(s) terminal or bus. The assembly shall include a main bonding jumper for connecting the grounded conductor(s) to the assembly enclosure.

21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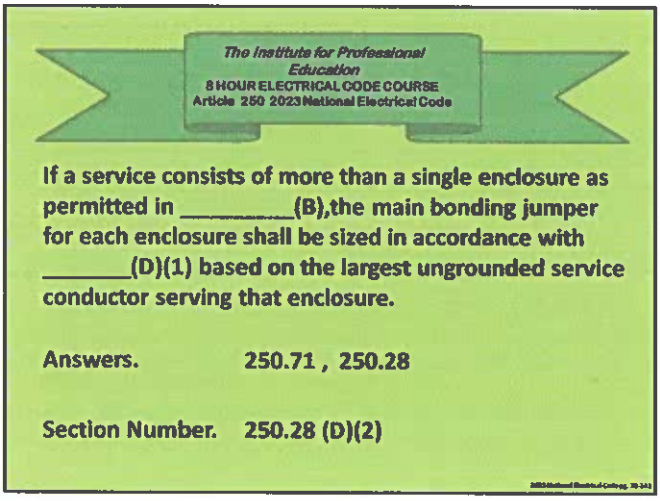
Article 250 2023 National Electrical Code
A grounding electrode conductor shall be used to connect the equipment grounding conductors, the service-equipment enclosures, and, where the system is grounded, the grounded service conductor to the grounding electrode(s) required by Part III of this article. This conductor shall be sized in accordance with
Answer 250.66
Section Number 250.24 (E)

22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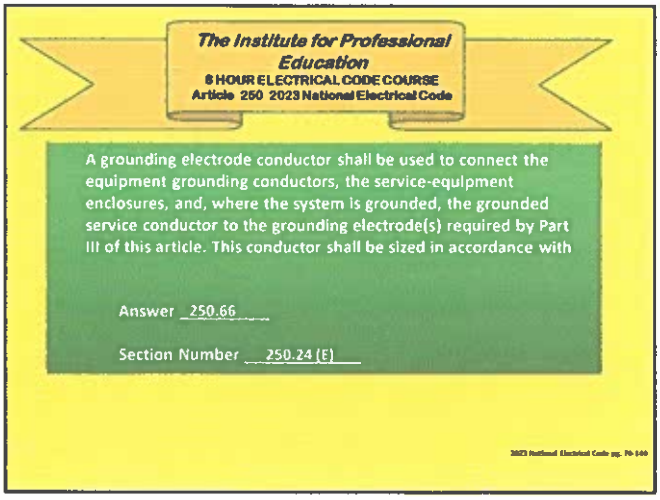
Article 250 2023 National Electrical Code
If a service consists of more than a single enclosure as permitted in _____(B), the main bonding jumper for each enclosure shall be sized in accordance with _____(D)(1) based on the largest ungrounded service conductor serving that enclosure.
Answers. 250.71 , 250.28
Section Number. 250.28 (D)(2)

23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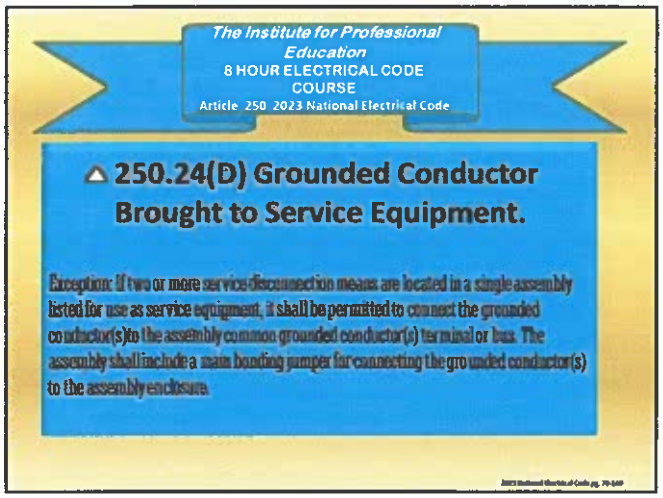
Article 250 2023 National Electrical Code
A grounding electrode conductor shall be used to connect the equipment grounding conductors, the service-equipment enclosures, and, where the system is grounded, the grounded service conductor to the grounding electrode(s) required by Part III of this article. This conductor shall be sized in accordance with
Answer 250.66
Section Number 250.24 (E)

24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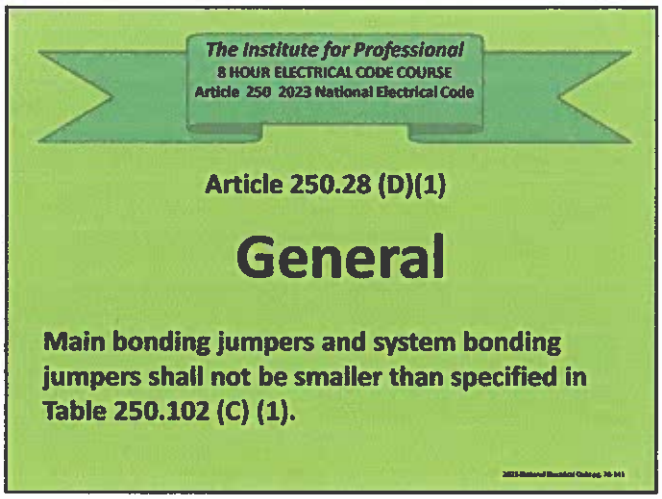
Article 250 2023 National Electrical Code
250.24(D) Grounded Conductor Brought to Service Equipment.
Exception: If two or more service disconnection means are located in a single assembly listed for use as service equipment, it shall be permitted to connect the grounded conductor(s) to the assembly common grounded conductor(s) terminal or bus. The assembly shall include a main bonding jumper for connecting the grounded conductor(s) to the assembly enclosure.

17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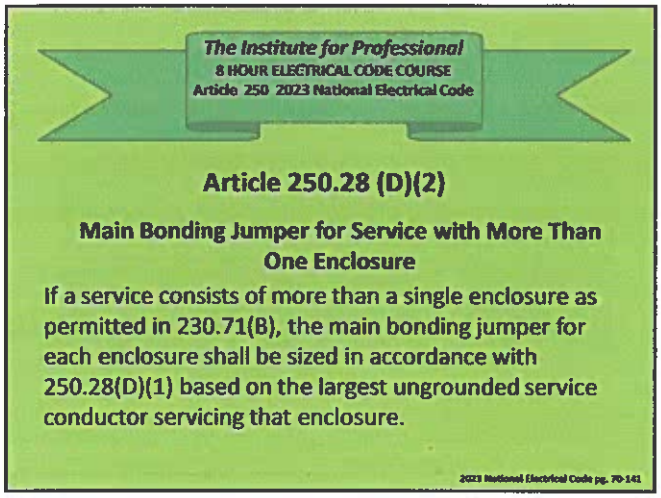
Article 250 2023 National Electrical Code
Article 250.28 (D)(1)
General
Main bonding jumpers and system bonding jumpers shall not be smaller than specified in Table 250.102 (C) (1).

18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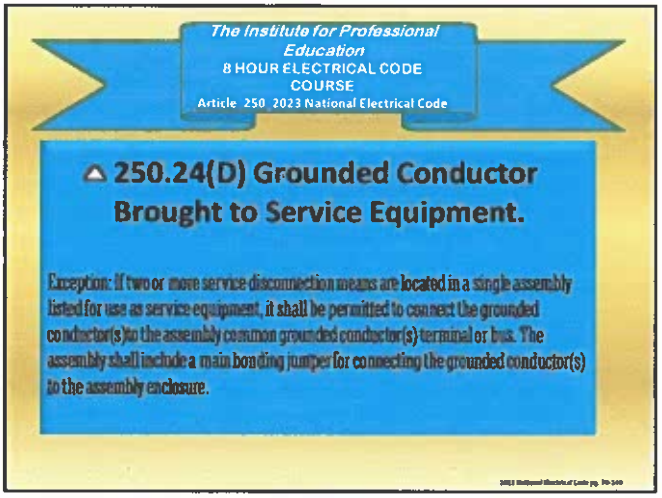
Article 250 2023 National Electrical Code
Article 250.28 (D)(2)
Main Bonding Jumper for Service with More Than One Enclosure
If a service consists of more than a single enclosure as permitted in 230.71(B), the main bonding jumper for each enclosure shall be sized in accordance with 250.28(D)(1) based on the largest ungrounded service conductor servicing that enclosure.
2023 National Electrical Code pg. 70-141

19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Article 250 2023 National Electrical Code
250.24(D) Grounded Conductor Brought to Service Equipment.
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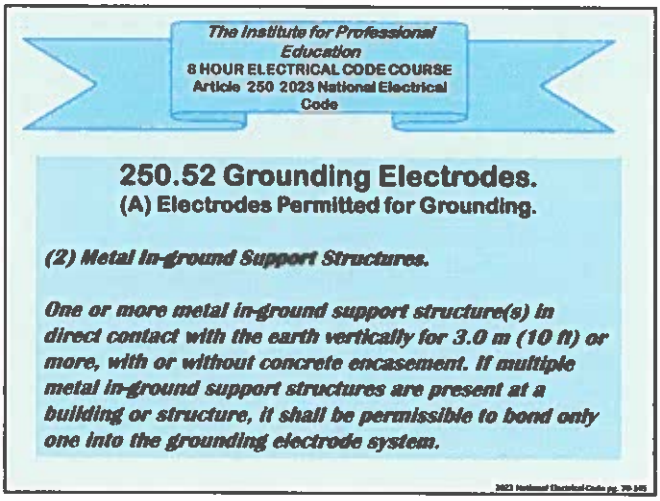
20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Article 250 2023 National Electrical Code
250.52 Grounding Electrodes.
(A) Electrodes Permitted for Grounding.
(2) Metal In-ground Support Structures.
One or more metal in-ground support structure(s) in direct contact with the earth vertically for 3.0 m (10 ft) or more, with or without concrete encasement. If multiple metal in-ground support structures are present at a building or structure, it shall be permissible to bond only one into the grounding electrode system.

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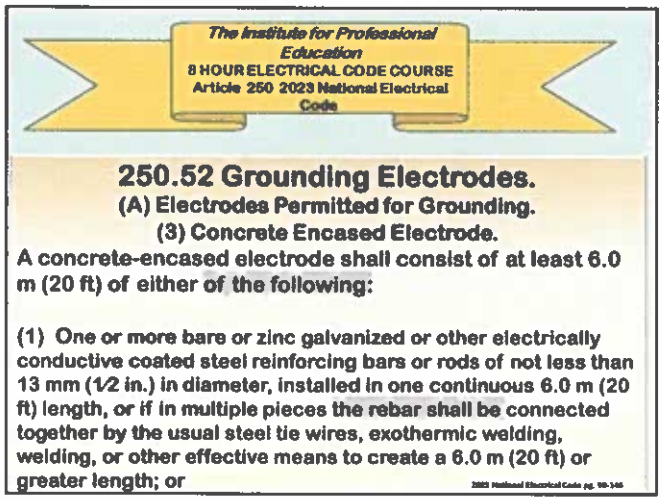
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Article 250 2023 National Electrical Code
250.52 Grounding Electrodes.
(A) Electrodes Permitted for Grounding.
(3) Concrete Encased Electrode.
A concrete-encased electrode shall consist of at least 6.0 m (20 ft) of either of the following:
(1) One or more bare or zinc galvanized or other electrically conductive coated steel reinforcing bars or rods of not less than 13 mm (1/2 in.) in diameter, installed in one continuous 6.0 m (20 ft) length, or if in multiple pieces the rebar shall be connected together by the usual steel tie wires, exothermic welding, welding, or other effective means to create a 6.0 m (20 ft) or greater length; or

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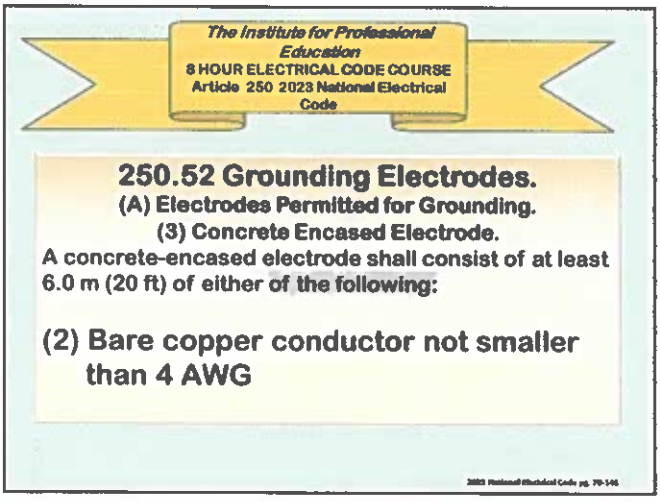
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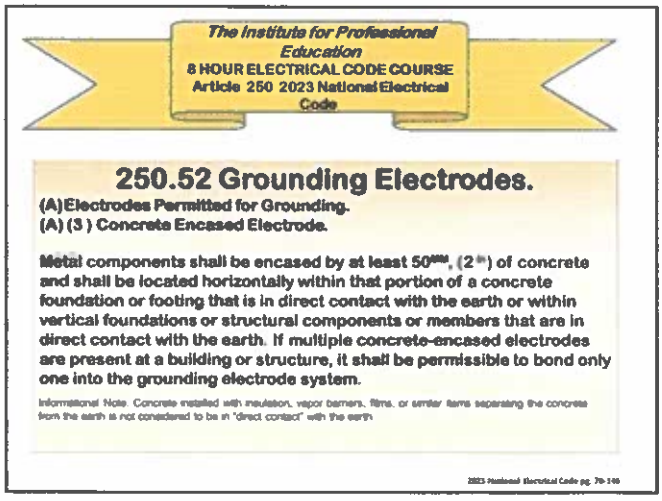
Article 250 2023 National Electrical Code
250.52 Grounding Electrodes.
(A) Electrodes Permitted for Grounding.
(3) Concrete Encased Electrode.
A concrete-encased electrode shall consist of at least 6.0 m (20 ft) of either of the following:
(2) Bare copper conductor not smaller than 4 AWG

31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Article 250 2023 National Electrical Code
250.52 Grounding Electrodes.
(A) Electrodes Permitted for Grounding.
(A) (3) Concrete Encased Electrode.
Metal components shall be encased by at least 50mm, (2 in) of concrete and shall be located horizontally within that portion of a concrete foundation or footing that is in direct contact with the earth or within vertical foundations or structural components or members that are in direct contact with the earth. If multiple concrete-encased electrodes are present at a building or structure, it shall be permissible to bond only one into the grounding electrode system.
Informational Note: Concrete installed with insulation, vapor barriers, films, or similar items separating the concrete from the earth is not considered to be in "direct contact" with the earth

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Article 250
Grounding and Bonding
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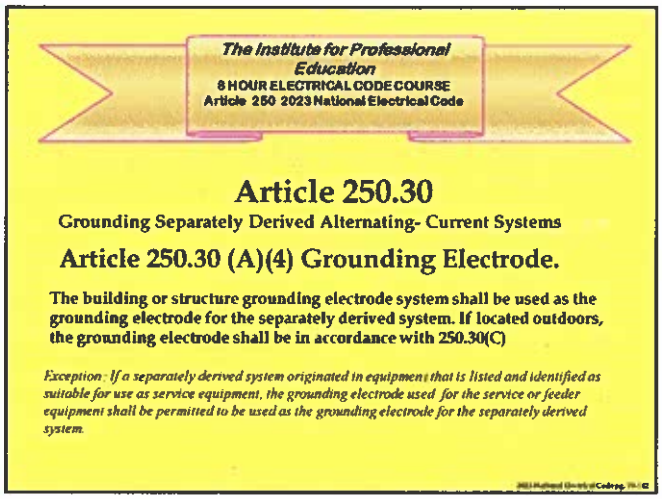
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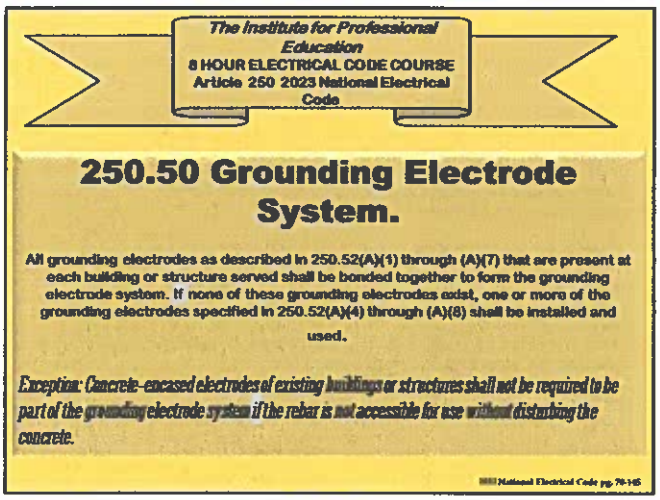
Article 250 2023 National Electrical Code
Article 250.30
Grounding Separately Derived Alternating- Current Systems
Article 250.30 (A)(4) Grounding Electrode.
The building or structure grounding electrode system shall be used as the grounding electrode for the separately derived system. If located outdoors, the grounding electrode shall be in accordance with 250.30(C)
Exception: If a separately derived system originated in equipment that is listed and identified as suitable for use as service equipment, the grounding electrode used for the service or feeder equipment shall be permitted to be used as the grounding electrode for the separately derived system.

26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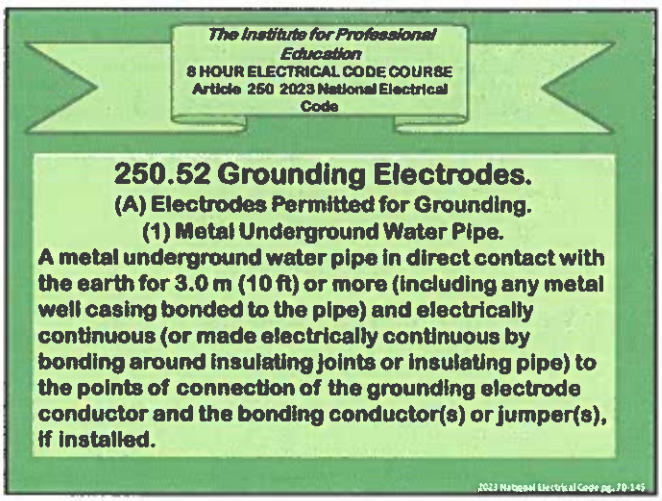
Article 250 2023 National Electrical Code
250.50 Grounding Electrode System.
All grounding electrodes as described in 250.52(A)(1) through (A)(7) that are present at each building or structure served shall be bonded together to form the grounding electrode system. If none of these grounding electrodes exist, one or more of the grounding electrodes specified in 250.52(A)(4) through (A)(8) shall be installed and used.
Exception: Concrete-encased electrodes of existing buildings or structures shall not be required to be part of the grounding electrode system if the rebar is not accessible for use without disturbing the concrete.

27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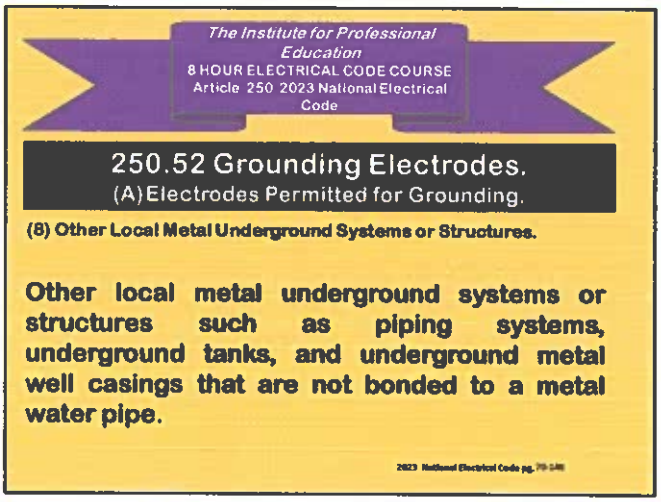
Article 250 2023 National Electrical Code
250.52 Grounding Electrodes.
(A) Electrodes Permitted for Grounding.
(1) Metal Underground Water Pipe.
A metal underground water pipe in direct contact with the earth for 3.0 m (10 ft) or more (including any metal well casing bonded to the pipe) and electrically continuous (or made electrically continuous by bonding around insulating joints or insulating pipe) to the points of connection of the grounding electrode conductor and the bonding conductor(s) or jumper(s), if installed.

28


The Institute for Professional Education
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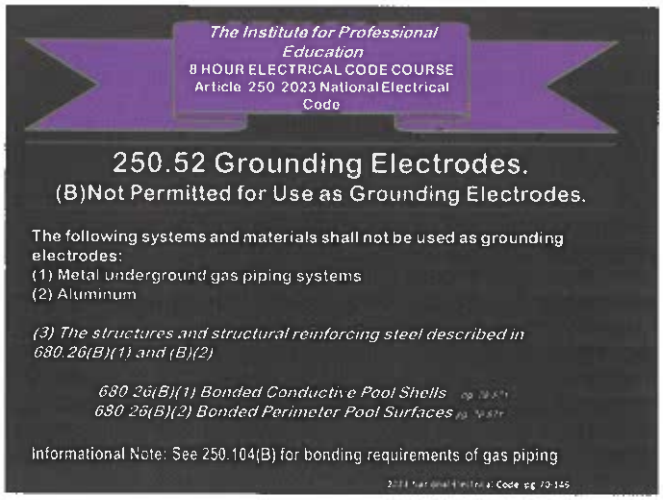
Article 250 2023 National Electrical Code
250.52 Grounding Electrodes.
(A)Electrodes Permitted for Grounding.
(8) Other Local Metal Underground Systems or Structures.
Other local metal underground systems or structures such as piping systems, underground tanks, and underground metal well casings that are not bonded to a metal water pipe.

37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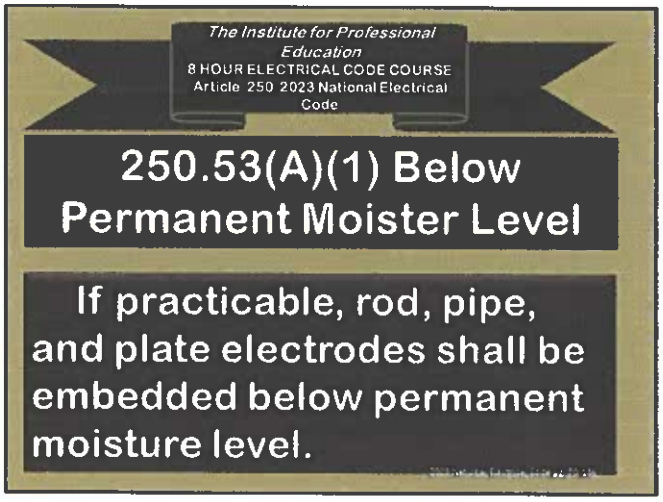
Article 250 2023 National Electrical Code
250.52 Grounding Electrodes.
(B)Not Permitted for Use as Grounding Electrodes.
The following systems and materials shall not be used as grounding electrodes:
(1) Metal underground gas piping systems
(2) Aluminum
(3) The structures and structural reinforcing steel described in 680.26(B)(1) and (B)(2)
680.26(B)(1) Bonded Conductive Pool Shells
680.26(B)(2) Bonded Perimeter Pool Surfaces
Informational Note: See 250.104(B) for bonding requirements of gas piping

38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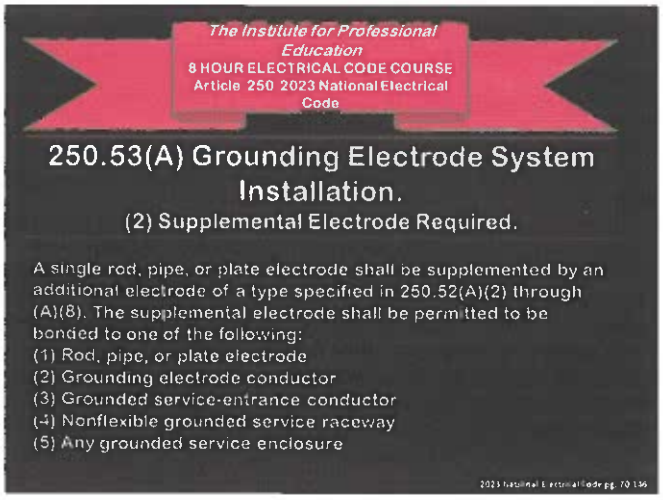
Article 250 2023 National Electrical Code
250.53(A)(1) Below Permanent Moister Level
If practicable, rod, pipe, and plate electrodes shall be embedded below permanent moisture level.

39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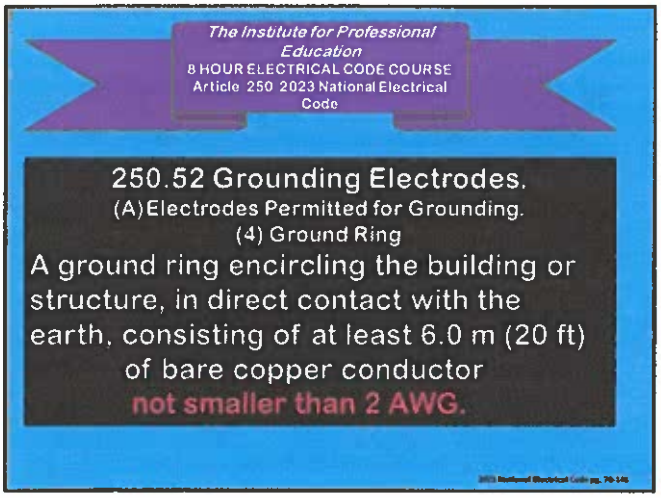
Article 250 2023 National Electrical Code
250.53(A) Grounding Electrode System Installation.
(2) Supplemental Electrode Required.
A single rod, pipe, or plate electrode shall be supplemented by an additional electrode of a type specified in 250.52(A)(2) through (A)(8). The supplemental electrode shall be permitted to be bonded to one of the following:
(1) Rod, pipe, or plate electrode
(2) Grounding electrode conductor
(3) Grounded service-entrance conductor
(4) Nonflexible grounded service raceway
(5) Any grounded service enclosure

40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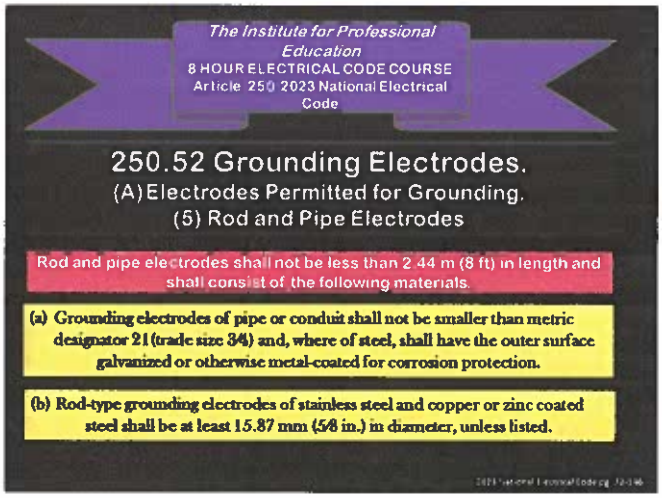
Article 250 2023 National Electrical Code
250.52 Grounding Electrodes.
(A) Electrodes Permitted for Grounding.
(4) Ground Ring
A ground ring encircling the building or structure, in direct contact with the earth, consisting of at least 6.0 m (20 ft) of bare copper conductor not smaller than 2 AWG.

33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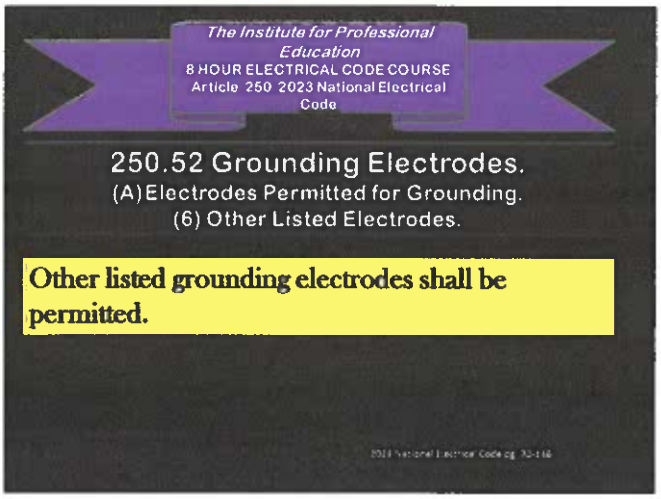
Article 250 2023 National Electrical Code
250.52 Grounding Electrodes.
(A) Electrodes Permitted for Grounding.
(5) Rod and Pipe Electrodes
Rod and pipe electrodes shall not be less than 2.44 m (8 ft) in length and shall consist of the following materials.
(a) Grounding electrodes of pipe or conduit shall not be smaller than metric designator 21 (trade size 3/4) and, where of steel, shall have the outer surface galvanized or otherwise metal-coated for corrosion protection.
(b) Rod-type grounding electrodes of stainless steel and copper or zinc coated steel shall be at least 15.87 mm (5/8 in.) in diameter, unless listed.

34


The Institute for Professional Education
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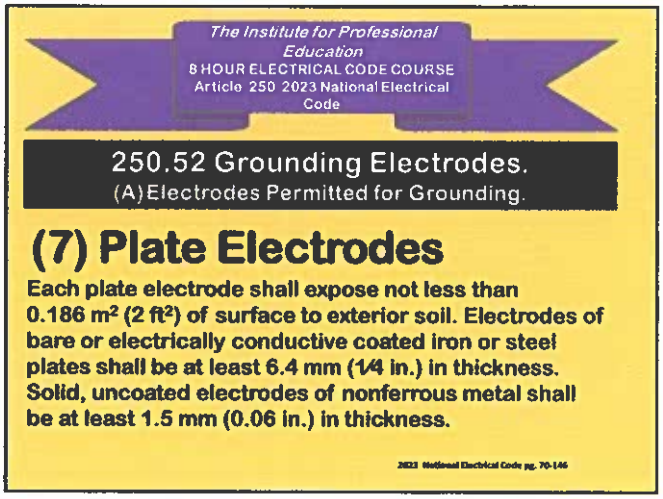
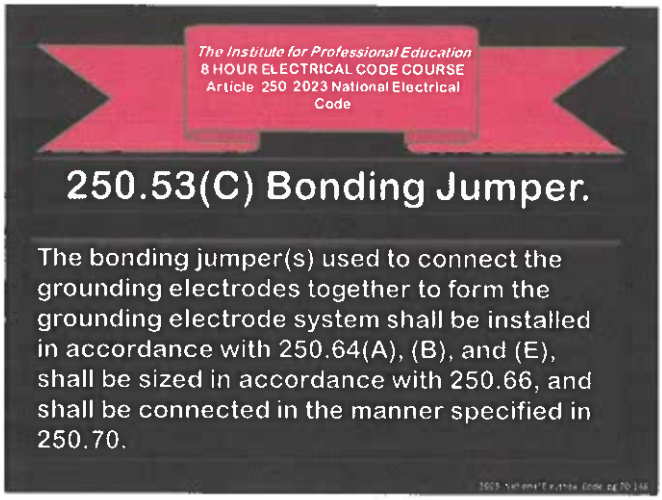
Article 250 2023 National Electrical Code
250.52 Grounding Electrodes.
(A) Electrodes Permitted for Grounding.
(6) Other Listed Electrodes.
Other listed grounding electrodes shall be permitted.

35


The Institute for Professional Education
8 HOUR ELECTRICAL CODE COURSE
Article 250 2023 National Electrical Code
250.52 Grounding Electrodes.
(A) Electrodes Permitted for Grounding.
(7) Plate Electrodes
Each plate electrode shall expose not less than 0.186 m² (2 ft²) of surface to exterior soil. Electrodes of bare or electrically conductive coated iron or steel plates shall be at least 6.4 mm (1/4 in.) in thickness. Solid, uncoated electrodes of nonferrous metal shall be at least 1.5 mm (0.06 in.) in thickness.

36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8 HOUR ELECTRICAL CODE COURSE
Article 250 2023 National Electrical Code
250.53(C) Bonding Jumper.
The bonding jumper(s) used to connect the grounding electrodes together to form the grounding electrode system shall be installed in accordance with 250.64(A), (B), and (E), shall be sized in accordance with 250.66, and shall be connected in the manner specified in 250.70.

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The Institute for Professional Education
8 HOUR ELECTRICAL CODE COURSE
Article 250 2020 National Electrical Code
Article 250.53(F)
Ground Ring.
The ground ring shall be installed not less than 750mm (30 in.) below the surface of the earth.

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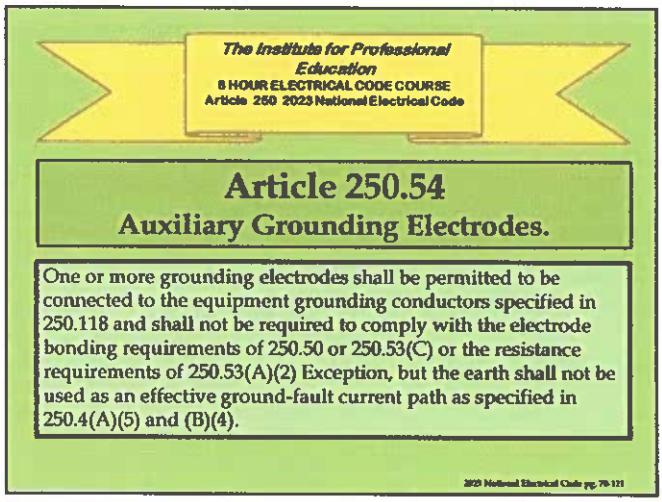
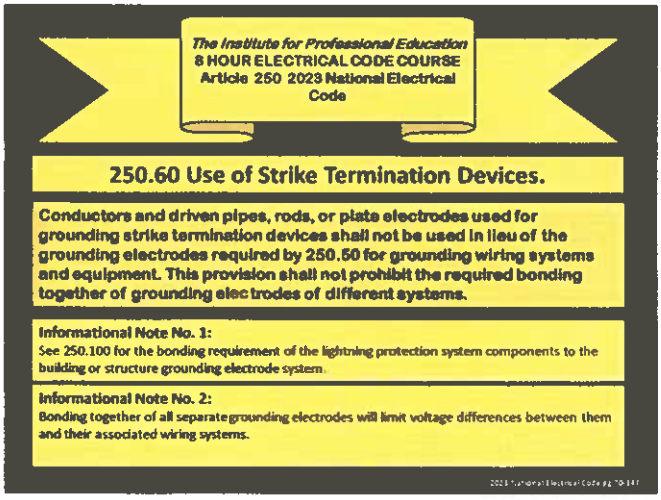
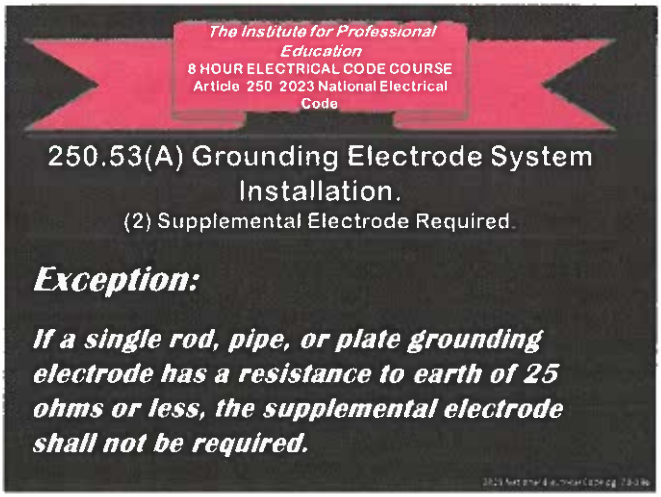

The Institute for Professional Education
8 HOUR ELECTRICAL CODE COURSE
Article 250 2023 National Electrical Code
Article 250.54
Auxiliary Grounding Electrodes.
One or more grounding electrodes shall be permitted to be connected to the equipment grounding conductors specified in 250.118 and shall not be required to comply with the electrode bonding requirements of 250.50 or 250.53(C) or the resistance requirements of 250.53(A)(2) Exception, but the earth shall not be used as an effective ground-fault current path as specified in 250.4(A)(5) and (B)(4).

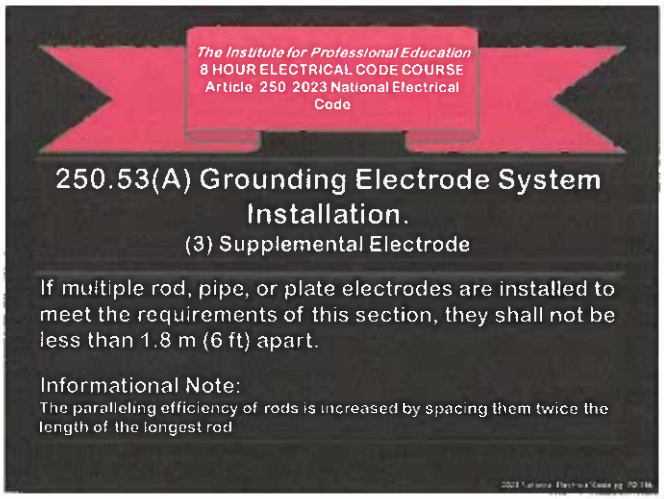
47


The Institute for Professional Education
8 HOUR ELECTRICAL CODE COURSE
Article 250 2023 National Electrical Code
250.60 Use of Strike Termination Devices.
Conductors and driven pipes, rods, or plate electrodes used for grounding strike termination devices shall not be used in lieu of the grounding electrodes required by 250.50 for grounding wiring systems and equipment. This provision shall not prohibit the required bonding together of grounding electrodes of different systems.
Informational Note No. 1:
See 250.100 for the bonding requirement of the lightning protection system components to the building or structure grounding electrode system.
Informational Note No. 2:
Bonding together of all separate grounding electrodes will limit voltage differences between them and their associated wiring systems.

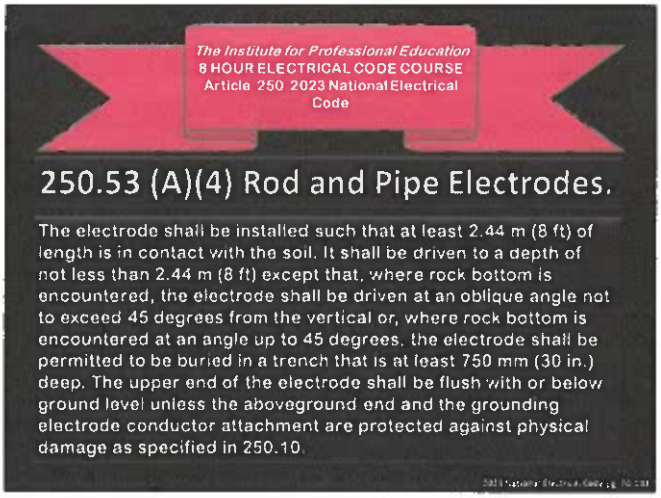
48


The Institute for Professional Education
8 HOUR ELECTRICAL CODE COURSE
Article 250 2023 National Electrical Code
250.53(A) Grounding Electrode System Installation.
(2) Supplemental Electrode Required.
Exception:
If a single rod, pipe, or plate grounding electrode has a resistance to earth of 25 ohms or less, the supplemental electrode shall not be required.

41


The Institute for Professional Education
8 HOUR ELECTRICAL CODE COURSE
Article 250 2023 National Electrical Code
250.53(A) Grounding Electrode System Installation.
(3) Supplemental Electrode
If multiple rod, pipe, or plate electrodes are installed to meet the requirements of this section, they shall not be less than 1.8 m (6 ft) apart.
Informational Note:
The paralleling efficiency of rods is increased by spacing them twice the length of the longest rod

42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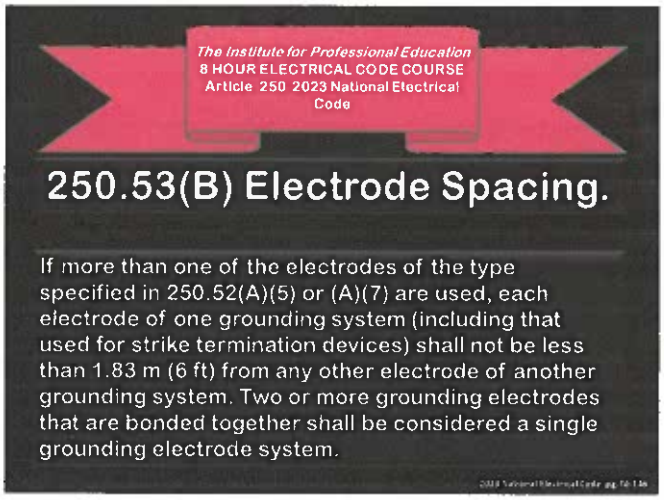
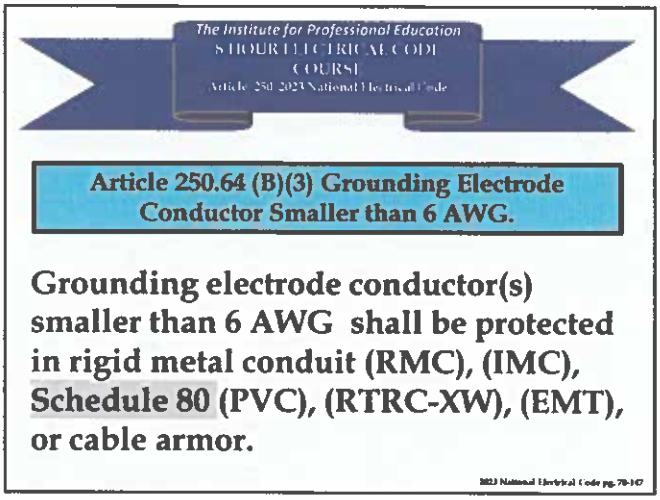
8 HOUR ELECTRICAL CODE COURSE
Article 250 2023 National Electrical Code
250.53 (A)(4) Rod and Pipe Electrodes.
The electrode shall be installed such that at least 2.44 m (8 ft) of length is in contact with the soil. It shall be driven to a depth of not less than 2.44 m (8 ft) except that, where rock bottom is encountered, the electrode shall be driven at an oblique angle not to exceed 45 degrees from the vertical or, where rock bottom is encountered at an angle up to 45 degrees, the electrode shall be permitted to be buried in a trench that is at least 750 mm (30 in.) deep. The upper end of the electrode shall be flush with or below ground level unless the aboveground end and the grounding electrode conductor attachment are protected against physical damage as specified in 250.10.

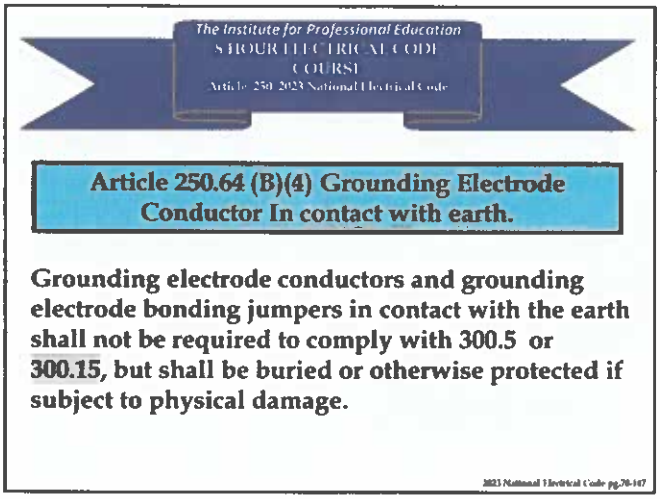
43


The Institute for Professional Education
8 HOUR ELECTRICAL CODE COURSE
Article 250 2023 National Electrical Code
250.53(B) Electrode Spacing.
If more than one of the electrodes of the type specified in 250.52(A)(5) or (A)(7) are used, each electrode of one grounding system (including that used for strike termination devices) shall not be less than 1.83 m (6 ft) from any other electrode of another grounding system. Two or more grounding electrodes that are bonded together shall be considered a single grounding electrode system.

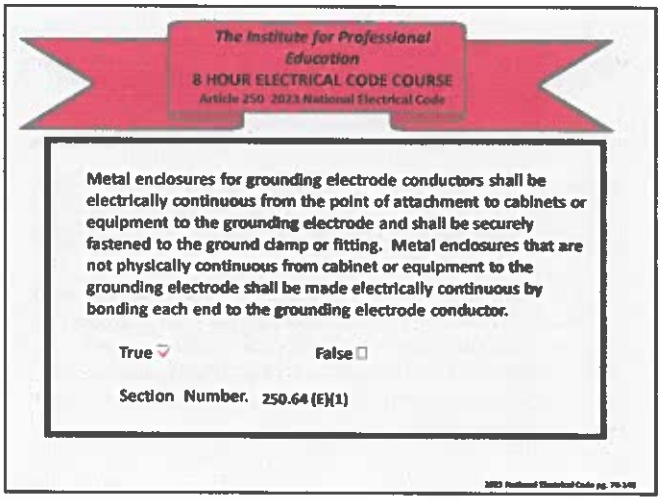
44


The Institute for Professional Education
8 HOUR ELECTRICAL CODE COURSE
Article 250 2023 National Electrical Code
Article 250.64 (B)(3) Grounding Electrode Conductor Smaller than 6 AWG.
Grounding electrode conductor(s) smaller than 6 AWG shall be protected in rigid metal conduit (RMC), (IMC), Schedule 80 (PVC), (RTRC-XW), (EMT), or cable armor.

53


The Institute for Professional Education
8 HOUR ELECTRICAL CODE COURSE
Article 250 2023 National Electrical Code
Article 250.64 (B)(4) Grounding Electrode Conductor In contact with earth.
Grounding electrode conductors and grounding electrode bonding jumpers in contact with the earth shall not be required to comply with 300.5 or 300.15, but shall be buried or otherwise protected if subject to physical damage.

54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Article 250 2023 National Electrical Code
Metal enclosures for grounding electrode conductors shall be electrically continuous from the point of attachment to cabinets or equipment to the grounding electrode and shall be securely fastened to the ground clamp or fitting. Metal enclosures that are not physically continuous from cabinet or equipment to the grounding electrode shall be made electrically continuous by bonding each end to the grounding electrode conductor.
True ☑ False ☐
Section Number. 250.64 (E)(1)

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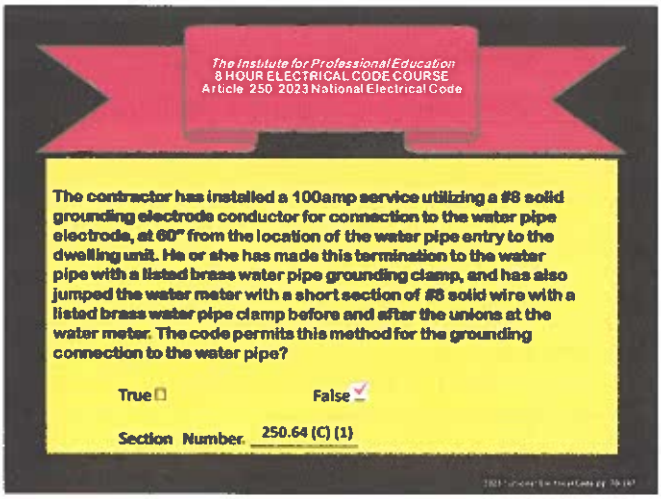
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Article 250 2023 National Electrical Code
The contractor has installed a 100amp service utilizing a #8 solid grounding electrode conductor for connection to the water pipe electrode, at 60" from the location of the water pipe entry to the dwelling unit. He or she has made this termination to the water pipe with a listed brass water pipe grounding clamp, and has also jumped the water meter with a short section of #8 solid wire with a listed brass water pipe clamp before and after the unions at the water meter. The code permits this method for the grounding connection to the water pipe?
True ☐ False ☑
Section Number. 250.64 (C) (1)

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8 HOUR ELECTRICAL CODE COURSE
Article 250 2023 National Electrical Code

Article 250.64 Grounding Electrode Conductor Installation

Grounding electrode conductors at the service, at each building or structure where supplied by a feeder(s) or branch circuit(s) or at a separately derived system, shall be installed as specified in 205.64(A) through (G).

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8 HOUR ELECTRICAL CODE COURSE
Article 250 2023 National Electrical Code

Article 250.64 (A) Aluminum or Copper- Clad Aluminum Conductors

Grounding electrode conductors of bare, covered, or insulated aluminum or coper-clad aluminum shall comply with the following:

(1) Bare or covered conductor without an extruded polymeric covering shall not be installed where subject to corrosive conditions or be installed in direct contact with concrete.
(2) Terminations made within outdoor enclosures that are listed and identified for the environment shall be permitted within 450 mm (18in.) of the bottom of the enclosure.
(3) Aluminum or copper-clad aluminum conductors external to buildings or equipment enclosures shall not be terminated within 450 mm (18in) of the earth.

2023 National Electrical Code pg. 70-147

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Article 250 2023 National Electrical Code

Article 250.64 (B) Securing and Protection Against Physical Damage.

If exposed, a grounding electrode conductor or its enclosure shall be securely fastened to the surface on which it is carried. Grounding electrode conductors shall be permitted to be installed on or through framing members.

2023 National Electrical Code pg. 70-147

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Article 250 2023 National Electrical Code

Article 250.64 (B)(2) Grounding Electrode Conductor exposed to physical damage.

A 6 AWG or larger copper or aluminum grounding electrode conductor exposed to physical damage shall be protected in rigid metal conduit (RMC), intermediate metal conduit (IMC), rigid polyvinyl chloride conduit (PVC), reinforced thermosetting resin conduit type XW (RTRC-XW), electrical metallic tubing (EMT), or cable armor.

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8 HOUR ELECTRICAL CODE COURSE
Article 250 2023 National Electrical Code

Article 250.66

Size of Alternating-Current Grounding Electrode Conductor.

Article 250.66 (B)

Connections to Concrete-Encased Electrode(s).

If the grounding electrode conductor or bonding jumper connected to a single or multiple concrete-encased electrodes(s), as described in 250.52(A)(3), does note extend on to other types of electrodes that require a larger size of conductor, the grounding electrode conductor shall not be required to be larger than 4 AWG copper wire.

2023 National Electrical Code pg.70-149

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Article 250 2023 National Electrical Code

Article 250.66

Size of Alternating-Current Grounding Electrode Conductor.

Article 250.66 (C)

Connections to Ground Rings.

If the grounding electrode conductor or bonding jumper connected to a ground ring, as described in 250.52(A)(4), does note extend on to other types of electrodes that require a larger size of conductor, the grounding electrode conductor shall not be required to be larger than conductor used for the ground ring.

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8 HOUR ELECTRICAL CODE COURSE
Article 250
2023 National Electrical Code

The contractor has installed a replacement 240-volt water heater and utilized die-electric union to make his connection to the water lines. What does the *Code* require the contractor to do to meet the requirements of grounding/bonding of the water piping system? What article of the *Code* requires this grounding/bonding?

The contractor must provide a bonding jumper from the hot to the cold water. The bonding conductor shall be of sufficient length to permit removal of such equipment while retaining the integrity of the bond.

Section Number. 250.68 (B)

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8 HOUR ELECTRICAL CODE COURSE
Article 250 2023 National Electrical Code

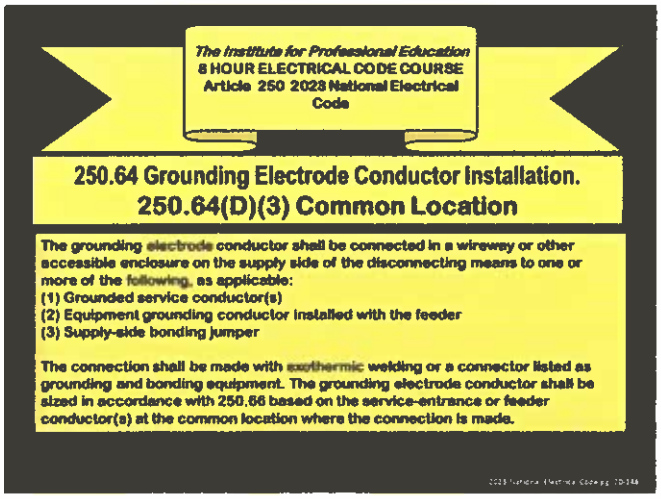
Article 250.68 Grounding Electrode Conductor and Bonding Jumper Connection to Grounding Electrodes.

250.68(C) Grounding Electrode Conductor Connections

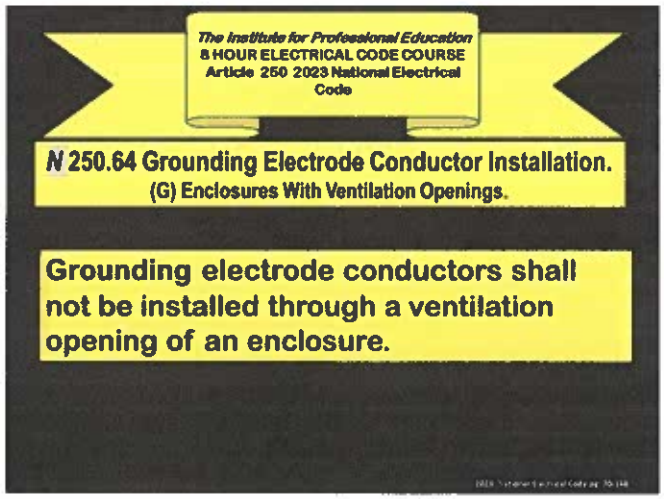
250.68(C)(1) Interior Metal water piping that is electrically continuous with a metal underground water pipe electrode and is located not more than 1.52m (5ft) from the point of entrance to the building shall be permitted to extend the connection to an electrode(s). Interior metal water piping located more than 1.52m(5ft) from the point of entrance to the building shall not be used as a conductor to interconnect electrodes of the grounding system.

2023 National Electrical Code pg. 70-149

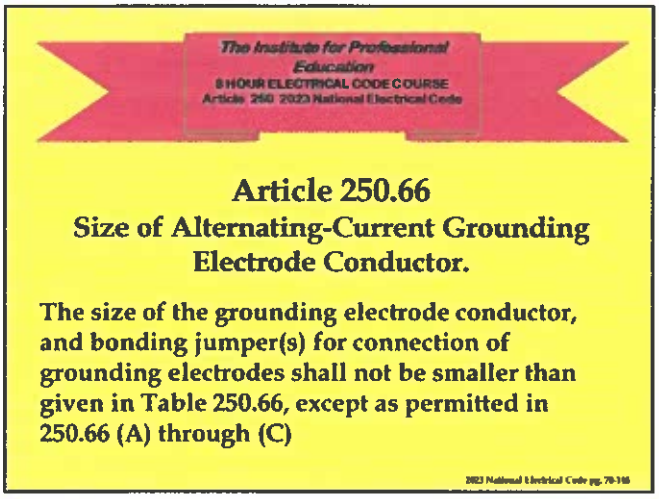
64


The Institute for Professional Education
8 HOUR ELECTRICAL CODE COURSE
Article 250 2023 National Electrical Code
250.64 Grounding Electrode Conductor Installation.
250.64(D)(3) Common Location
The grounding electrode conductor shall be connected in a wireway or other accessible enclosure on the supply side of the disconnecting means to one or more of the following, as applicable:
(1) Grounded service conductor(s)
(2) Equipment grounding conductor installed with the feeder
(3) Supply-side bonding jumper
The connection shall be made with exothermic welding or a connector listed as grounding and bonding equipment. The grounding electrode conductor shall be sized in accordance with 250.66 based on the service-entrance or feeder conductor(s) at the common location where the connection is made.

57


The Institute for Professional Education
8 HOUR ELECTRICAL CODE COURSE
Article 250 2023 National Electrical Code
N 250.64 Grounding Electrode Conductor Installation.
(G) Enclosures With Ventilation Openings.
Grounding electrode conductors shall not be installed through a ventilation opening of an enclosure.

58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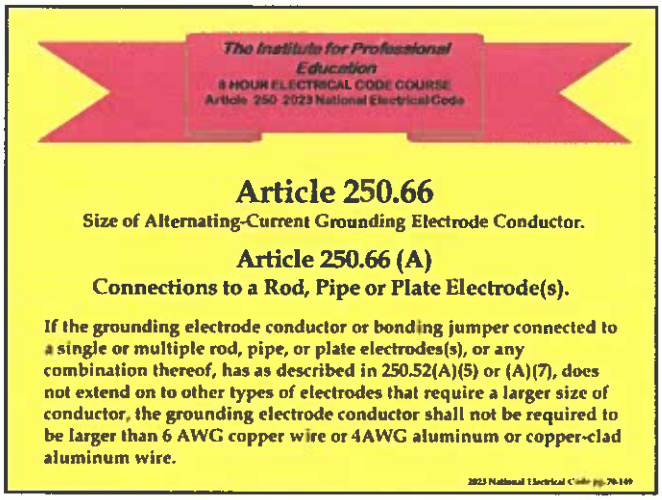
8 HOUR ELECTRICAL CODE COURSE
Article 250 2023 National Electrical Code
Article 250.66
Size of Alternating-Current Grounding Electrode Conductor.
The size of the grounding electrode conductor, and bonding jumper(s) for connection of grounding electrodes shall not be smaller than given in Table 250.66, except as permitted in 250.66 (A) through (C)

59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Article 250 2023 National Electrical Code
Article 250.66
Size of Alternating-Current Grounding Electrode Conductor.
Article 250.66 (A)
Connections to a Rod, Pipe or Plate Electrode(s).
If the grounding electrode conductor or bonding jumper connected to a single or multiple rod, pipe, or plate electrodes(s), or any combination thereof, has as described in 250.52(A)(5) or (A)(7), does not extend on to other types of electrodes that require a larger size of conductor, the grounding electrode conductor shall not be required to be larger than 6 AWG copper wire or 4AWG aluminum or copper-clad aluminum wire.

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Article 250 2023 National Electrical Code

Article 250.68 Grounding Electrode Conductor and Bonding Jumper Connection to Grounding Electrodes.

Section 250.68(C)(3) in accordance with the following: Section 250.68(C)(3)(b)

The rebar extension shall not be exposed to contact with the earth without corrosion protection.

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8 HOUR ELECTRICAL CODE COURSE
Article 250 2023 National Electrical Code

Article 250.68 Grounding Electrode Conductor and Bonding Jumper Connection to Grounding Electrodes.

Section 250.68(C)(3) in accordance with the following: Section 250.68(C)(3)(c)

Rebar shall not be used as a conductor to interconnect the electrodes of grounding electrode system.

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2023 National Electrical Code

The code permits a metal sheath or armored cable listed for service conductors to be insulated from the interior of a rigid metal underground raceway, provided the metal sheath or armored cable is not grounded at the building or structure.

True ☑ False ☐

Section Number. 250.84 (B)

2023 National Electrical Code pg. 70-150

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Article 250 2023 National Electrical Code

250.92 Services

(A)Bonding of Equipment for Services.
The normally non-current-carrying metal parts of equipment indicated in the following shall be bonded together.

(1) All raceways, cable trays, cablebus framework, auxiliary gutters, or service cable armor or sheath that enclose, contain, or support service conductors, except as permitted in 250.80.
(2) All enclosures containing service conductors, including meter fittings, boxes, or the like, interposed in the service raceway or armor

Let's review the requirements for service grounding

2023 National Electrical Code pg. 70-150

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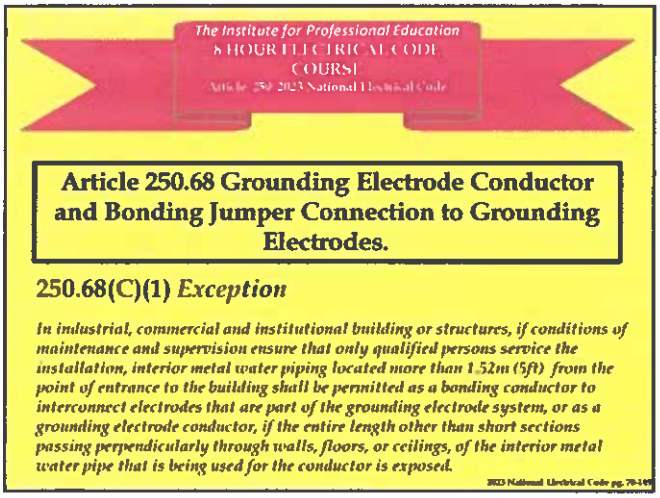
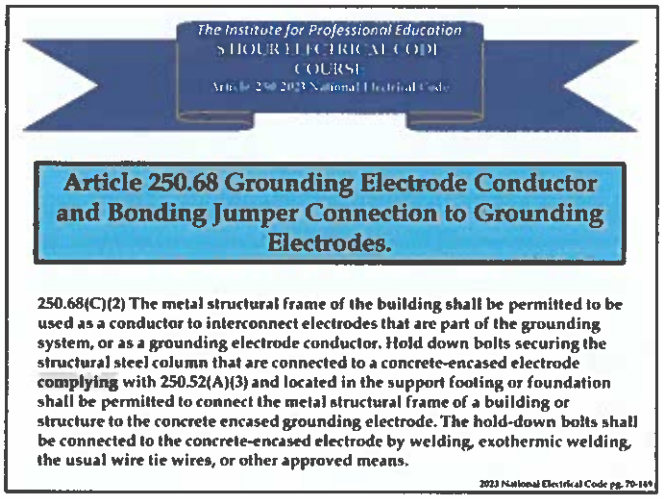

The Institute for Professional Education
8 HOUR ELECTRICAL CODE
COURSE
Article 250 2023 National Electrical Code
Article 250.68 Grounding Electrode Conductor and Bonding Jumper Connection to Grounding Electrodes.
250.68(C)(1) Exception
In industrial, commercial and institutional building or structures, if conditions of maintenance and supervision ensure that only qualified persons service the installation, interior metal water piping located more than 1.52m (5ft) from the point of entrance to the building shall be permitted as a bonding conductor to interconnect electrodes that are part of the grounding electrode system, or as a grounding electrode conductor, if the entire length other than short sections passing perpendicularly through walls, floors, or ceilings, of the interior metal water pipe that is being used for the conductor is exposed.
2023 National Electrical Code pg. 70-149

65


The Institute for Professional Education
8 HOUR ELECTRICAL CODE
COURSE
Article 250 2023 National Electrical Code
Article 250.68 Grounding Electrode Conductor and Bonding Jumper Connection to Grounding Electrodes.
250.68(C)(2) The metal structural frame of the building shall be permitted to be used as a conductor to interconnect electrodes that are part of the grounding system, or as a grounding electrode conductor. Hold down bolts securing the structural steel column that are connected to a concrete-encased electrode complying with 250.52(A)(3) and located in the support footing or foundation shall be permitted to connect the metal structural frame of a building or structure to the concrete encased grounding electrode. The hold-down bolts shall be connected to the concrete-encased electrode by welding, exothermic welding, the usual wire tie wires, or other approved means.
2023 National Electrical Code pg. 70-149

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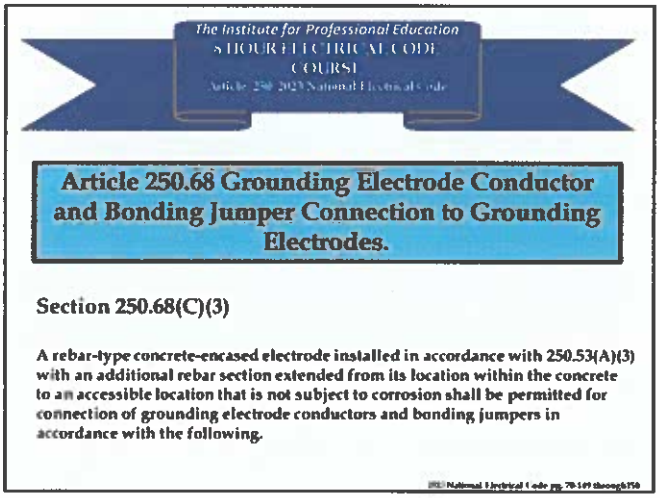
The Institute for Professional Education
8 HOUR ELECTRICAL CODE
COURSE
Article 250 2023 National Electrical Code
Article 250.68 Grounding Electrode Conductor and Bonding Jumper Connection to Grounding Electrodes.
Section 250.68(C)(3)
A rebar-type concrete-encased electrode installed in accordance with 250.53(A)(3) with an additional rebar section extended from its location within the concrete to an accessible location that is not subject to corrosion shall be permitted for connection of grounding electrode conductors and bonding jumpers in accordance with the following.
2023 National Electrical Code pg. 70-149 through 150

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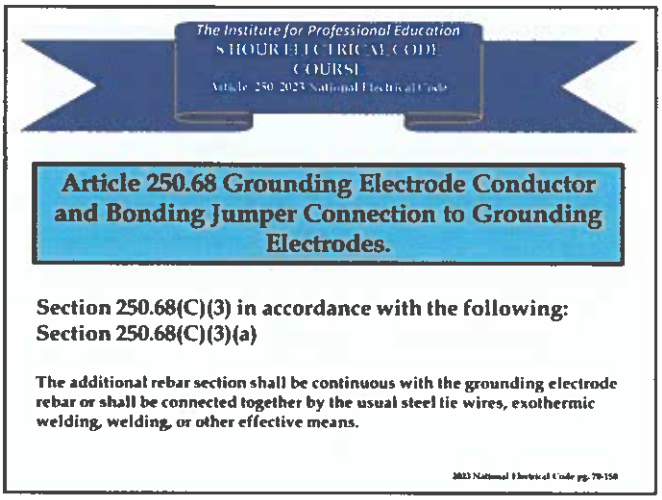
The Institute for Professional Education
8 HOUR ELECTRICAL CODE
COURSE
Article 250 2023 National Electrical Code
Article 250.68 Grounding Electrode Conductor and Bonding Jumper Connection to Grounding Electrodes.
Section 250.68(C)(3) in accordance with the following:
Section 250.68(C)(3)(a)
The additional rebar section shall be continuous with the grounding electrode rebar or shall be connected together by the usual steel tie wires, exothermic welding, welding, or other effective means.
2023 National Electrical Code pg. 70-150

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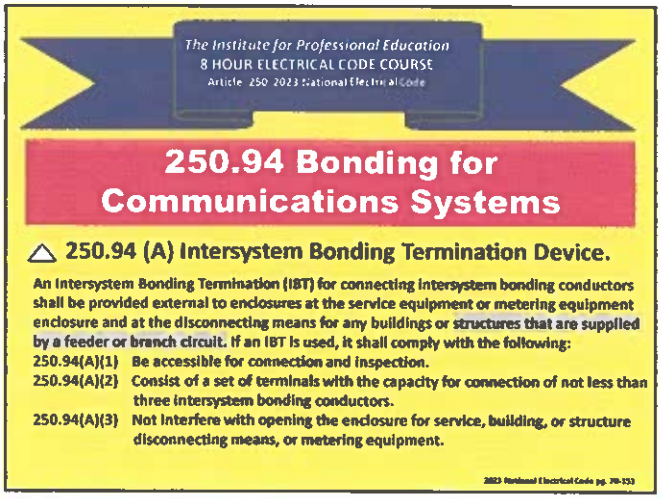
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Article 250 2023 National Electrical Code
250.94 Bonding for Communications Systems
△ 250.94 (A) Intersystem Bonding Termination Device.
An Intersystem Bonding Termination (IBT) for connecting intersystem bonding conductors shall be provided external to enclosures at the service equipment or metering equipment enclosure and at the disconnecting means for any buildings or structures that are supplied by a feeder or branch circuit. If an IBT is used, it shall comply with the following:
250.94(A)(1) Be accessible for connection and inspection.
250.94(A)(2) Consist of a set of terminals with the capacity for connection of not less than three intersystem bonding conductors.
250.94(A)(3) Not interfere with opening the enclosure for service, building, or structure disconnecting means, or metering equipment.

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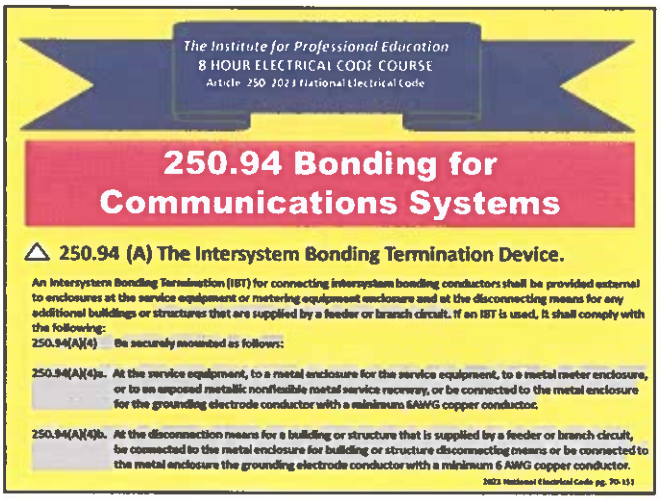
The Institute for Professional Education
8 HOUR ELECTRICAL CODE COURSE
Article 250 2023 National Electrical Code
250.94 Bonding for Communications Systems
△ 250.94 (A) The Intersystem Bonding Termination Device.
An Intersystem Bonding Termination (IBT) for connecting intersystem bonding conductors shall be provided external to enclosures at the service equipment or metering equipment enclosure and at the disconnecting means for any additional buildings or structures that are supplied by a feeder or branch circuit. If an IBT is used, it shall comply with the following:
250.94(A)(4) Be securely mounted as follows:
250.94(A)(4)a. At the service equipment, to a metal enclosure for the service equipment, to a metal meter enclosure, or to an exposed metallic nonflexible metal service raceway, or be connected to the metal enclosure for the grounding electrode conductor with a minimum 6AWG copper conductor.
250.94(A)(4)b. At the disconnection means for a building or structure that is supplied by a feeder or branch circuit, be connected to the metal enclosure for building or structure disconnecting means or be connected to the metal enclosure the grounding electrode conductor with a minimum 6 AWG copper conductor.

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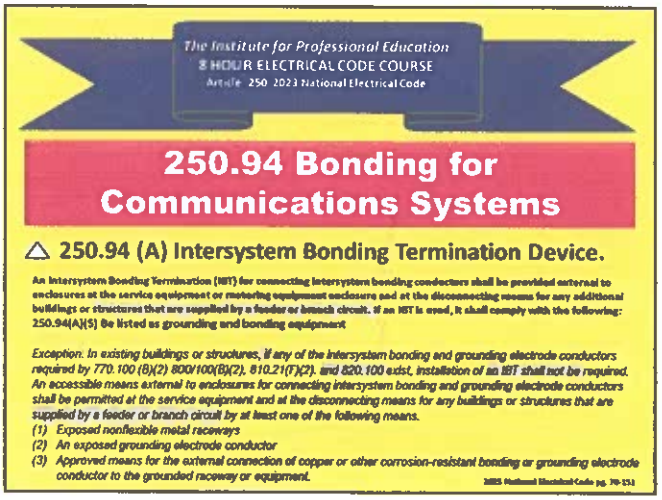
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Article 250 2023 National Electrical Code
250.94 Bonding for Communications Systems
△ 250.94 (A) Intersystem Bonding Termination Device.
An Intersystem Bonding Termination (IBT) for connecting intersystem bonding conductors shall be provided external to enclosures at the service equipment or metering equipment enclosure and at the disconnecting means for any additional buildings or structures that are supplied by a feeder or branch circuit. If an IBT is used, it shall comply with the following:
250.94(A)(5) Be listed as grounding and bonding equipment
Exception: In existing buildings or structures, if any of the intersystem bonding and grounding electrode conductors required by 770.100 (B)(2) 800/100(B)(2), 810.21(F)(2), and 820.100 exist, installation of an IBT shall not be required. An accessible means external to enclosures for connecting intersystem bonding and grounding electrode conductors shall be permitted at the service equipment and at the disconnecting means for any buildings or structures that are supplied by a feeder or branch circuit by at least one of the following means.
(1) Exposed nonflexible metal raceways
(2) An exposed grounding electrode conductor
(3) Approved means for the external connection of copper or other corrosion-resistant bonding or grounding electrode conductor to the grounded raceway or equipment.

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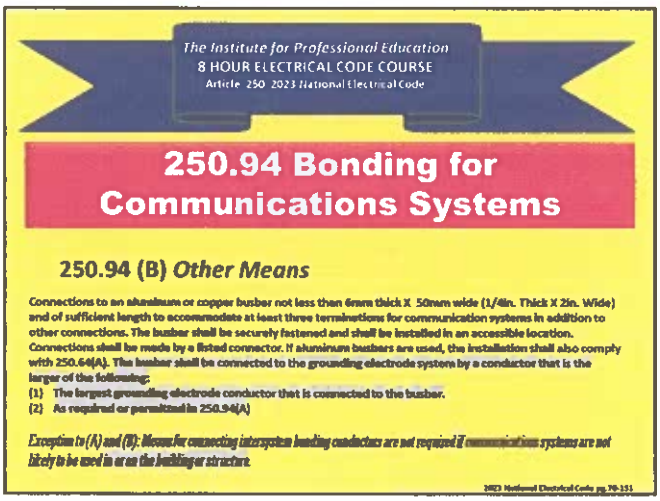
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Article 250 2023 National Electrical Code
250.94 Bonding for Communications Systems
250.94 (B) Other Means
Connections to an aluminum or copper busbar not less than 6mm thick X 50mm wide (1/4in. Thick X 2in. Wide) and of sufficient length to accommodate at least three terminations for communication systems in addition to other connections. The busbar shall be securely fastened and shall be installed in an accessible location. Connections shall be made by a listed connector. If aluminum busbars are used, the installation shall also comply with 250.64(A). The busbar shall be connected to the grounding electrode system by a conductor that is the larger of the following:
(1) The largest grounding electrode conductor that is connected to the busbar.
(2) As required or permitted in 250.94(A)

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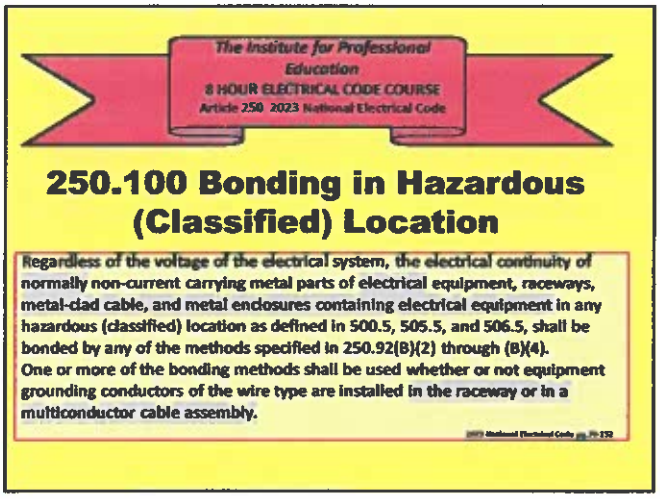
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Article 250 2023 National Electrical Code
250.100 Bonding in Hazardous (Classified) Location
Regardless of the voltage of the electrical system, the electrical continuity of normally non-current carrying metal parts of electrical equipment, raceways, metal-clad cable, and metal enclosures containing electrical equipment in any hazardous (classified) location as defined in 500.5, 505.5, and 506.5, shall be bonded by any of the methods specified in 250.92(B)(2) through (B)(4). One or more of the bonding methods shall be used whether or not equipment grounding conductors of the wire type are installed in the raceway or in a multiconductor cable assembly.

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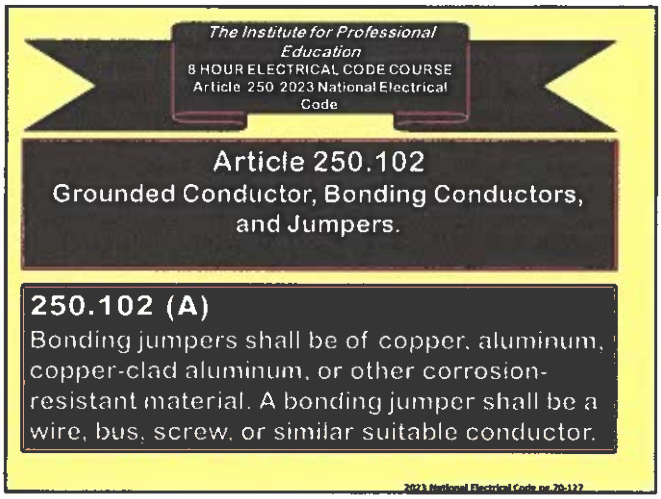
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Article 250 2023 National Electrical Code
Article 250.102
Grounded Conductor, Bonding Conductors, and Jumpers.
250.102 (A)
Bonding jumpers shall be of copper, aluminum, copper-clad aluminum, or other corrosion-resistant material. A bonding jumper shall be a wire, bus, screw, or similar suitable conductor.

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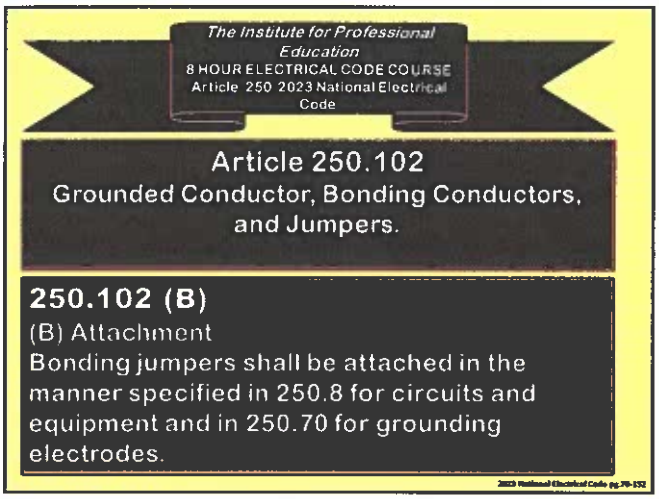
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Article 250 2023 National Electrical Code
Article 250.102
Grounded Conductor, Bonding Conductors, and Jumpers.
250.102 (B)
(B) Attachment
Bonding jumpers shall be attached in the manner specified in 250.8 for circuits and equipment and in 250.70 for grounding electrodes.

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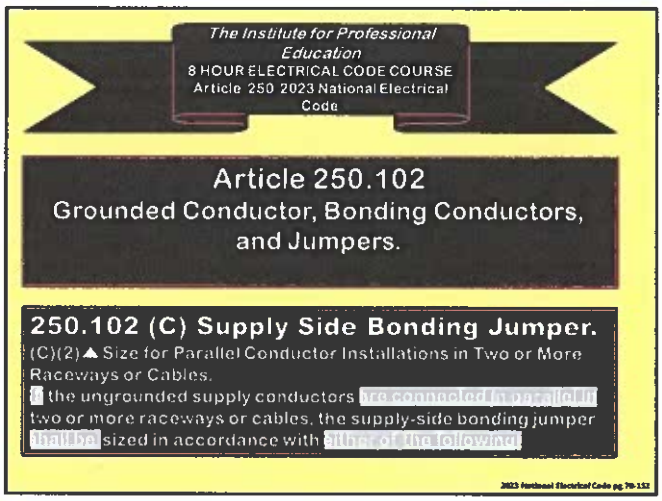
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Article 250 2023 National Electrical Code
Article 250.102
Grounded Conductor, Bonding Conductors, and Jumpers.
250.102 (C) Supply Side Bonding Jumper.
(C)(2) Size for Parallel Conductor Installations in Two or More Raceways or Cables.
If the ungrounded supply conductors are connected in parallel in two or more raceways or cables, the supply-side bonding jumper shall be sized in accordance with either of the following:

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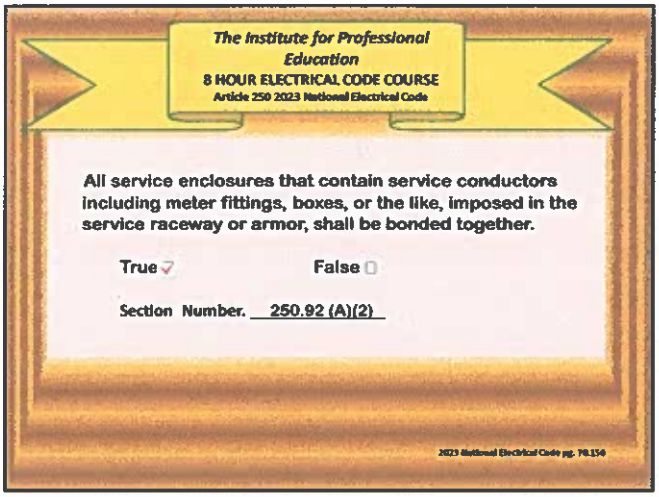
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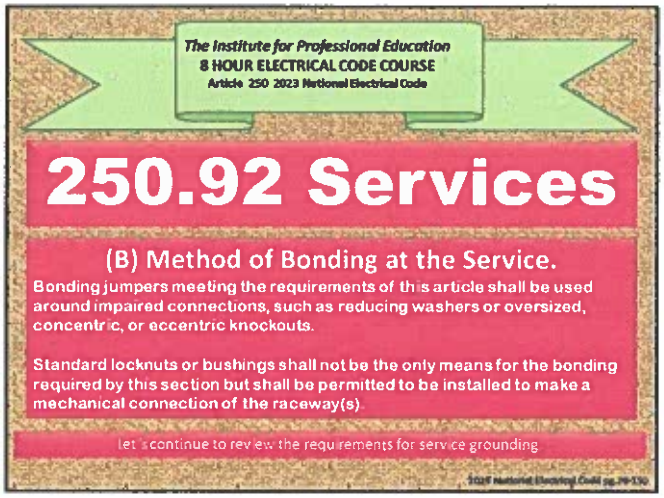
Article 250 2023 National Electrical Code
All service enclosures that contain service conductors including meter fittings, boxes, or the like, imposed in the service raceway or armor, shall be bonded together.
True
False
Section Number. 250.92 (A)(2)

73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Article 250 2023 National Electrical Code
250.92 Services
(B) Method of Bonding at the Service.
Bonding jumpers meeting the requirements of this article shall be used around impaired connections, such as reducing washers or oversized, concentric, or eccentric knockouts.
Standard locknuts or bushings shall not be the only means for the bonding required by this section but shall be permitted to be installed to make a mechanical connection of the raceway(s).
let's continue to review the requirements for service grounding

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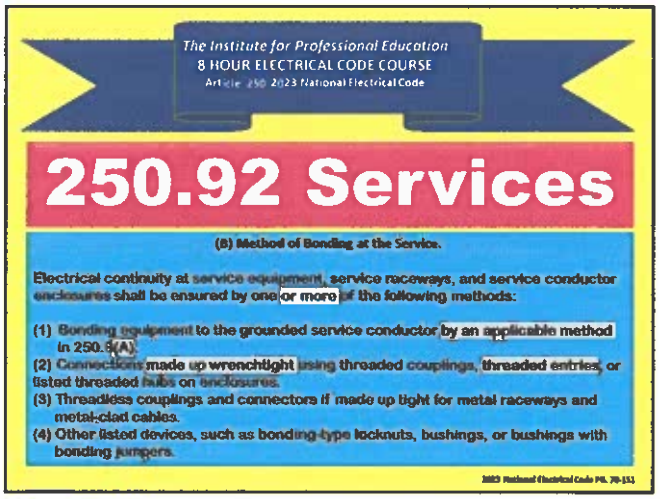
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Article 250 2023 National Electrical Code
250.92 Services
(B) Method of Bonding at the Service.
Electrical continuity at service equipment, service raceways, and service conductor enclosures shall be ensured by one or more of the following methods:
(1) Bonding equipment to the grounded service conductor by an applicable method in 250.8(A).
(2) Connections made up wrenchtight using threaded couplings, threaded entries, or listed threaded hubs on enclosures.
(3) Threadless couplings and connectors if made up tight for metal raceways and metal-clad cables.
(4) Other listed devices, such as bonding-type locknuts, bushings, or bushings with bonding jumpers.

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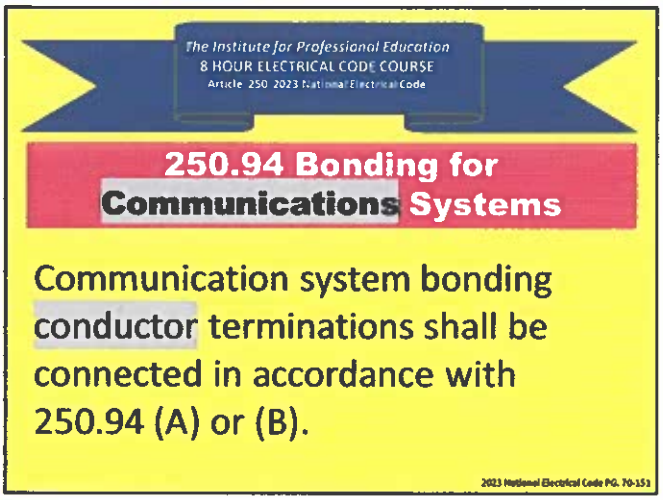
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Article 250 2023 National Electrical Code
250.94 Bonding for Communications Systems
Communication system bonding conductor terminations shall be connected in accordance with 250.94 (A) or (B).
2023 National Electrical Code PG. 70-151

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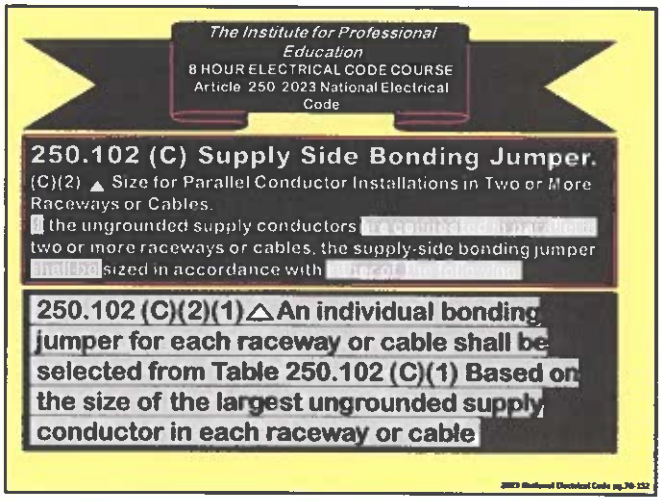
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Article 250 2023 National Electrical Code
250.102 (C) Supply Side Bonding Jumper.
(C)(2) ▲ Size for Parallel Conductor Installations in Two or More Raceways or Cables.
If the ungrounded supply conductors are connected in parallel in two or more raceways or cables, the supply-side bonding jumper shall be sized in accordance with one of the following:
250.102 (C)(2)(1)△An individual bonding jumper for each raceway or cable shall be selected from Table 250.102 (C)(1) Based on the size of the largest ungrounded supply conductor in each raceway or cable

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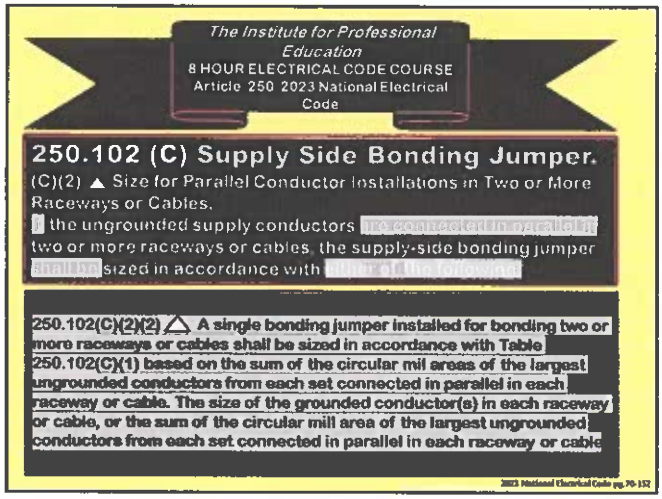
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Article 250 2023 National Electrical Code
250.102 (C) Supply Side Bonding Jumper.
(C)(2) ▲ Size for Parallel Conductor Installations in Two or More Raceways or Cables.
If the ungrounded supply conductors are connected in parallel in two or more raceways or cables, the supply-side bonding jumper shall be sized in accordance with one of the following:
250.102(C)(2)(2) △ A single bonding jumper installed for bonding two or more raceways or cables shall be sized in accordance with Table 250.102(C)(1) based on the sum of the circular mil areas of the largest ungrounded conductors from each set connected in parallel in each raceway or cable. The size of the grounded conductor(s) in each raceway or cable, or the sum of the circular mill area of the largest ungrounded conductors from each set connected in parallel in each raceway or cable

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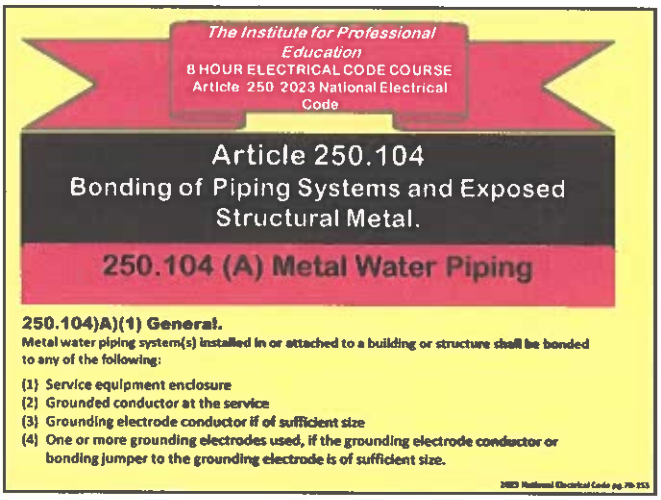
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Article 250 2023 National Electrical Code
Article 250.104
Bonding of Piping Systems and Exposed Structural Metal.
250.104 (A) Metal Water Piping
250.104)A)(1) General.
Metal water piping system(s) installed in or attached to a building or structure shall be bonded to any of the following:
(1) Service equipment enclosure
(2) Grounded conductor at the service
(3) Grounding electrode conductor if of sufficient size
(4) One or more grounding electrodes used, if the grounding electrode conductor or bonding jumper to the grounding electrode is of sufficient size.

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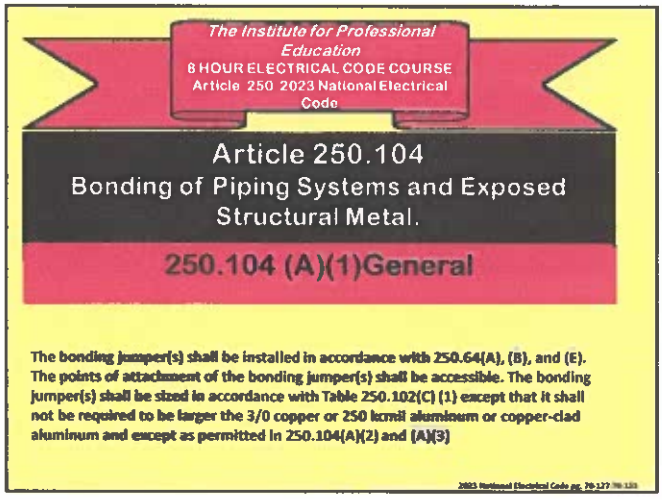
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Article 250 2023 National Electrical Code
Article 250.104
Bonding of Piping Systems and Exposed Structural Metal.
250.104 (A)(1)General
The bonding jumper(s) shall be installed in accordance with 250.64(A), (B), and (E). The points of attachment of the bonding jumper(s) shall be accessible. The bonding jumper(s) shall be sized in accordance with Table 250.102(C) (1) except that it shall not be required to be larger the 3/0 copper or 250 kcmil aluminum or copper-clad aluminum and except as permitted in 250.104(A)(2) and (A)(3)

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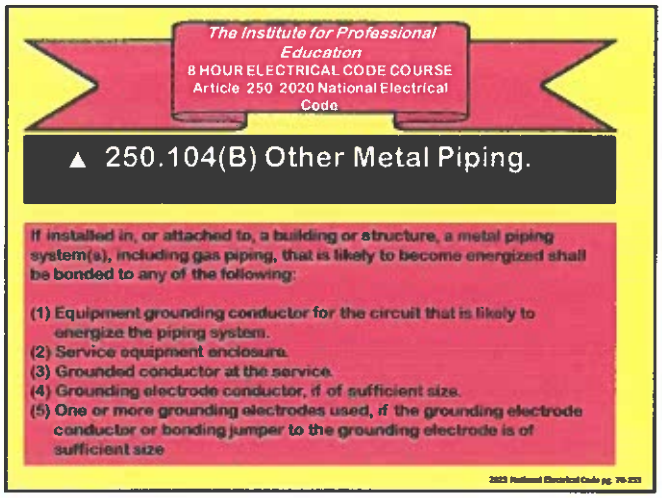
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▲ 250.104(B) Other Metal Piping.
If installed in, or attached to, a building or structure, a metal piping system(s), including gas piping, that is likely to become energized shall be bonded to any of the following:
(1) Equipment grounding conductor for the circuit that is likely to energize the piping system.
(2) Service equipment enclosure.
(3) Grounded conductor at the service.
(4) Grounding electrode conductor, if of sufficient size.
(5) One or more grounding electrodes used, if the grounding electrode conductor or bonding jumper to the grounding electrode is of sufficient size

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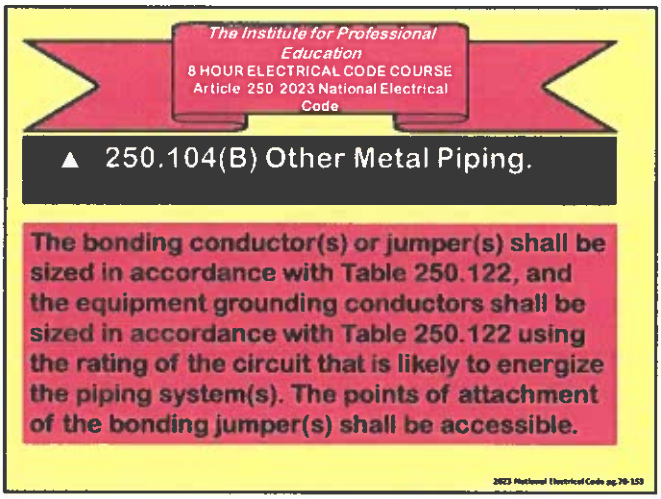
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Article 250 2023 National Electrical Code
▲ 250.104(B) Other Metal Piping.
The bonding conductor(s) or jumper(s) shall be sized in accordance with Table 250.122, and the equipment grounding conductors shall be sized in accordance with Table 250.122 using the rating of the circuit that is likely to energize the piping system(s). The points of attachment of the bonding jumper(s) shall be accessible.

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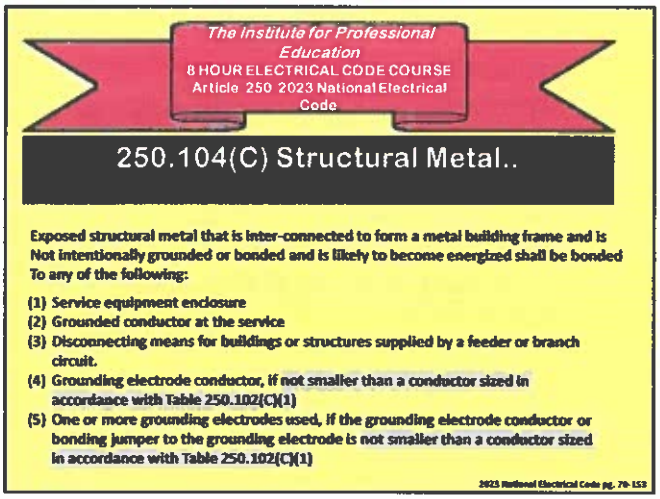
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Article 250 2023 National Electrical Code
250.104(C) Structural Metal..
Exposed structural metal that is inter-connected to form a metal building frame and is Not intentionally grounded or bonded and is likely to become energized shall be bonded To any of the following:
(1) Service equipment enclosure
(2) Grounded conductor at the service
(3) Disconnecting means for buildings or structures supplied by a feeder or branch circuit.
(4) Grounding electrode conductor, if not smaller than a conductor sized in accordance with Table 250.102(C)(1)
(5) One or more grounding electrodes used, if the grounding electrode conductor or bonding jumper to the grounding electrode is not smaller than a conductor sized in accordance with Table 250.102(C)(1)

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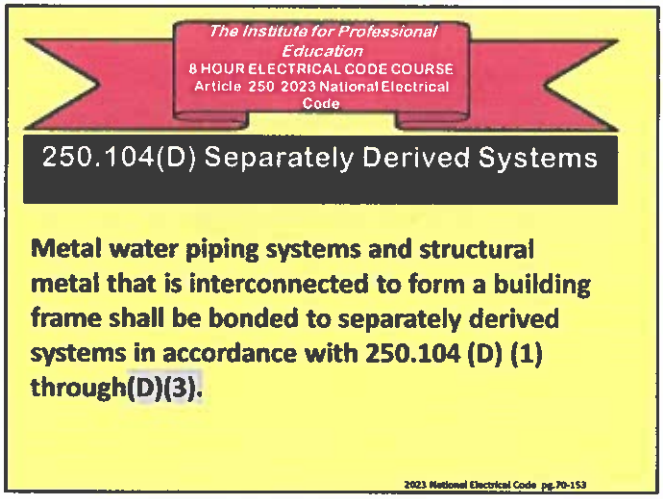
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Article 250 2023 National Electrical Code
250.104(D) Separately Derived Systems
Metal water piping systems and structural metal that is interconnected to form a building frame shall be bonded to separately derived systems in accordance with 250.104 (D) (1) through(D)(3).
2023 National Electrical Code pg.70-153

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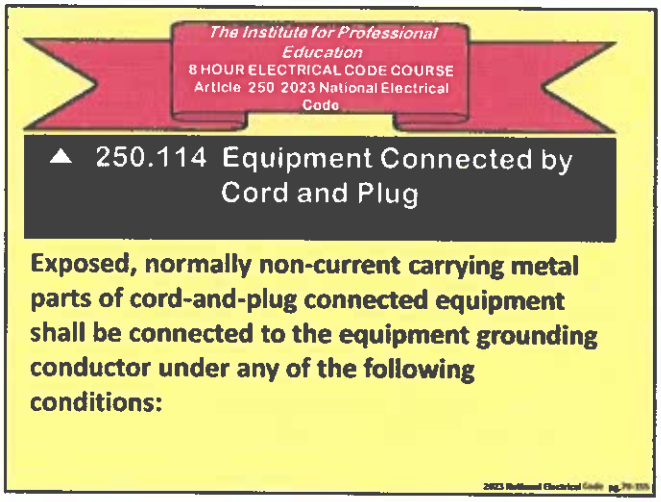
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▲ 250.114 Equipment Connected by Cord and Plug
Exposed, normally non-current carrying metal parts of cord-and-plug connected equipment shall be connected to the equipment grounding conductor under any of the following conditions:

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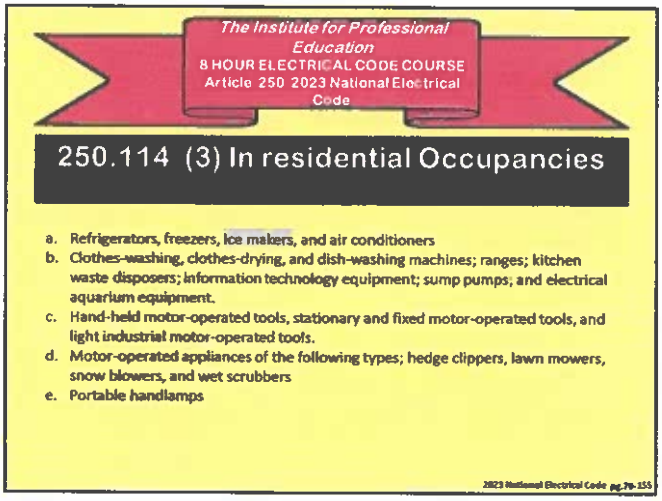
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250.114 (3) In residential Occupancies
a. Refrigerators, freezers, ice makers, and air conditioners
b. Clothes-washing, clothes-drying, and dish-washing machines; ranges; kitchen waste disposers; information technology equipment; sump pumps; and electrical aquarium equipment.
c. Hand-held motor-operated tools, stationary and fixed motor-operated tools, and light industrial motor-operated tools.
d. Motor-operated appliances of the following types; hedge clippers, lawn mowers, snow blowers, and wet scrubbers
e. Portable handlamps

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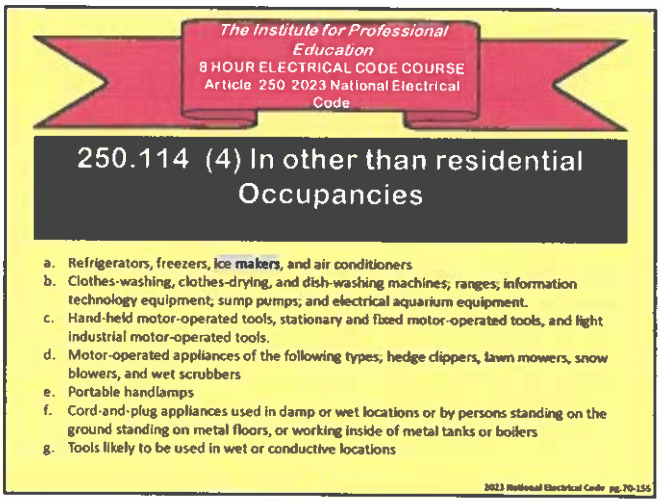
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Article 250 2023 National Electrical Code
250.114 (4) In other than residential Occupancies
a. Refrigerators, freezers, ice makers, and air conditioners
b. Clothes-washing, clothes-drying, and dish-washing machines; ranges; information technology equipment; sump pumps; and electrical aquarium equipment.
c. Hand-held motor-operated tools, stationary and fixed motor-operated tools, and light industrial motor-operated tools.
d. Motor-operated appliances of the following types; hedge clippers, lawn mowers, snow blowers, and wet scrubbers
e. Portable handlamps
f. Cord-and-plug appliances used in damp or wet locations or by persons standing on the ground standing on metal floors, or working inside of metal tanks or boilers
g. Tools likely to be used in wet or conductive locations

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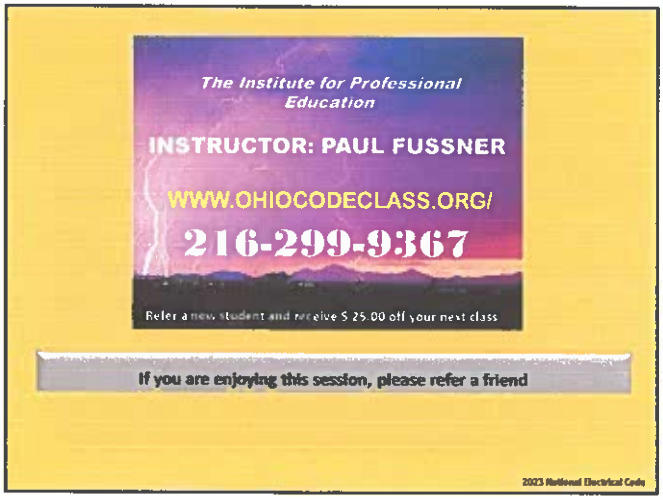
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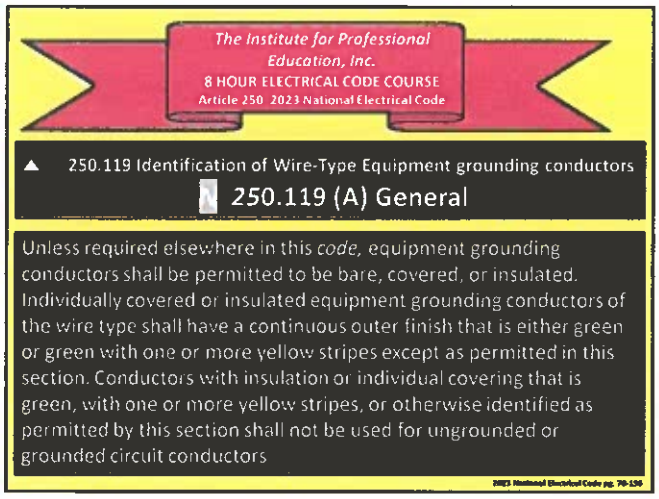
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Article 250 2023 National Electrical Code
▲ 250.119 Identification of Wire-Type Equipment grounding conductors
250.119 (A) General
Unless required elsewhere in this code, equipment grounding conductors shall be permitted to be bare, covered, or insulated. Individually covered or insulated equipment grounding conductors of the wire type shall have a continuous outer finish that is either green or green with one or more yellow stripes except as permitted in this section. Conductors with insulation or individual covering that is green, with one or more yellow stripes, or otherwise identified as permitted by this section shall not be used for ungrounded or grounded circuit conductors

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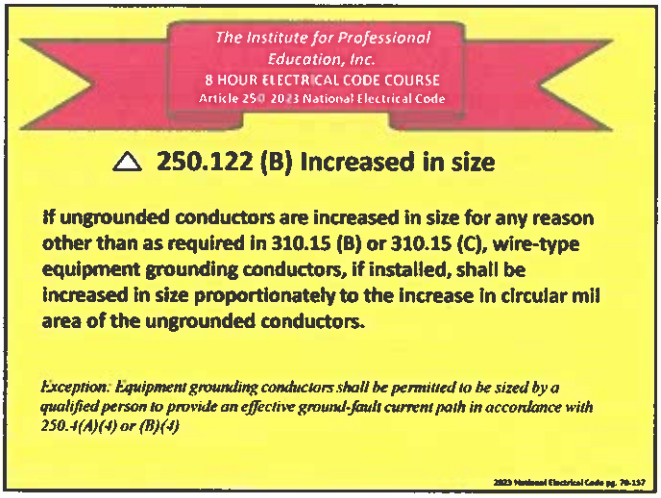
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Article 250 2023 National Electrical Code
△ 250.122 (B) Increased in size
If ungrounded conductors are increased in size for any reason other than as required in 310.15 (B) or 310.15 (C), wire-type equipment grounding conductors, if installed, shall be increased in size proportionately to the increase in circular mil area of the ungrounded conductors.
Exception: Equipment grounding conductors shall be permitted to be sized by a qualified person to provide an effective ground-fault current path in accordance with 250.4(A)(4) or (B)(4)

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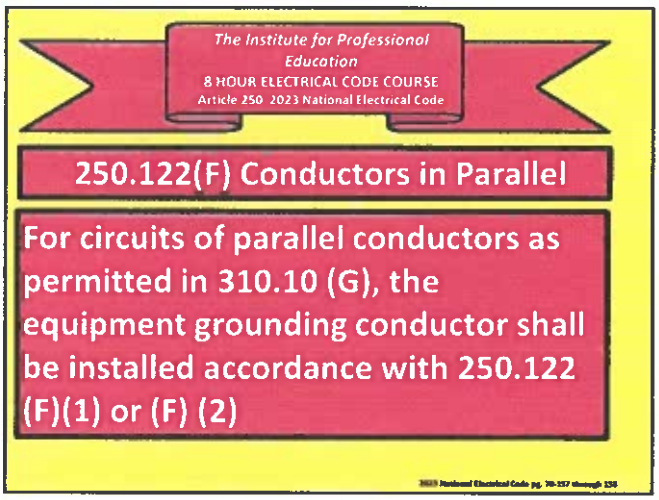
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250.122(F) Conductors in Parallel
For circuits of parallel conductors as permitted in 310.10 (G), the equipment grounding conductor shall be installed accordance with 250.122 (F)(1) or (F) (2)

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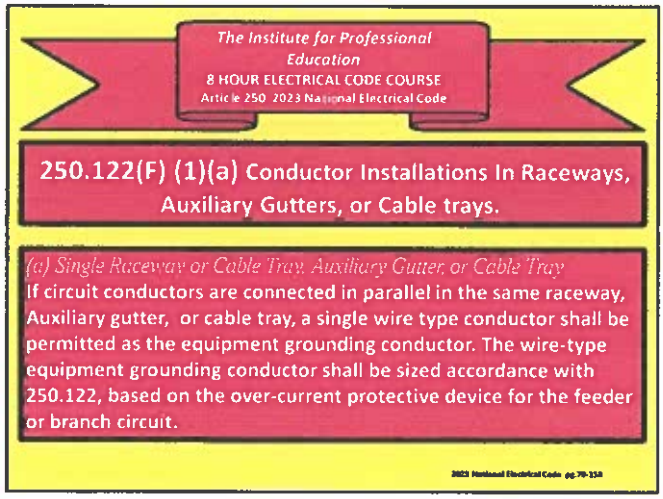
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Article 250 2023 National Electrical Code
250.122(F) (1)(a) Conductor Installations In Raceways, Auxiliary Gutters, or Cable trays.
(a) Single Raceway or Cable Tray, Auxiliary Gutter, or Cable Tray
If circuit conductors are connected in parallel in the same raceway, Auxiliary gutter, or cable tray, a single wire type conductor shall be permitted as the equipment grounding conductor. The wire-type equipment grounding conductor shall be sized accordance with 250.122, based on the over-current protective device for the feeder or branch circuit.

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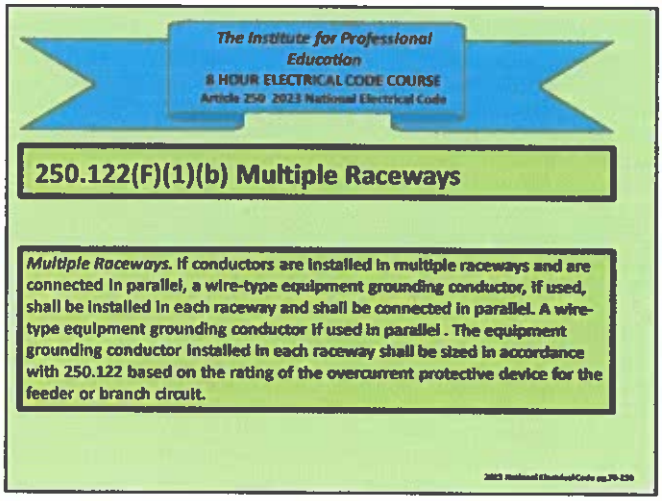

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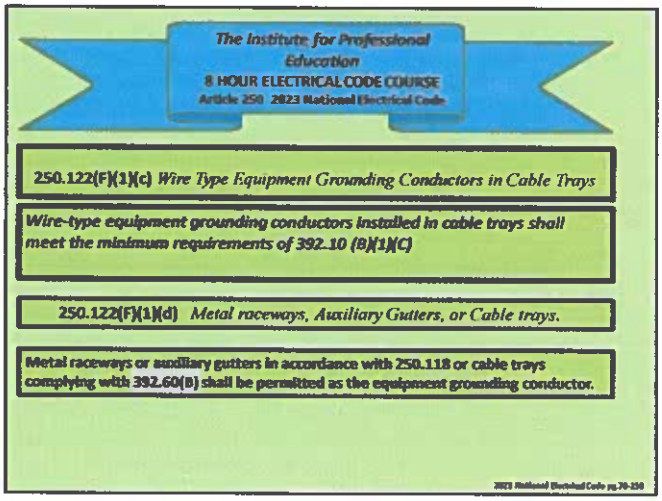

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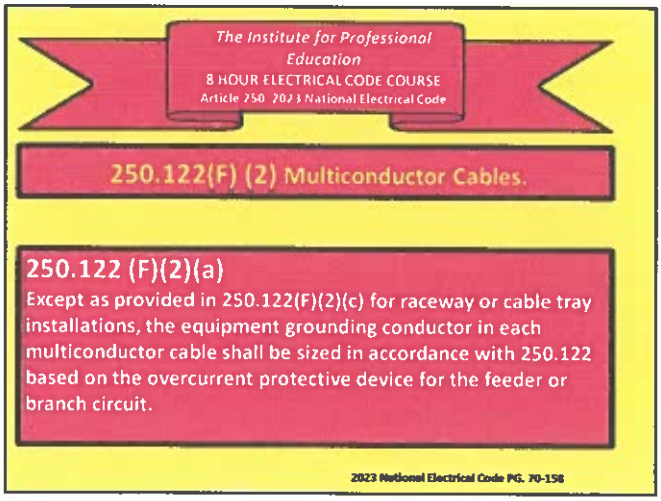

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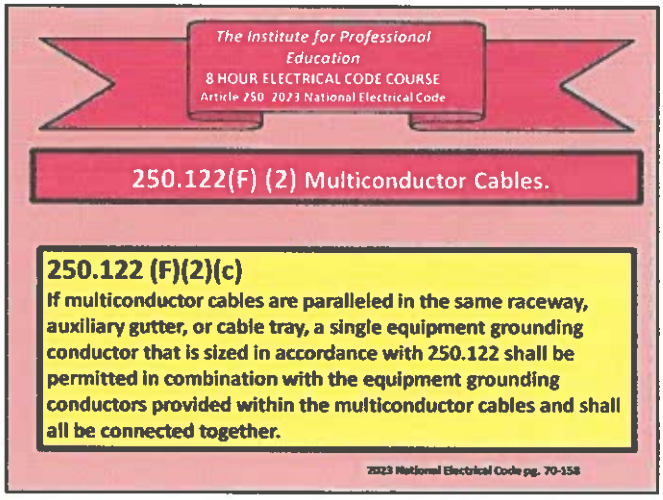

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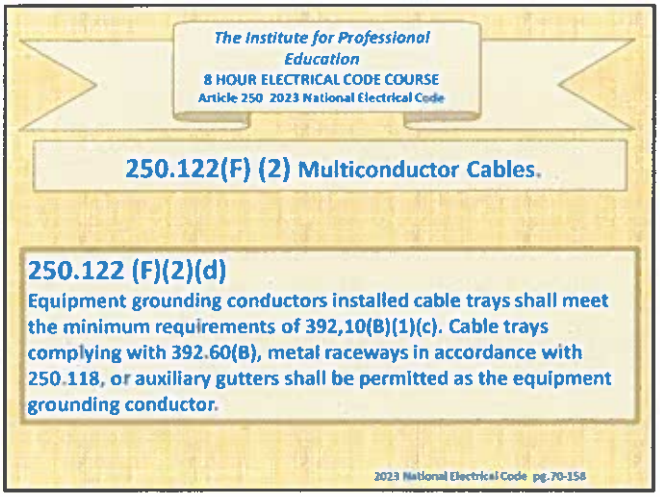

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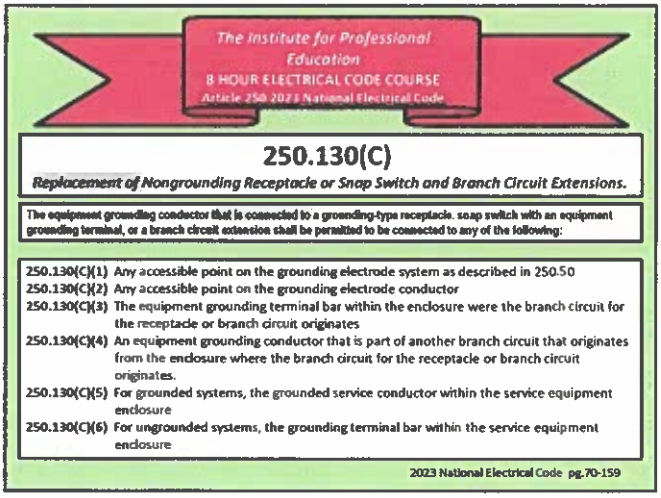

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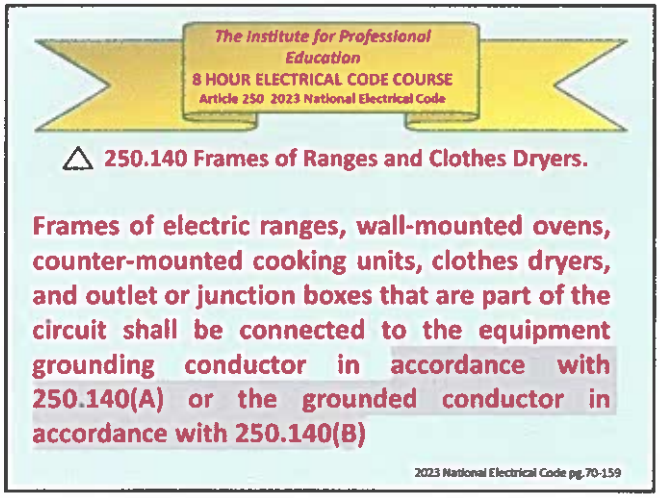

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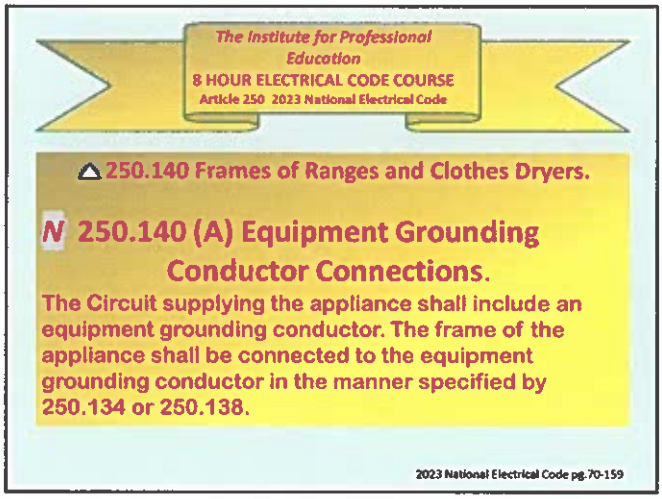

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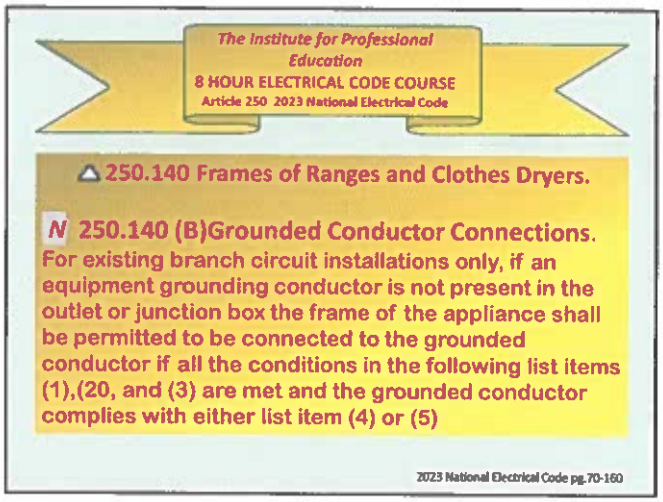

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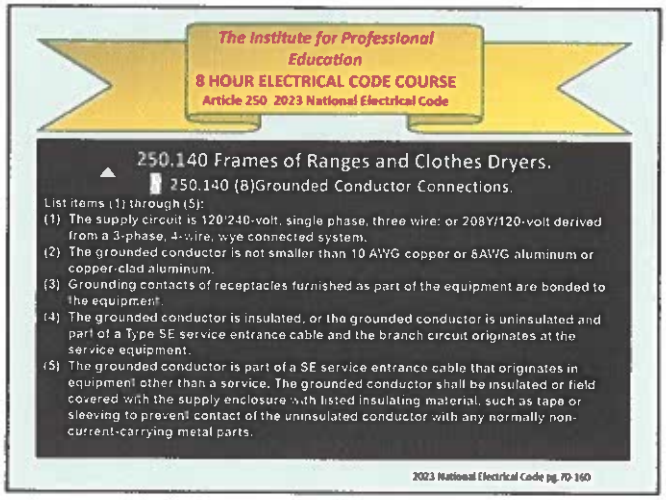

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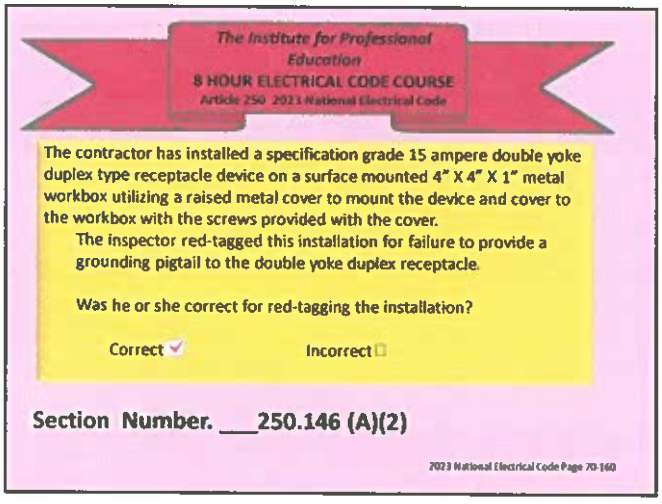

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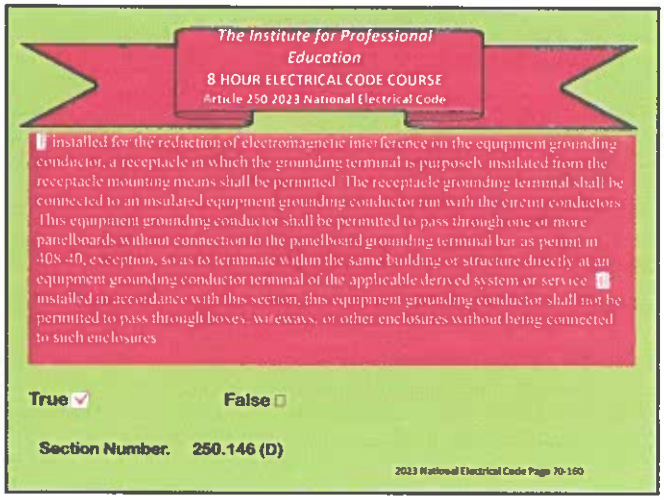

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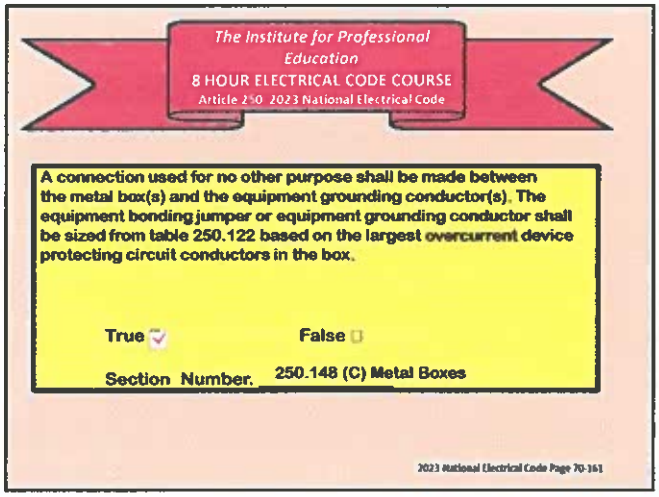

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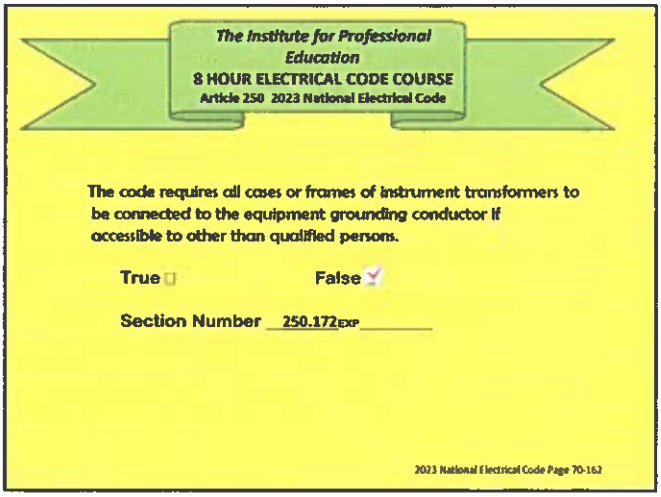

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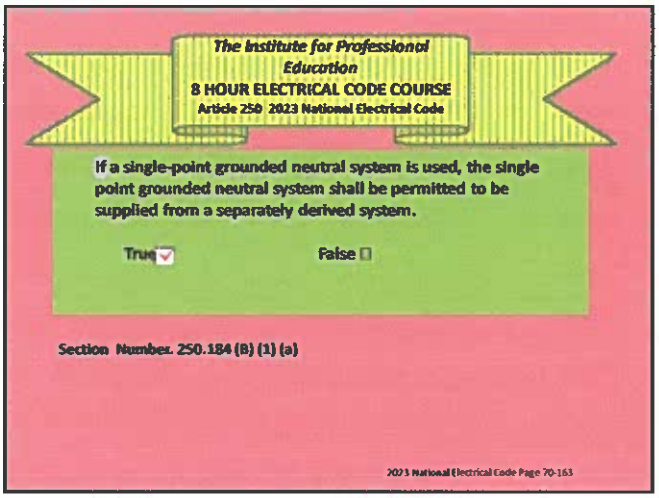

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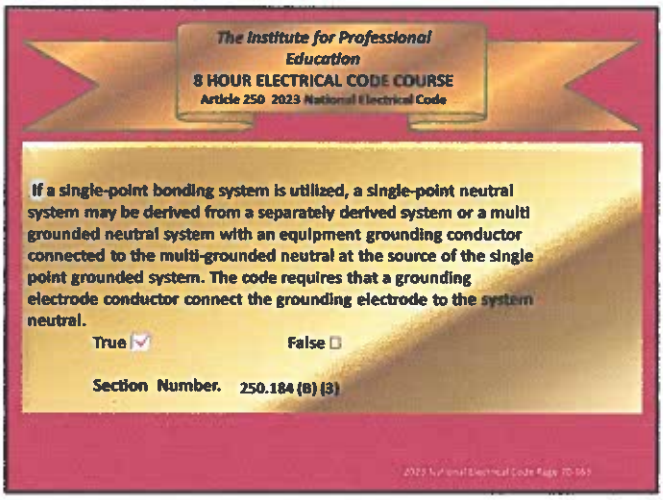

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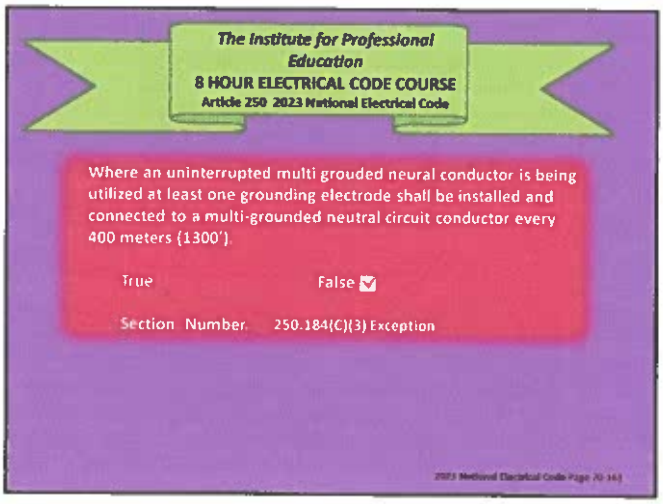

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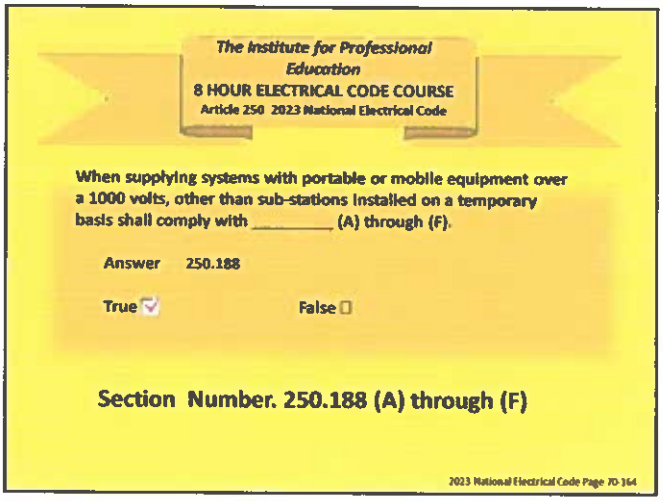

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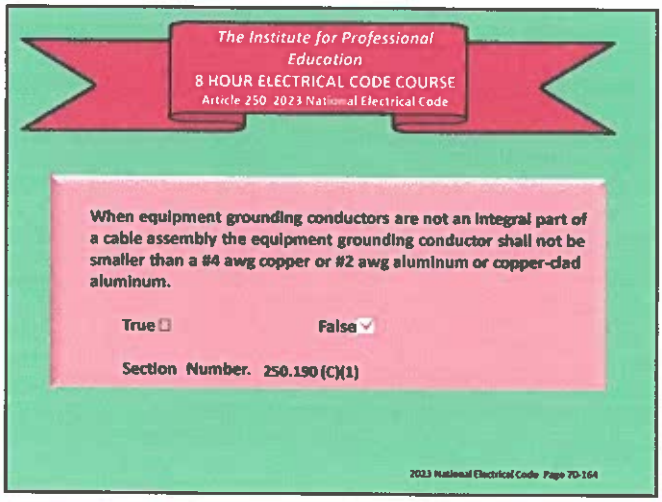

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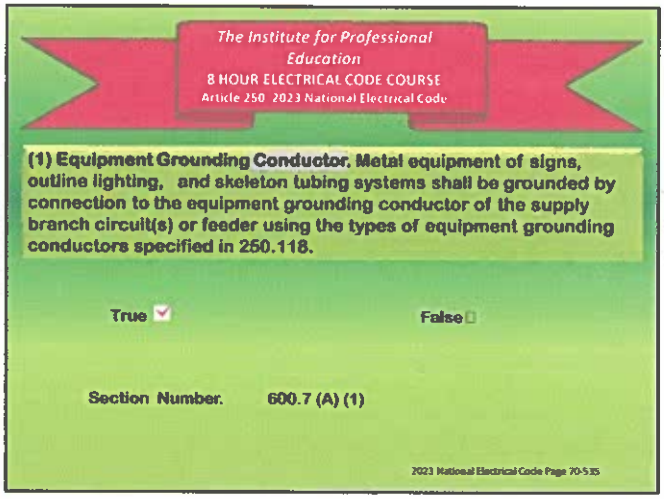

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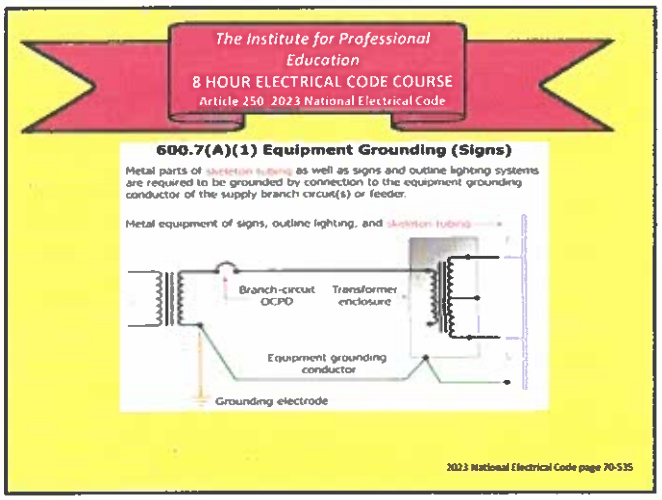
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8 HOUR ELECTRICAL CODE COURSE
Article 250 2023 National Electrical Code
600.7(A)(1) Equipment Grounding (Signs)
Metal parts of skeleton tubing as well as signs and outline lighting systems are required to be grounded by connection to the equipment grounding conductor of the supply branch circuit(s) or feeder.
Metal equipment of signs, outline lighting, and skeleton tubing
Branch-circuit OCPD
Transformer enclosure
Equipment grounding conductor
Grounding electrode
2023 National Electrical Code page 70-535

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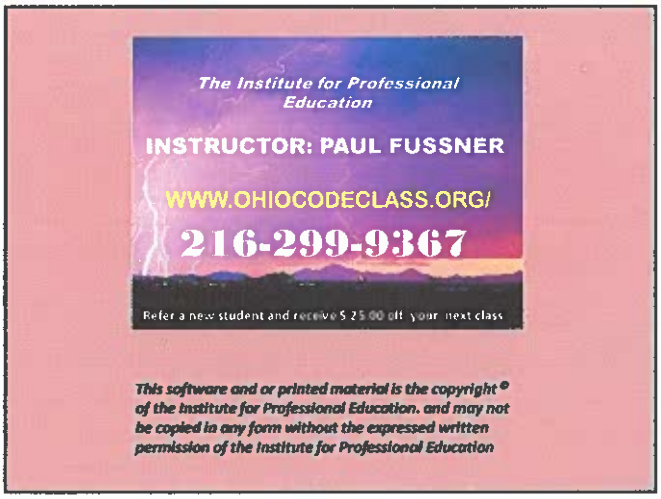
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122

File Attachments for Item:

ER-2 2023 NEC Articles 230-242 (Institute for Professional Education)

All certifications (4 hours)

Staff Notes:

ESIAC Recommendation:

Committee Recommendation:

Mike DeWine, Governor
Jon Husted, Lt. Governor

Board of Building Standards

Application for Continuing Education Course Approval

Provider Information:

Name: Paul R. Fussner BBS # 504

Organization: Institute for professional Education

Address: 30508 Ronald Drive, Willowick, Ohio 44095

E-mail: pfussner@paulfussner.onmicrosoft.com Telephone: 216-299-9367

Website: www.ohiocodeclass.org/

Conference Sponsor (if applicable) Elaine's Educational Services, LLC Conference Email: vfussner1955@gmail.com

Check here if Course Renewal: _____ Prior course number _____ _____ *(i.e. BBS2018-429)*

Renewals will only be granted for identical content and certifications, within the current code cycle.
Attach a copy of prior course approval letter for confirmation. No further information is required.

New Course Information:

Course title: 4-Hour 2023 National Electrical Code Articles 230-242

Course instructor Paul R. Fussner BBS #504

Course description: 4-Hour Power Point Presentation with questions and answers covering the 2023 National Electrical Code Articles 230-242, a 10 minute break at the top of the hour, with lunch break taken from 12:00 to 1:00 pm. This course will be offered throughout the calendar year, Option # one will be a virtual on line Zoom session, option # two live sessions at various locations as noted in the attached proposed schedule.

Instructional hours per session: 4-Hours Number of Sessions: _____

Course Date(s) and Location: See attached proposed schedule

Special Content:

Code Administration: ____
Existing Buildings: ____
Electrical Instruction: X
Plumbing Instruction: ____

Conference Course: Course will be offered live and on line
Conference Name: 4-Hour Power Point Presentation Articles 230-242
Conference location: See attached proposed schedule

Course to be offered online? Yes **On Demand** ____ **Webinar** Virtual Zoom Session

Course Website: www.ohiocodeclass.org/.

Detail online course participation confirmation method *(i.e. test, quizlets, participant activity confirmation)*:
Each student logs in with course link provided after verification of certifications and photo ID , this information reviewed again during sign in or log in on the day of the course

Course applicable for the following certifications

Residential Certifications Only: ____ Commercial Certifications: ____
Administrative Course, All Certifications: X

Application materials included:

X Course Outline or Course Learning Objectives (as noted above)
X Power Point Presentation Materials/Slides (as noted above)
____ Assessment Materials (for online courses)
X Presenter Bio

Please submit application and materials in .pdf format to: michael.lane@com.ohio.gov or BBS@com.ohio.gov

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BOARD OF BUILDING STANDARDS

Paul Robert Fussner, dba

THE INSTITUTE FOR PROFESSIONAL EDUCATION

30508 Ronald Drive
Willowick, Ohio 44095-4341
pfussner@paulfussner.onmicrosoft.com

November 21, 2023

Ohio Board of Building Standards
6606 Tussing Rd
Reynoldsburg, Ohio 43068-9009

REGARDING: Course Syllabus Electrical Contractor. 4-Hour Study of 2023 National Electrical Code Changes Articles 230-242

In-person student classes utilize the normal sign-in method of showing a picture ID and state license before signing the BBS registration sheet, sign-in begins 30 minutes before the session start time.

Computer sign-in and registration(s) begin 30 minutes before the session, utilizing the Zoom login link assigned to each student who has pre-registered by mail or online. Students may log in with a computer, tablet, or smartphone.

Sessions are timed as shown below, (please note the session(s) may be scheduled for 8:00 am or 1:00 pm Start times.

8:00 am or 1:00 pm	Beginning of PowerPoint presentation and review of: Articles 230 through 242 of the 2023 National Electrical Code
8:50 am or 1:50 pm	Ten-minute break. 50 minutes per hour of study of the PowerPoint presentation.
9:50 am or 2:50 pm	Ten-minute break. 50 minutes per hour of study of the PowerPoint presentation.
10:50 am or 3:50 pm	Ten-minute break. 50 minutes per hour of study of the PowerPoint presentation.
12:00 pm or 5:00 pm	Students Dismissed

Note: 4-hour online sessions may be given in the morning or afternoon according to the schedule to be established in November 2023 for the 2024 calendar year.

Paul Robert Fussner, dba
The Institute for Professional Education
30508 Ronald Drive
Willowick, Ohio 44095-4341
pfussner@paulfussner.onmicrosoft.com

INSTRUCTOR QUALIFICATIONS:

- State Certified Electrical Safety Inspector #504
- State Certified Building Inspector #504
- Building Official #504
- Residential Building Official #504
- Board of Building Standards Instructor, Electrical Safety Inspector Re-certification, established in 1999.
- OCILB Instructor, state-licensed, electrical, plumbing, HVAC, and Hydronics contractors continuing education courses, established in 1999.

50 years of experience in the building and electrical trades, as Founder and President of the Gibson Robert Company, Inc. I expedited all new work including researching and ordering the proper electrical equipment required for a safe, efficient installation, while meeting the requirements of The NFPA 70 Electrical Code, The B.O.C.A. Code, and The Ohio Building Code.

29 years of experience as a State Certified Electrical Safety Inspector, 24 years experience as a State Certified Building Inspector with 12 years of departmental management experience.

14 years as Building Official #504

Former Chairman, Western Reserve Chapter International Association of Electrical Inspectors. Two years as Education Chairman, Western Reserve Chapter of the IAEI.

Owner of The Institute for Professional Education, a State of Ohio Training Agency for the Mandatory Continuing Education Credits for Electrical Safety Inspectors and State Licensed Electrical Contractors. Accredited by the Ohio Board of Building Standards and the Ohio Construction industry licensing board. established 1999.

2024 IN-PERSON and ONLINE ZOOM SESSION(S) SCHEDULE for all OCILB. Contractors and BBS Certifications

TO REGISTER FOR A CLASS, VISIT OUR WEB PAGE:

WWW.OHIOCODECLASS.ORG / OR CALL 216-299-9367

January 13	**8-Hr Online Virtual Zoom Session** 2023 NEC Article 250 Understanding Grounding and Bonding	**Course # 3750064**
February 17	**4-hr Online Virtual Zoom Session** 7:45 am-12:00 pm 2023 NEC Articles 90-200	**Course # 3750066**
	4-Hr Online Virtual Zoom Session 1:00 pm - 5:00 pm 2023 NEC Articles 230-242	**Course # 3750060**
	2-Hr Online Virtual Zoom Session 5:00 pm - 7:00 pm 2019 RCO Chapter 113 Existing	**Course # 3750061**
March 23	**8-Hr Online Virtual Zoom Session** 2023 National Electrical Code Article's 230 – 314	**Course # 3750062**
April 27	**4-Hr Online Virtual Zoom Session** 7:45 am-12:00 pm 2023 NEC Articles 90-200	**Course # 3750066**
	4-Hr Online Virtual Zoom Session 1:00 pm - 5:00 pm 2023 NEC Articles 230-242	**Course # 3750060**
	2-Hr Online Virtual Zoom Session 5:00 pm - 7:00 pm 2019 RCO Chapter 3401.1(2)(1)	**Course # 3750065**
May 18	**8-Hr Online Virtual Zoom Session** 2023 National Electrical Code Article's 90 – 210	**Course # 3750063**
June 17	**8-Hr Live in-person session** 2023 NEC Article 250 Understanding Grounding and Bonding	**Course # 3750064**
	Location: Grace Church 36300 Ridge Rd, Willoughby, Ohio 44094 **Rear Lower Level Entrance**	
July 27	**8-Hr Online Virtual Zoom Session** 2023 National Electrical Code Article's 230 – 314	**Course # 3750062**
August 14	**4-Hr Weekday Virtual Zoom Session** 7:45 am-12:00 pm 2023 NEC Articles 90-200	**Course # 3750066**
August 21	**4-Hr Weekday Virtual Zoom Session** 7:45 am-12:00 pm 2023 NEC Articles 230-242	**Course # 3750060**
September 7	**4-Hr Live in Person Session** 7:45 am-12:00 pm 2023 NEC Articles 90-200	**Course # 3750066**
	4-Hr Live in Person Session 1:00 pm - 5:00 pm 2023 NEC Articles 230-242	**Course # 3750060**
	2-Hr Live in Person Session 5:00 pm - 7:00 pm 2019 RCO Chapter 113 Existing	**Course # 3750061**
	Location: Cretan Party Center 13853 W. 168th Street & Lorain Rd, Cleveland, Ohio 44111	
October 19	**4-Hr Live in Person Session** 7:45 am-12:00 pm 2023 NEC Articles 90-200	**Course # 3750066**
	4-Hr Live in Person Session 1:00 pm - 5:00 pm 2023 NEC Articles 230-242	**Course # 3750060**
	2-Hr Live in Person Session 5:00 pm - 7:00 pm 2019 RCO Chapter 3401.1(2)(1)	**Course # 3750065**
	Location: Huntsburg Civic Center 12396 Madison Rd. (Rt,528 & 322) Middlefield, Ohio 44062 Use the rear entrance	
November 16	**8-Hr Online Virtual Zoom Session** 2023 National Electrical Code Article 250 Grounding and Bonding	**Course # 3750064**
December 7	**4-Hr Live in Person Session** 7:45 am-12:00 pm 2023 NEC Articles 90-200	**Course # 3750066**
	4-Hr Live in Person Session 1:00 pm - 5:00 pm 2023 NEC Articles 230-242	**Course # 3750060**
	2-Hr Live in Person Session 5:00 pm - 7:00 pm 2019 RCO Chapter 113 Existing	**Course # 3750061**

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Ten Hours of Education	**$200.00**
Eight Hours of Education	**$180.00**
Four Hours of Education	**$ 90.00**
Two Hours of Education	**$ 50.00**

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Instructor: Paul Fussner

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2023 National Electrical Code

1

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2023 NATIONAL ELECTRICAL CODE

230.9 (B) Vertical Clearance.

The vertical clearance of final spans above, or within 900mm (3ft) measured horizontally of platforms, projections, or surfaces that will permit personal contact shall be maintained in accordance with 230.24(B).

2023 National Electrical Code Pg.70-100

2

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230.10 Vegetation as Support.

Vegetation such as trees shall not be used for support of overhead service conductors or service equipment.

2023 National Electrical Code PG.70-100

3

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2023 NATIONAL ELECTRICAL CODE

230.28 Service Masts as Supports.

Only power service-drop or overhead service conductors shall be permitted to be attached to a service mast. Service masts used for the support of service-drop or overhead service conductors shall be installed in accordance with 230.28(A) and (B).

2023 National Electrical Code Pg. 70-100

4

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2023 NATIONAL ELECTRICAL CODE

230.28 Service Masts as Supports.

(A)Strength.
The service mast shall be of adequate strength or be supported by braces or guy wires to withstand safely the strain imposed by the service-drop or overhead service conductors. Hubs intended for use with a conduit that serves as a service mast shall be identified for use with service-entrance equipment.

2023 National Electrical Code Pg. 70-108

5

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2023 NATIONAL ELECTRICAL CODE

230.28 Service Masts as Supports.

(B) Attachment.
Service-drop or overhead service conductors shall not be attached to a service mast between a weather head or the end of the conduit and a coupling, where the coupling is located above the last point of securement to the building or other structure or is located above the building or other structure.

2023 National Electrical Code Pg. 70-108

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2023 NATIONAL ELECTRICAL CODE

230.28 Service Masts as Supports.

Support clamps must be listed for use as service equipment

2023 National Electrical Code Pg. 70-108

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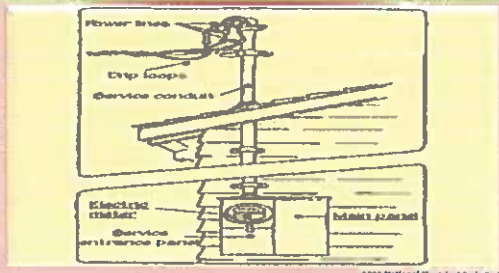
2023 NATIONAL ELECTRICAL CODE

230.28 Service Masts as Supports.



2023 National Electrical Code Pg 70-108

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Slide 7

PF1 Paul Fussner, 7/21/2020

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2023 NATIONAL ELECTRICAL CODE

230.29 Supports over Buildings.

Service conductors passing over a roof shall be securely supported by substantial structures. For a grounded system, where the substantial structure is metal, it shall be bonded by means of a bonding jumper and listed connector to the grounded overhead service conductor. Where practicable, such supports shall be independent of the building.

2023 National Electrical Code Pg.70-109

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III. Underground Service Conductors 230.30 (B) Wiring Methods.

230.30(B) Wiring Methods (Underground Service Conductors)

A list of acceptable wiring methods for "Underground Service Conductors" was added at 230.30(B)

Underground service conductors are required to be installed in accordance with the applicable requirements of the *NEC* for the type of wiring method used and shall be limited to the following wiring methods

(1) Type RMC conduit
(2) Type IMC conduit
(3) Type NUCC conduit
(4) Type HDPE conduit
(5) Type PVC conduit
(11) Type TC-Er Cable where identified for service entrance use and direct burial applications
(6) Type RTRC conduit
(7) Type IGS cable
(8) Type USE conductors or cables
(9) Type MV or Type MC cable identified for direct burial applications
(10) Type MI cable, where suitably protected against physical damage and corrosion

2023 NEC Pg. 70-109

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2023 NATIONAL ELECTRICAL CODE

230.40 Number of Service-Entrance Conductor Sets

Each service drop, set of overhead service conductors, set of underground service conductors or service lateral shall supply only one set of service-entrance conductors.

2023 National Electrical Code Pg. 70-109

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230.40 Number of Service-Entrance Conductor Sets

Exception No.1: A building with more than one occupancy shall be permitted to have one set of service-entrance conductors for each service, as permitted in 230.2, run to each occupancy or group of occupancies. If the number of service disconnect locations for any given classification of service does not exceed six, the requirements of 230.2(E) shall apply at each location. If the number of service disconnect locations exceeds six for any given supply classification, the following conditions shall apply:

(1). All service disconnect locations for all supply characteristics together with any branch circuit or feeder supply sources shall be clearly described using graphics or text, or both, on one or more plaques
(2). The plaques shall be located in an approved, readily accessible location(s) on the building or structure served and as near as practicable to the point(s) of attachment or entry(ies) for each service drop or service lateral and for each set of overhead or underground service conductors.

2023 National Electrical Code Pg. 70-109

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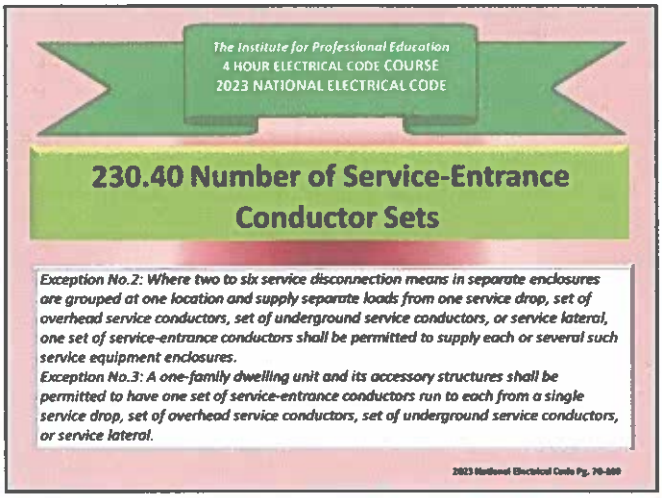
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2023 NATIONAL ELECTRICAL CODE
230.40 Number of Service-Entrance Conductor Sets
Exception No.2: Where two to six service disconnection means in separate enclosures are grouped at one location and supply separate loads from one service drop, set of overhead service conductors, set of underground service conductors, or service lateral, one set of service-entrance conductors shall be permitted to supply each or several such service equipment enclosures.
Exception No.3: A one-family dwelling unit and its accessory structures shall be permitted to have one set of service-entrance conductors run to each from a single service drop, set of overhead service conductors, set of underground service conductors, or service lateral.

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2023 NATIONAL ELECTRICAL CODE
230.40 Number of Service-Entrance Conductor Sets
Exception No.4: Two or three-family dwelling, multifamily dwellings, and multiple occupancy buildings shall be permitted to have one set of service-entrance conductors installed to supply the circuits covered in 210.25
Exception No.5: One set of service-entrance conductors connected to the supply side of the normal service disconnecting means shall be permitted to supply each or several systems covered by 230.82(5) or 230.82(6)

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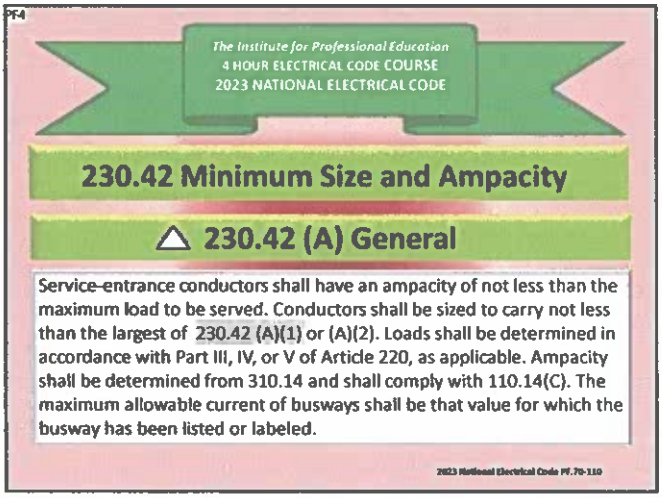
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2023 NATIONAL ELECTRICAL CODE
230.42 Minimum Size and Ampacity
△ 230.42 (A) General
Service-entrance conductors shall have an ampacity of not less than the maximum load to be served. Conductors shall be sized to carry not less than the largest of 230.42 (A)(1) or (A)(2). Loads shall be determined in accordance with Part III, IV, or V of Article 220, as applicable. Ampacity shall be determined from 310.14 and shall comply with 110.14(C). The maximum allowable current of busways shall be that value for which the busway has been listed or labeled.

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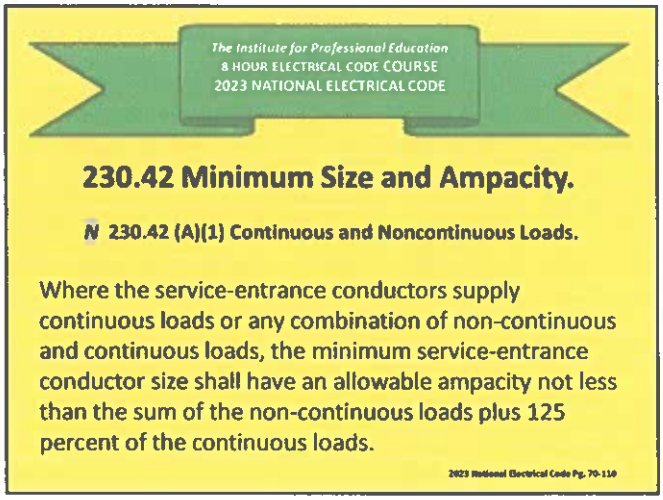
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4 HOUR ELECTRICAL CODE COURSE
2023 NATIONAL ELECTRICAL CODE
230.42 Minimum Size and Ampacity.
N 230.42 (A)(1) Continuous and Noncontinuous Loads.
Where the service-entrance conductors supply continuous loads or any combination of non-continuous and continuous loads, the minimum service-entrance conductor size shall have an allowable ampacity not less than the sum of the non-continuous loads plus 125 percent of the continuous loads.

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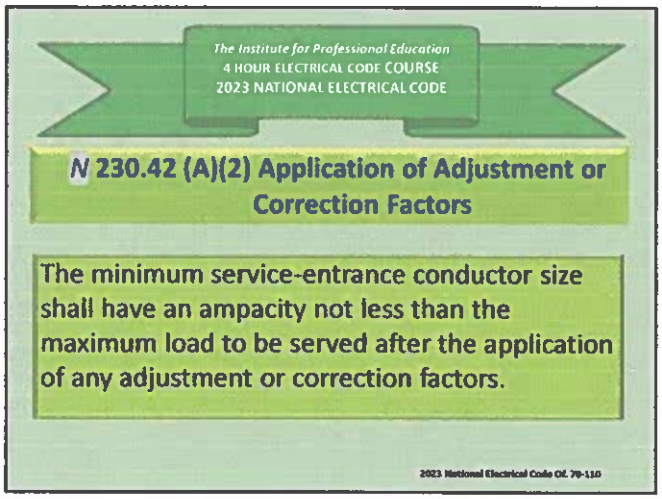
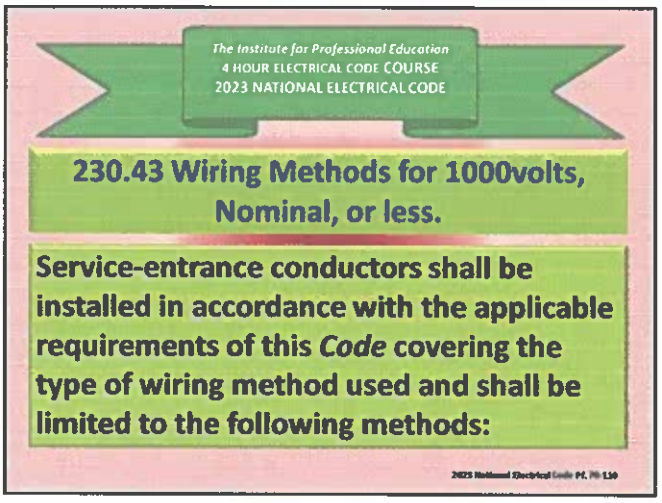
Slide 15

PF4 Paul Fussner, 11/20/2020


The Institute for Professional Education
4 HOUR ELECTRICAL CODE COURSE
2023 NATIONAL ELECTRICAL CODE
N 230.42 (A)(2) Application of Adjustment or Correction Factors
The minimum service-entrance conductor size shall have an ampacity not less than the maximum load to be served after the application of any adjustment or correction factors.

17


The Institute for Professional Education
4 HOUR ELECTRICAL CODE COURSE
2023 NATIONAL ELECTRICAL CODE
230.43 Wiring Methods for 1000volts, Nominal, or less.
Service-entrance conductors shall be installed in accordance with the applicable requirements of this Code covering the type of wiring method used and shall be limited to the following methods:

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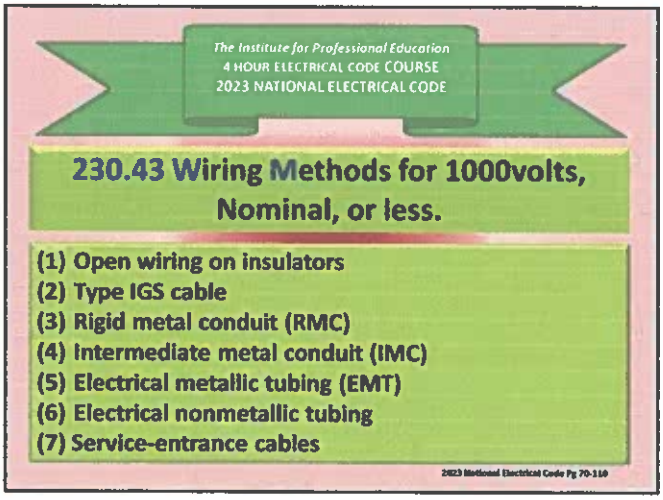
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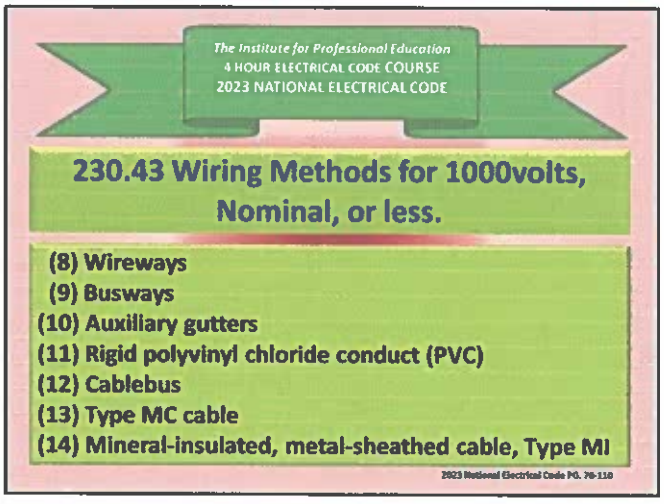
2023 NATIONAL ELECTRICAL CODE
230.43 Wiring Methods for 1000volts, Nominal, or less.
(1) Open wiring on insulators
(2) Type IGS cable
(3) Rigid metal conduit (RMC)
(4) Intermediate metal conduit (IMC)
(5) Electrical metallic tubing (EMT)
(6) Electrical nonmetallic tubing
(7) Service-entrance cables

19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230.43 Wiring Methods for 1000volts, Nominal, or less.
(8) Wireways
(9) Busways
(10) Auxiliary gutters
(11) Rigid polyvinyl chloride conduct (PVC)
(12) Cablebus
(13) Type MC cable
(14) Mineral-insulated, metal-sheathed cable, Type MI

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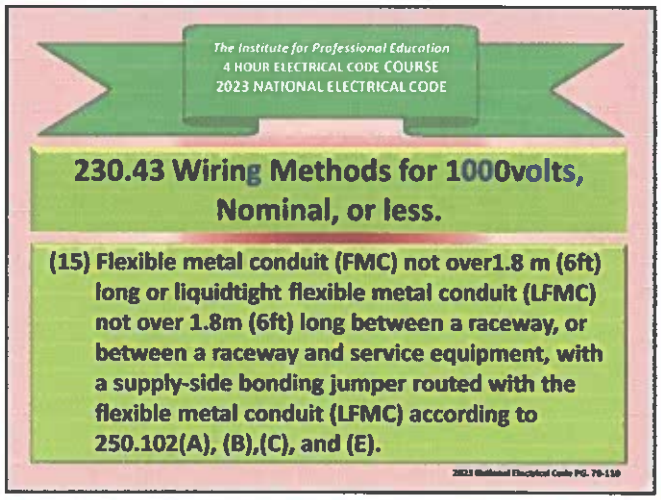
The Institute for Professional Education
4 HOUR ELECTRICAL CODE COURSE
2023 NATIONAL ELECTRICAL CODE
230.43 Wiring Methods for 1000volts, Nominal, or less.
(15) Flexible metal conduit (FMC) not over1.8 m (6ft) long or liquidtight flexible metal conduit (LFMC) not over 1.8m (6ft) long between a raceway, or between a raceway and service equipment, with a supply-side bonding jumper routed with the flexible metal conduit (LFMC) according to 250.102(A), (B),(C), and (E).

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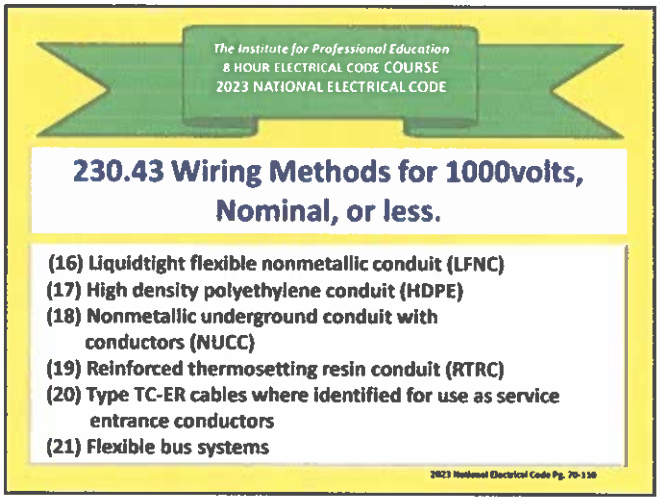
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8 HOUR ELECTRICAL CODE COURSE
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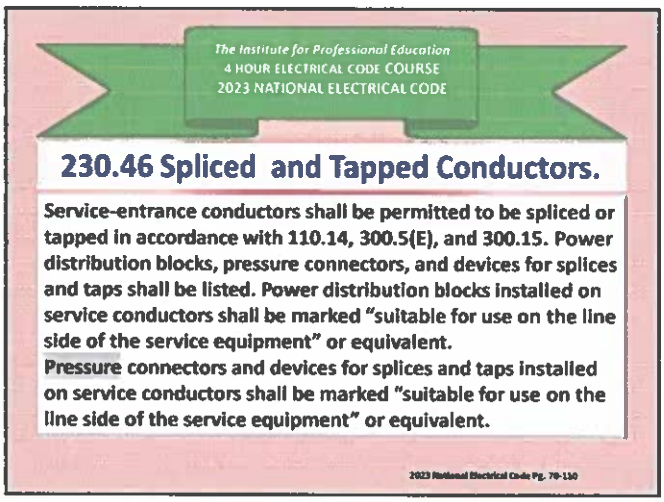
230.43 Wiring Methods for 1000volts, Nominal, or less.
(16) Liquidtight flexible nonmetallic conduit (LFNC)
(17) High density polyethylene conduit (HDPE)
(18) Nonmetallic underground conduit with conductors (NUCC)
(19) Reinforced thermosetting resin conduit (RTRC)
(20) Type TC-ER cables where identified for use as service entrance conductors
(21) Flexible bus systems

22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230.46 Spliced and Tapped Conductors.
Service-entrance conductors shall be permitted to be spliced or tapped in accordance with 110.14, 300.5(E), and 300.15. Power distribution blocks, pressure connectors, and devices for splices and taps shall be listed. Power distribution blocks installed on service conductors shall be marked "suitable for use on the line side of the service equipment" or equivalent.
Pressure connectors and devices for splices and taps installed on service conductors shall be marked "suitable for use on the line side of the service equipment" or equivalent.

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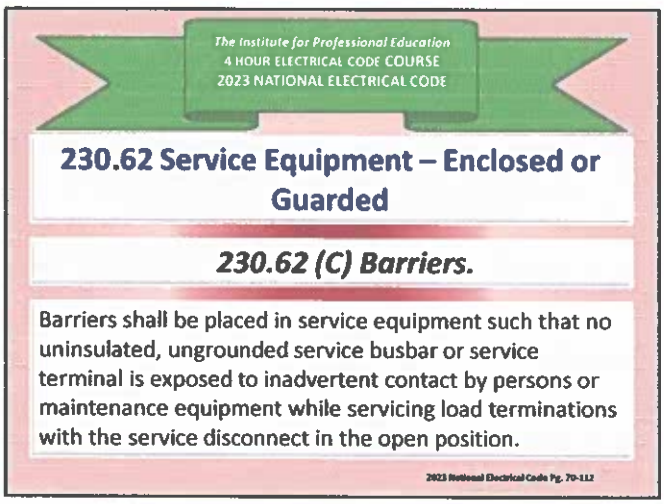
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230.62 Service Equipment – Enclosed or Guarded
230.62 (C) Barriers.
Barriers shall be placed in service equipment such that no uninsulated, ungrounded service busbar or service terminal is exposed to inadvertent contact by persons or maintenance equipment while servicing load terminations with the service disconnect in the open position.

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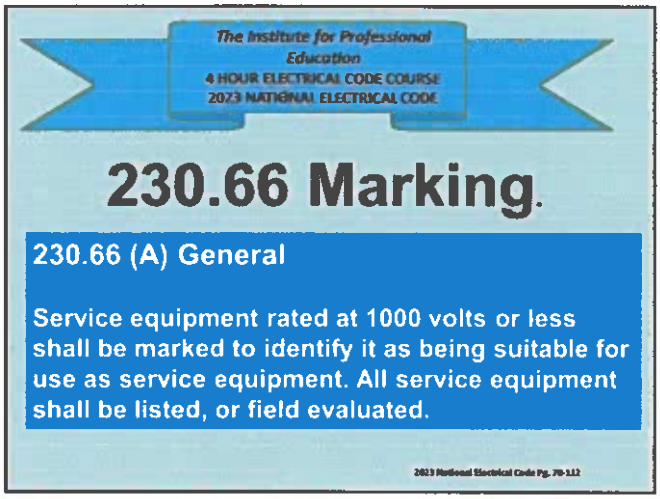
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4 HOUR ELECTRICAL CODE COURSE
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230.66 Marking.
230.66 (A) General
Service equipment rated at 1000 volts or less shall be marked to identify it as being suitable for use as service equipment. All service equipment shall be listed, or field evaluated.

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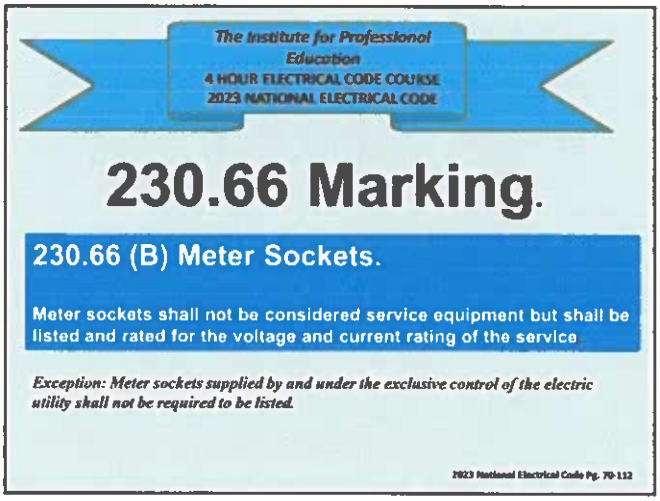
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230.66 Marking.
230.66 (B) Meter Sockets.
Meter sockets shall not be considered service equipment but shall be listed and rated for the voltage and current rating of the service
Exception: Meter sockets supplied by and under the exclusive control of the electric utility shall not be required to be listed.

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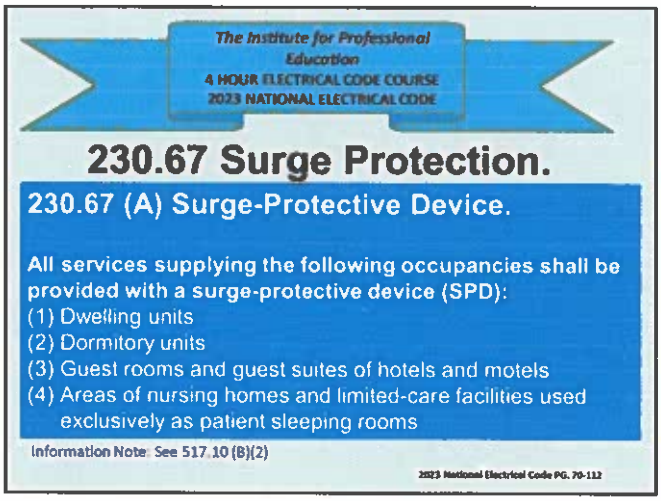
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2023 NATIONAL ELECTRICAL CODE
230.67 Surge Protection.
230.67 (A) Surge-Protective Device.
All services supplying the following occupancies shall be provided with a surge-protective device (SPD):
(1) Dwelling units
(2) Dormitory units
(3) Guest rooms and guest suites of hotels and motels
(4) Areas of nursing homes and limited-care facilities used exclusively as patient sleeping rooms
Information Note: See 517.10 (B)(2)

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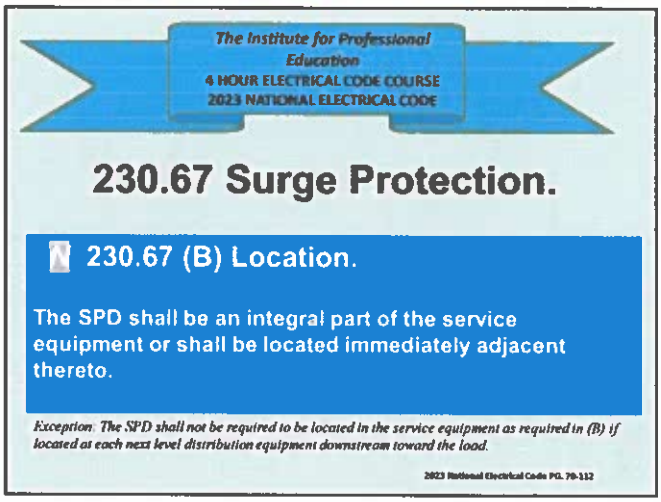
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230.67 Surge Protection.
230.67 (B) Location.
The SPD shall be an integral part of the service equipment or shall be located immediately adjacent thereto.
Exception: The SPD shall not be required to be located in the service equipment as required in (B) if located at each next level distribution equipment downstream toward the load.

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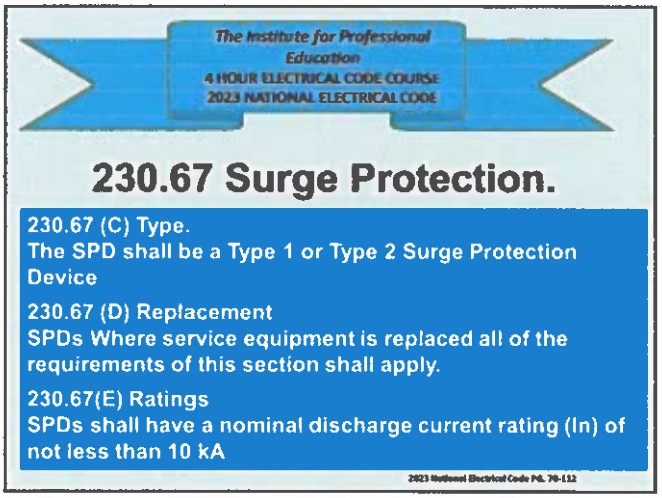
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230.67 Surge Protection.
230.67 (C) Type.
The SPD shall be a Type 1 or Type 2 Surge Protection Device
230.67 (D) Replacement
SPDs Where service equipment is replaced all of the requirements of this section shall apply.
230.67(E) Ratings
SPDs shall have a nominal discharge current rating (In) of not less than 10 kA

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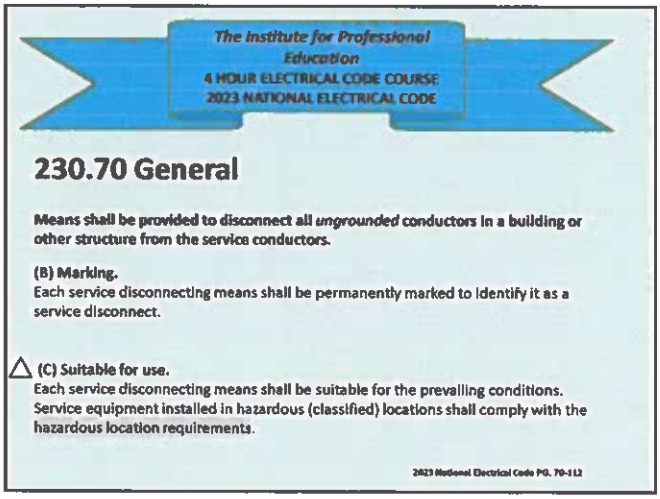
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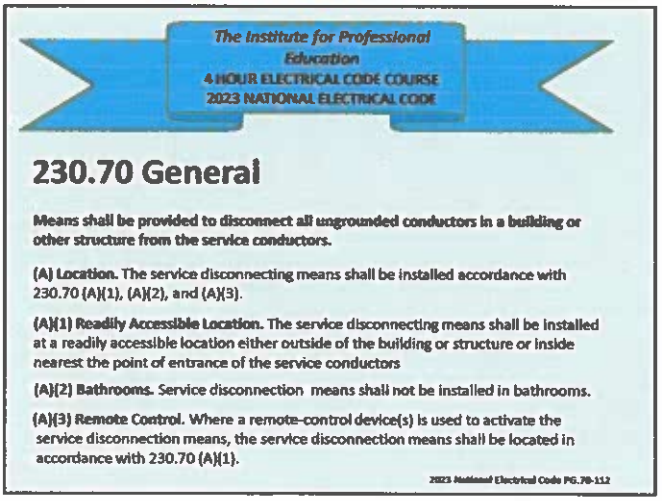
230.70 General
Means shall be provided to disconnect all ungrounded conductors in a building or other structure from the service conductors.
(B) Marking.
Each service disconnecting means shall be permanently marked to identify it as a service disconnect.
(C) Suitable for use.
Each service disconnecting means shall be suitable for the prevailing conditions. Service equipment installed in hazardous (classified) locations shall comply with the hazardous location requirements.

31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230.70 General
Means shall be provided to disconnect all ungrounded conductors in a building or other structure from the service conductors.
(A) Location. The service disconnecting means shall be installed accordance with 230.70 (A)(1), (A)(2), and (A)(3).
(A)(1) Readily Accessible Location. The service disconnecting means shall be installed at a readily accessible location either outside of the building or structure or inside nearest the point of entrance of the service conductors
(A)(2) Bathrooms. Service disconnection means shall not be installed in bathrooms.
(A)(3) Remote Control. Where a remote-control device(s) is used to activate the service disconnection means, the service disconnection means shall be located in accordance with 230.70 (A)(1).

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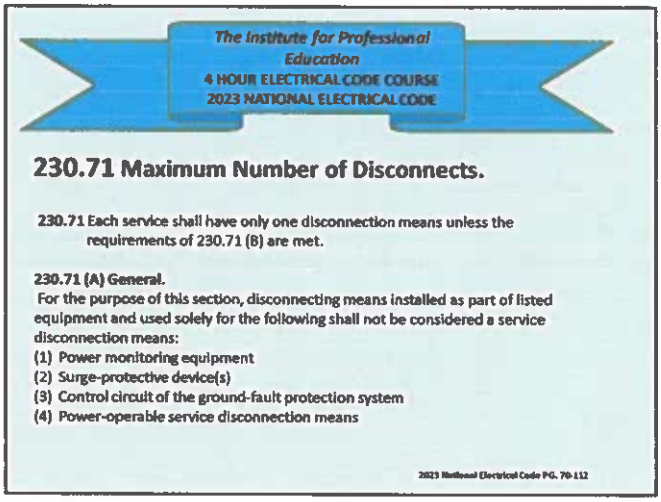
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2023 NATIONAL ELECTRICAL CODE
230.71 Maximum Number of Disconnects.
230.71 Each service shall have only one disconnection means unless the requirements of 230.71 (B) are met.
230.71 (A) General.
For the purpose of this section, disconnecting means installed as part of listed equipment and used solely for the following shall not be considered a service disconnection means:
(1) Power monitoring equipment
(2) Surge-protective device(s)
(3) Control circuit of the ground-fault protection system
(4) Power-operable service disconnection means

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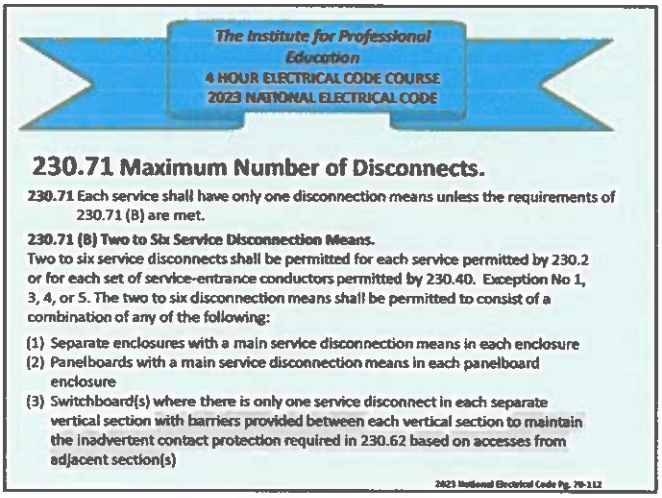
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4 HOUR ELECTRICAL CODE COURSE
2023 NATIONAL ELECTRICAL CODE
230.71 Maximum Number of Disconnects.
230.71 Each service shall have only one disconnection means unless the requirements of 230.71 (B) are met.
230.71 (B) Two to Six Service Disconnection Means.
Two to six service disconnects shall be permitted for each service permitted by 230.2 or for each set of service-entrance conductors permitted by 230.40. Exception No 1, 3, 4, or 5. The two to six disconnection means shall be permitted to consist of a combination of any of the following:
(1) Separate enclosures with a main service disconnection means in each enclosure
(2) Panelboards with a main service disconnection means in each panelboard enclosure
(3) Switchboard(s) where there is only one service disconnect in each separate vertical section with barriers provided between each vertical section to maintain the inadvertent contact protection required in 230.62 based on accesses from adjacent section(s)
2023 National Electrical Code Pg. 70-112

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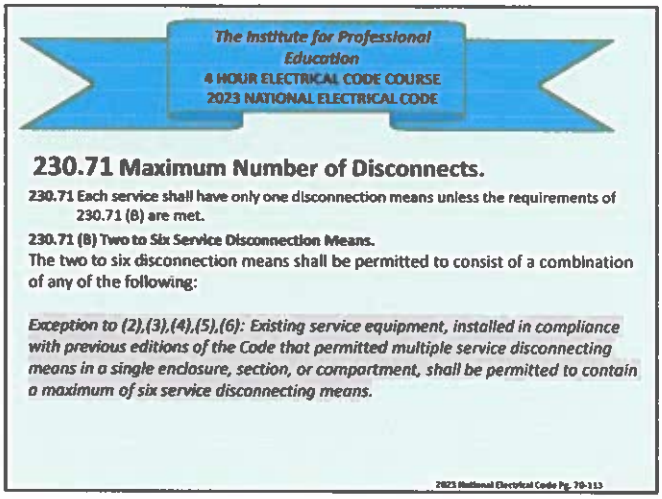
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4 HOUR ELECTRICAL CODE COURSE
2023 NATIONAL ELECTRICAL CODE
230.71 Maximum Number of Disconnects.
230.71 Each service shall have only one disconnection means unless the requirements of 230.71 (B) are met.
230.71 (B) Two to Six Service Disconnection Means.
The two to six disconnection means shall be permitted to consist of a combination of any of the following:
Exception to (2),(3),(4),(5),(6): Existing service equipment, installed in compliance with previous editions of the Code that permitted multiple service disconnecting means in a single enclosure, section, or compartment, shall be permitted to contain a maximum of six service disconnecting means.
2023 National Electrical Code Pg. 70-113

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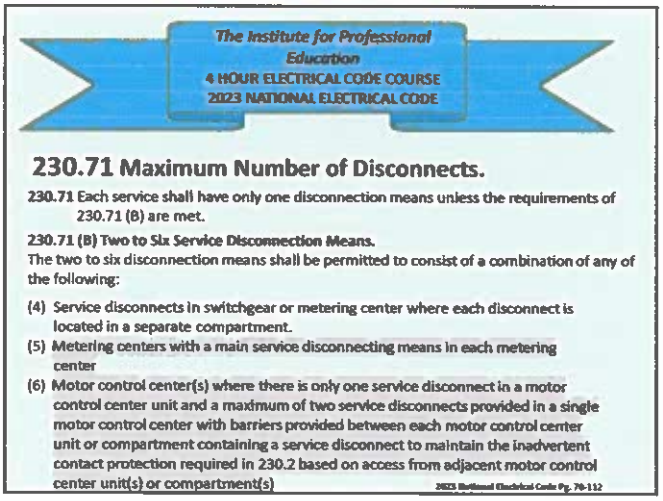
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4 HOUR ELECTRICAL CODE COURSE
2023 NATIONAL ELECTRICAL CODE
230.71 Maximum Number of Disconnects.
230.71 Each service shall have only one disconnection means unless the requirements of 230.71 (B) are met.
230.71 (B) Two to Six Service Disconnection Means.
The two to six disconnection means shall be permitted to consist of a combination of any of the following:
(4) Service disconnects in switchgear or metering center where each disconnect is located in a separate compartment.
(5) Metering centers with a main service disconnecting means in each metering center
(6) Motor control center(s) where there is only one service disconnect in a motor control center unit and a maximum of two service disconnects provided in a single motor control center with barriers provided between each motor control center unit or compartment containing a service disconnect to maintain the inadvertent contact protection required in 230.2 based on access from adjacent motor control center unit(s) or compartment(s)
2023 National Electrical Code Pg. 70-112

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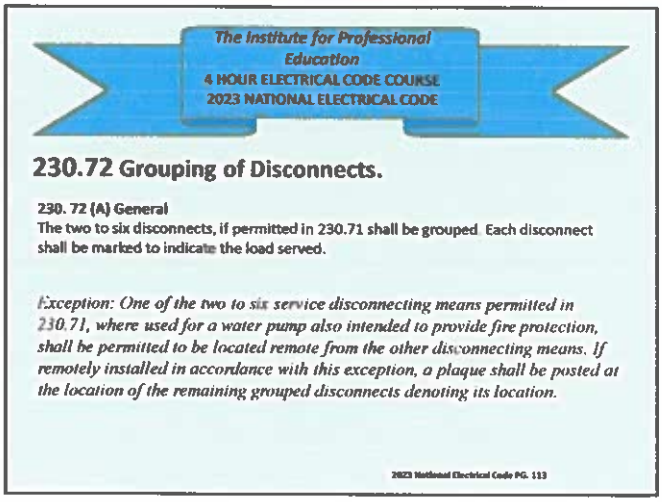
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2023 NATIONAL ELECTRICAL CODE
230.72 Grouping of Disconnects.
230. 72 (A) General
The two to six disconnects, if permitted in 230.71 shall be grouped. Each disconnect shall be marked to indicate the load served.
Exception: One of the two to six service disconnecting means permitted in 230.71, where used for a water pump also intended to provide fire protection, shall be permitted to be located remote from the other disconnecting means. If remotely installed in accordance with this exception, a plaque shall be posted at the location of the remaining grouped disconnects denoting its location.
2023 National Electrical Code PG. 113

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230.72 Grouping of Disconnects.

230. 72 (B) Additional Service Disconnecting Means

The one or more additional service disconnecting means for fire pumps, emergency systems, legally required standby, or optional standby services permitted in 230.2 shall be installed remote from the one to six service disconnection means for normal service to minimize the possibility of simultaneous interruption of supply.

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230.72 Grouping of Disconnects.

230. 72 (C) Access to Occupants.

In a multi-occupancy building, each occupant shall have access to the occupant's service disconnecting means.

Exception: In a multiple-occupancy building where electric service and electrical maintenance are provided by the building management and where these are under continuous building management supervision the service disconnecting means supplying more than one occupancy shall be permitted to be accessible to authorized management personnel only.

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△230.75 Disconnection of Grounded Conductor.

Where the service disconnection means does not disconnect the grounded conductor from the premises wiring, other means shall be provided for this purpose in the service equipment. A terminal or bus to which all grounded conductors can be attached by means of a pressure connector shall be permitted for this purpose. In a multisection switchboard or switchgear, disconnects for the grounded conductor shall be permitted to be in any section of the switchboard or switchgear, if the switchboard or switchgear section is marked to indicate a grounded conductor disconnect is located within.

Informational Note:
In switchgear or multisection switchboards, the disconnection means provided for the grounded conductor is typically identified as a neutral disconnect link and is typically located in the bus to which the service grounded conductor is connected.

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230.79 Rating of Service Disconnecting Means.

The service disconnecting means shall have a rating not less than the calculated load to be carried, determined in accordance with Part III, IV, or V of Article 220, as applicable. In no case shall the rating be lower than specified in 230.79 (A),(B),(C), or (D)

230.79(A) One-Circuit Installations.
For installation of supply only limited loads of a single branch circuit, the service disconnecting means shall have a rating of not less than 15 amperes

230.79(B) Two-Circuit Installations.
For installations consisting of not more than two 2-wire branch circuits, the service disconnecting means shall have a rating of not less than 30 amperes

230.79(C) One-Family Dwellings.
For a one-family dwelling, the service disconnecting means shall have a rating of not less than 100 amperes.

230.79(D) All others.
For all other installations, the service disconnecting means shall have a rating of not less the 60 amperes

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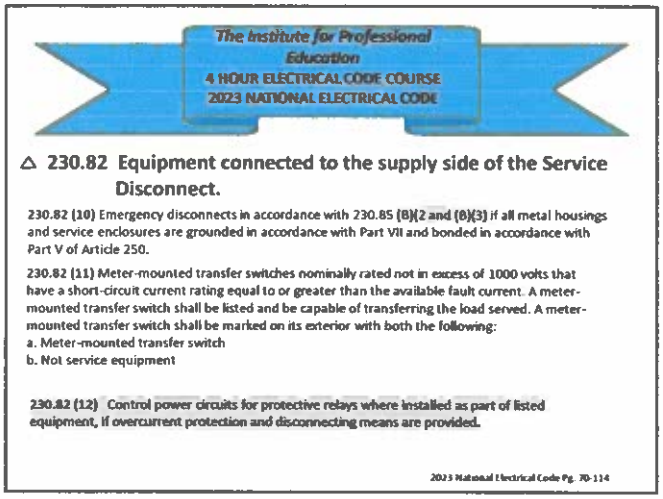
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△ 230.82 Equipment connected to the supply side of the Service Disconnect.
230.82 (10) Emergency disconnects in accordance with 230.85 (B)(2 and (B)(3) if all metal housings and service enclosures are grounded in accordance with Part VII and bonded in accordance with Part V of Article 250.
230.82 (11) Meter-mounted transfer switches nominally rated not in excess of 1000 volts that have a short-circuit current rating equal to or greater than the available fault current. A meter-mounted transfer switch shall be listed and be capable of transferring the load served. A meter-mounted transfer switch shall be marked on its exterior with both the following:
a. Meter-mounted transfer switch
b. Not service equipment
230.82 (12) Control power circuits for protective relays where installed as part of listed equipment, if overcurrent protection and disconnecting means are provided.
2023 National Electrical Code Pg. 70-114

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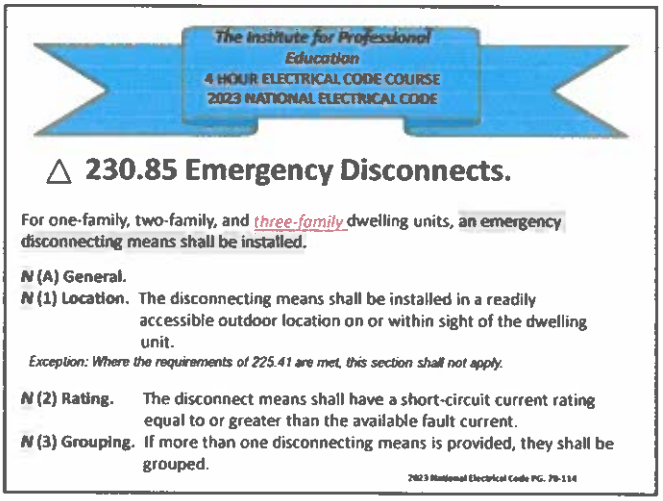
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△ 230.85 Emergency Disconnects.
For one-family, two-family, and three-family dwelling units, an emergency disconnecting means shall be installed.
N (A) General.
N (1) Location. The disconnecting means shall be installed in a readily accessible outdoor location on or within sight of the dwelling unit.
Exception: Where the requirements of 225.41 are met, this section shall not apply.
N (2) Rating. The disconnect means shall have a short-circuit current rating equal to or greater than the available fault current.
N (3) Grouping. If more than one disconnecting means is provided, they shall be grouped.
2023 National Electrical Code PG. 70-114

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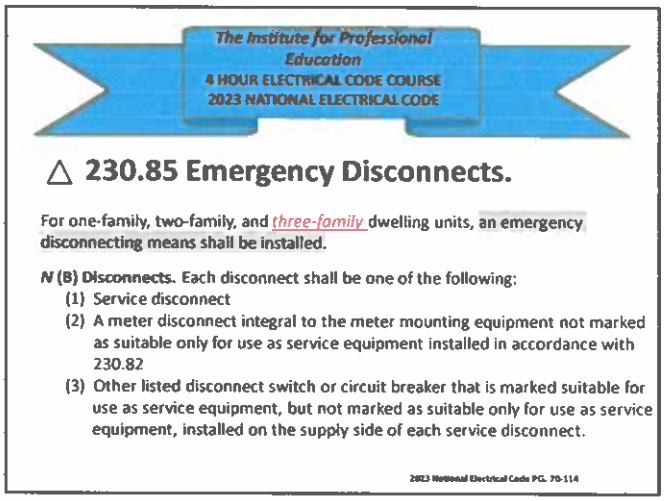
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4 HOUR ELECTRICAL CODE COURSE
2023 NATIONAL ELECTRICAL CODE
△ 230.85 Emergency Disconnects.
For one-family, two-family, and three-family dwelling units, an emergency disconnecting means shall be installed.
N (B) Disconnects. Each disconnect shall be one of the following:
(1) Service disconnect
(2) A meter disconnect integral to the meter mounting equipment not marked as suitable only for use as service equipment installed in accordance with 230.82
(3) Other listed disconnect switch or circuit breaker that is marked suitable for use as service equipment, but not marked as suitable only for use as service equipment, installed on the supply side of each service disconnect.
2023 National Electrical Code PG. 70-114

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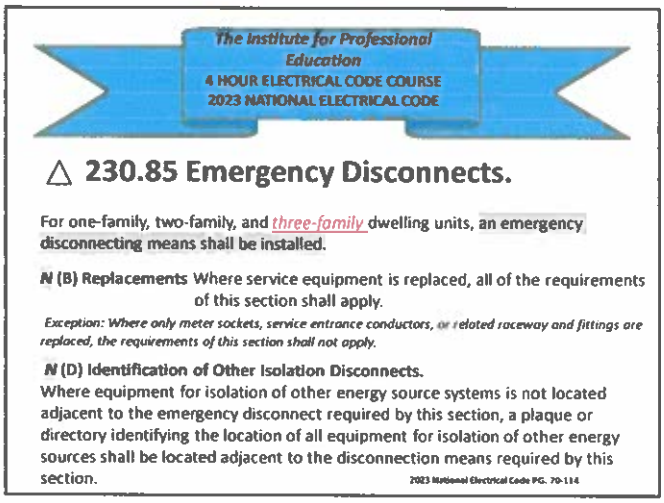
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△ 230.85 Emergency Disconnects.
For one-family, two-family, and three-family dwelling units, an emergency disconnecting means shall be installed.
N (B) Replacements Where service equipment is replaced, all of the requirements of this section shall apply.
Exception: Where only meter sockets, service entrance conductors, or related raceway and fittings are replaced, the requirements of this section shall not apply.
N (D) Identification of Other Isolation Disconnects.
Where equipment for isolation of other energy source systems is not located adjacent to the emergency disconnect required by this section, a plaque or directory identifying the location of all equipment for isolation of other energy sources shall be located adjacent to the disconnection means required by this section.
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△ 230.85 Emergency Disconnects.

For one-family, two-family, and three-family dwelling units, an emergency disconnecting means shall be installed.

***N* (E) Marking**
N* (1) *Marking Text. The disconnecting means shall be marked as follows:
(1) Service Disconnect. **EMERGENCY DISCONNECT, SERVICE DISCONNECT**
(2) Meter disconnects installed in accordance with 230.82(3) and marked as follows: **EMERGENCY DISCONNECT, METER DISCONNECT NOT SERVICE EQUIPMENT**
(3) Other listed disconnect switches or circuit breakers on the supply side of each service disconnect that are marked suitable for use as service equipment and marked as follows:
EMERGENCY DISCONNECT, NOT SERVICE EQUIPMENT

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△ 230.85 Emergency Disconnects.

For one-family, two-family, and three-family dwelling units, an emergency disconnecting means shall be installed.

***N* (E) Marking**
N* (2) *Marking Location and Size.

Markings shall comply with 110.21(B) and both of the following:

(1) The marking or labels shall be located on the outside front of the disconnect enclosure with red background and white text.
(2) The letter shall be at least 13mm (1/2 in.) high.

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230.91 Location.

The service overcurrent device shall be an integral part of the service disconnection means or shall be located immediately adjacent thereto. Where fuses are used as the service overcurrent device, the disconnecting means shall be located ahead of the supply side of the Fuses.

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230.92 Locked Service Overcurrent Devices.

Where the service overcurrent devices are locked or sealed or are not readily accessible to the occupant, branch-circuit or feeder overcurrent devices shall be installed on the load side, shall be mounted in a readily accessible location, and shall be of lower ampere rating than the service overcurrent device.

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230.95 Ground-Fault Protection of Equipment.

230.95 (C) Performance Testing.

The ground-fault protection system shall be performance tested when first installed onsite. This testing shall be conducted by a qualified person(s) using a test process of primary current injection, in accordance with instructions that shall be provided with the equipment. A written record of this testing shall be made and shall be available to the authority having jurisdiction.

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N 240.2 Reconditioned Equipment.

N 240.2(A) Reconditioning Not Permitted The following equipment shall not be reconditioned:
(1) Equipment providing ground-fault protection of equipment
(2) Ground-fault circuit interrupters
(3) Low-voltage fuse holders and low-voltage nonrenewable fusses
(4) Molded-case circuit breakers
(5) Low-voltage power circuit breakers electronic trip units

N 240.2 (B) Reconditioning Permitted. The following equipment shall be permitted to be reconditioned
(1) Low-voltage power circuit breakers
(2) Electromechanical protective relays and current transformers
Reconditioned equipment shall be listed as reconditioned and comply with 110.21(A)(2).

2023 National Electrical Code Pg.70-122

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240.4 Protection of Conductors

240.4 (D) Small Conductors

Unless specifically permitted in 240.4(E) or (G), the overcurrent protection shall not exceed that required by 240.4 (D)(1) through (D)(8) after any correction factors for ambient temperature and number of conductors have been applied.

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240.4 Protection of Conductors

N 240.4 (D)(3) 14 AWG Copper-Clad-Aluminum

10 amperes, provided all of the following conditions are met:
(1) Continuous loads do not exceed 8 amperes
(2) Overcurrent protection is provided by one of the following :

a. Branch-circuit breakers are listed and marked for use with 14 AWG copper-clad aluminum conductor.
b. Branch-circuit-rated fuses are listed and marked for use with 14 AWG copper-clad aluminum conductor.

2023 National Electrical Code Pg.70-123

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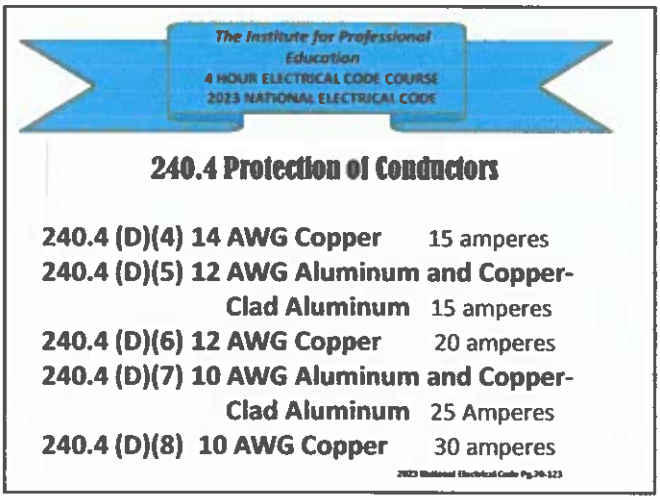
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2023 NATIONAL ELECTRICAL CODE
240.4 Protection of Conductors
240.4 (D)(4) 14 AWG Copper 15 amperes
240.4 (D)(5) 12 AWG Aluminum and Copper-Clad Aluminum 15 amperes
240.4 (D)(6) 12 AWG Copper 20 amperes
240.4 (D)(7) 10 AWG Aluminum and Copper-Clad Aluminum 25 Amperes
240.4 (D)(8) 10 AWG Copper 30 amperes

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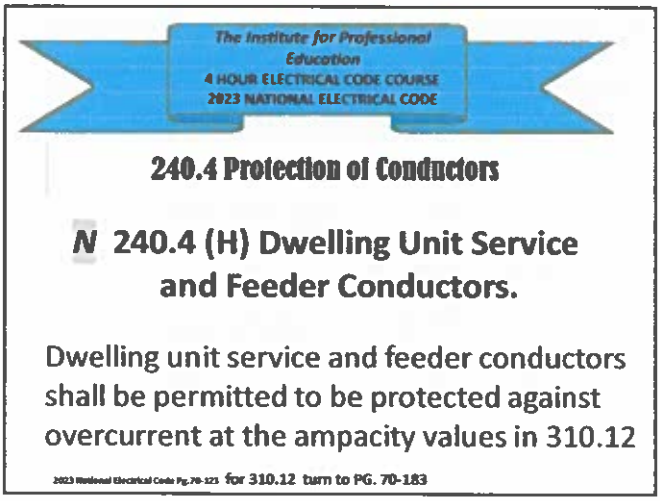
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2023 NATIONAL ELECTRICAL CODE
240.4 Protection of Conductors
N 240.4 (H) Dwelling Unit Service and Feeder Conductors.
Dwelling unit service and feeder conductors shall be permitted to be protected against overcurrent at the ampacity values in 310.12
for 310.12 turn to PG. 70-183

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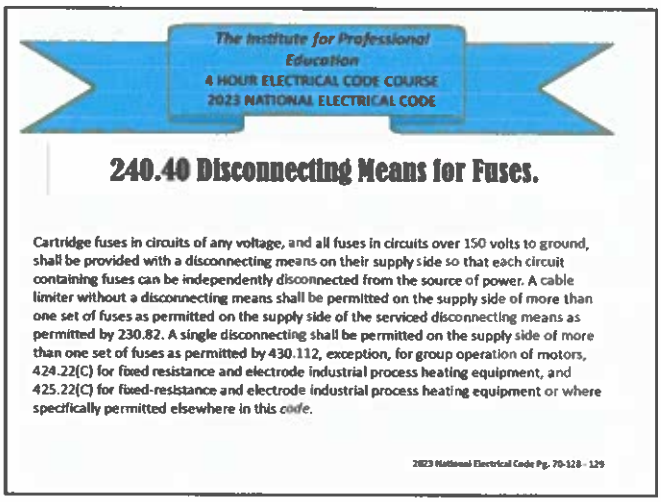
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240.40 Disconnecting Means for Fuses.
Cartridge fuses in circuits of any voltage, and all fuses in circuits over 150 volts to ground, shall be provided with a disconnecting means on their supply side so that each circuit containing fuses can be independently disconnected from the source of power. A cable limiter without a disconnecting means shall be permitted on the supply side of more than one set of fuses as permitted on the supply side of the serviced disconnecting means as permitted by 230.82. A single disconnecting shall be permitted on the supply side of more than one set of fuses as permitted by 430.112, exception, for group operation of motors, 424.22(C) for fixed resistance and electrode industrial process heating equipment, and 425.22(C) for fixed-resistance and electrode industrial process heating equipment or where specifically permitted elsewhere in this code.

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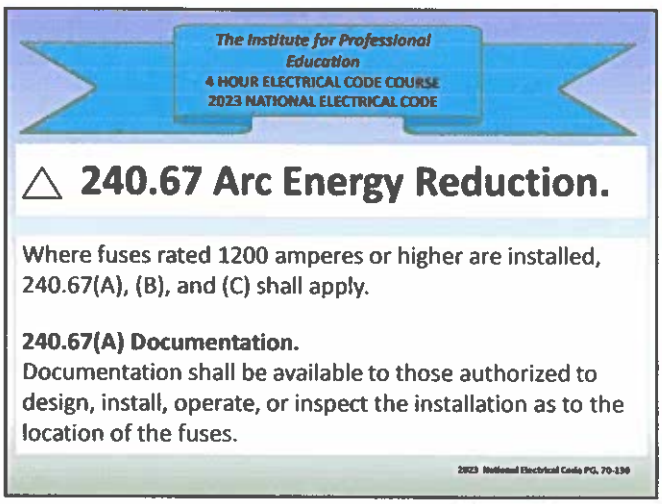
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△ 240.67 Arc Energy Reduction.
Where fuses rated 1200 amperes or higher are installed, 240.67(A), (B), and (C) shall apply.
240.67(A) Documentation.
Documentation shall be available to those authorized to design, install, operate, or inspect the installation as to the location of the fuses.

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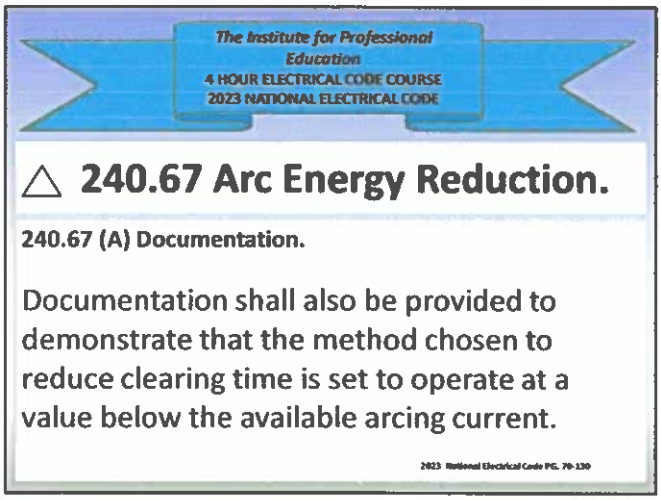
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△ 240.67 Arc Energy Reduction.
240.67 (A) Documentation.
Documentation shall also be provided to demonstrate that the method chosen to reduce clearing time is set to operate at a value below the available arcing current.

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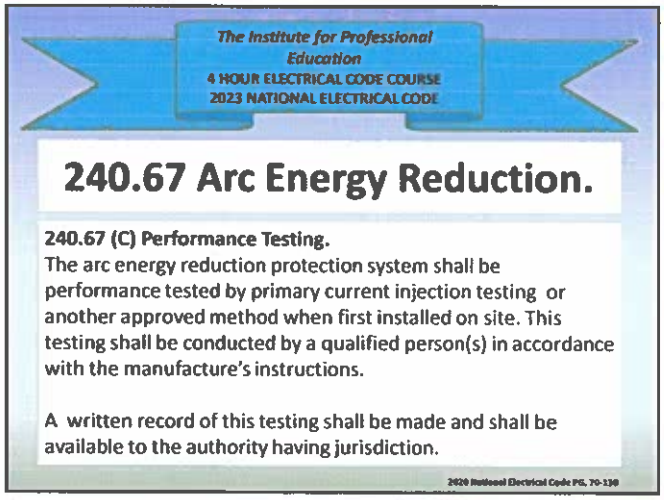
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4 HOUR ELECTRICAL CODE COURSE
2023 NATIONAL ELECTRICAL CODE
240.67 Arc Energy Reduction.
240.67 (C) Performance Testing.
The arc energy reduction protection system shall be performance tested by primary current injection testing or another approved method when first installed on site. This testing shall be conducted by a qualified person(s) in accordance with the manufacture's instructions.
A written record of this testing shall be made and shall be available to the authority having jurisdiction.

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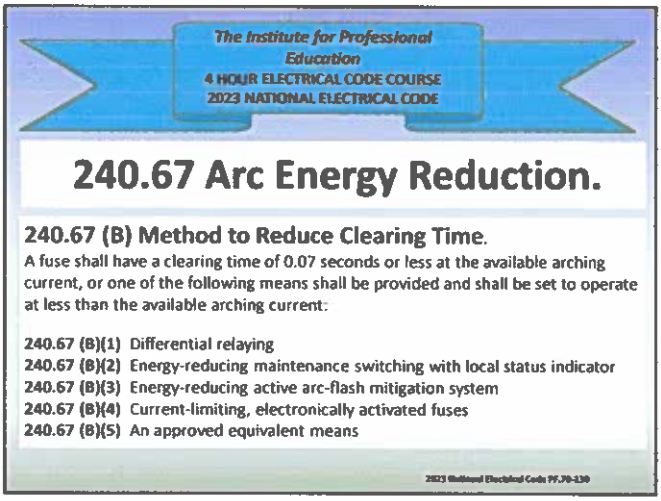
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2023 NATIONAL ELECTRICAL CODE
240.67 Arc Energy Reduction.
240.67 (B) Method to Reduce Clearing Time.
A fuse shall have a clearing time of 0.07 seconds or less at the available arching current, or one of the following means shall be provided and shall be set to operate at less than the available arching current:
240.67 (B)(1) Differential relaying
240.67 (B)(2) Energy-reducing maintenance switching with local status indicator
240.67 (B)(3) Energy-reducing active arc-flash mitigation system
240.67 (B)(4) Current-limiting, electronically activated fuses
240.67 (B)(5) An approved equivalent means

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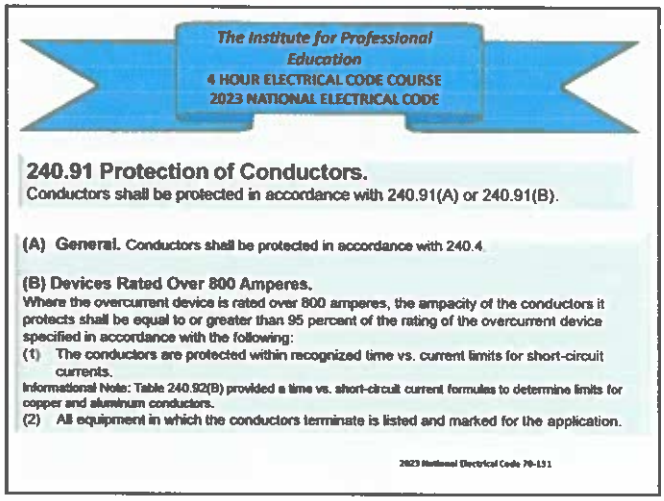
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240.91 Protection of Conductors.
Conductors shall be protected in accordance with 240.91(A) or 240.91(B).
(A) General. Conductors shall be protected in accordance with 240.4.
(B) Devices Rated Over 800 Amperes.
Where the overcurrent device is rated over 800 amperes, the ampacity of the conductors it protects shall be equal to or greater than 95 percent of the rating of the overcurrent device specified in accordance with the following:
(1) The conductors are protected within recognized time vs. current limits for short-circuit currents.
Informational Note: Table 240.92(B) provided a time vs. short-circuit current formulas to determine limits for copper and aluminum conductors.
(2) All equipment in which the conductors terminate is listed and marked for the application.

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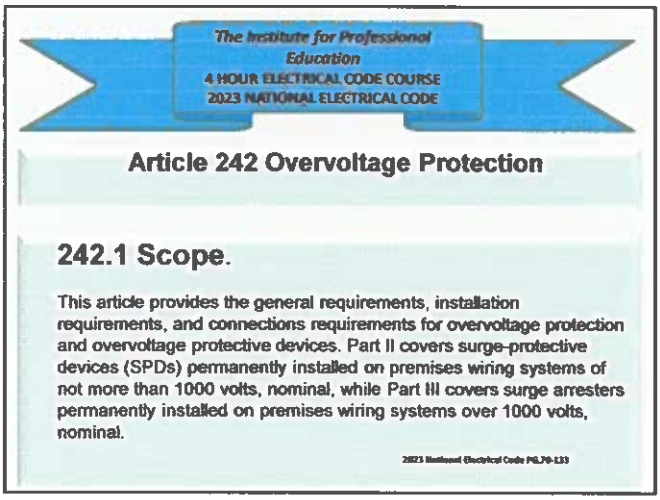
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Article 242 Overvoltage Protection
242.1 Scope.
This article provides the general requirements, installation requirements, and connections requirements for overvoltage protection and overvoltage protective devices. Part II covers surge-protective devices (SPDs) permanently installed on premises wiring systems of not more than 1000 volts, nominal, while Part III covers surge arresters permanently installed on premises wiring systems over 1000 volts, nominal.

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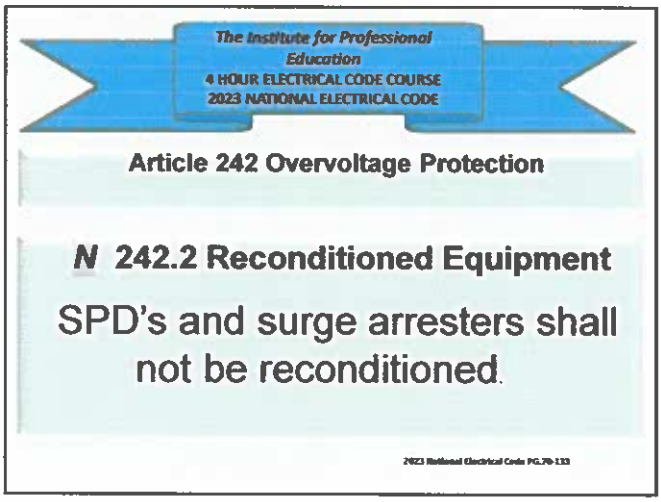
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Article 242 Overvoltage Protection
N 242.2 Reconditioned Equipment
SPD's and surge arresters shall not be reconditioned.

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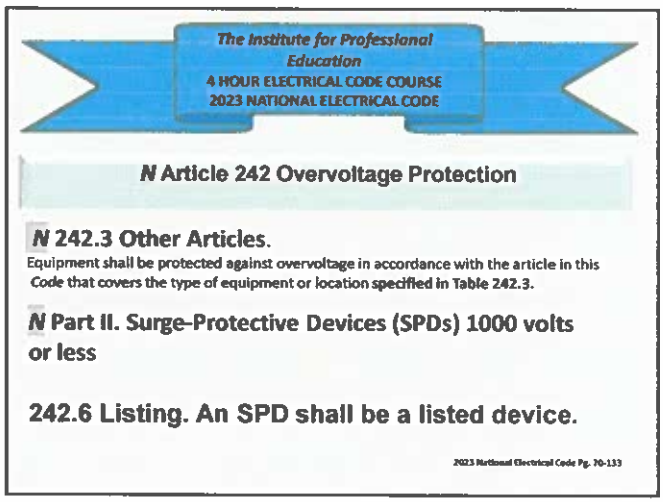
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N Article 242 Overvoltage Protection
N 242.3 Other Articles.
Equipment shall be protected against overvoltage in accordance with the article in this Code that covers the type of equipment or location specified in Table 242.3.
N Part II. Surge-Protective Devices (SPDs) 1000 volts or less
242.6 Listing. An SPD shall be a listed device.

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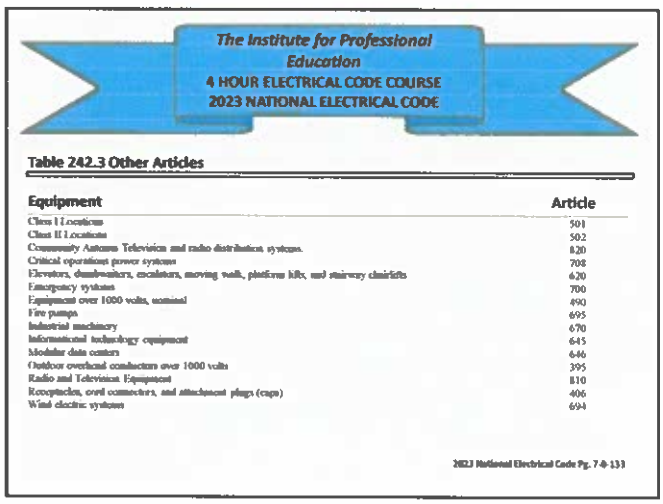
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2023 NATIONAL ELECTRICAL CODE
Table 242.3 Other Articles
Equipment
Article
Class I Locations 501
Class II Locations 502
Community Antenna Television and radio distribution systems. 820
Critical operations power systems 708
Elevators, dumbwaiters, escalators, moving walk, platform lifts, and stairway chairlifts 620
Emergency systems 700
Equipment over 1000 volts, nominal 490
Fire pumps 695
Industrial machinery 670
Informational technology equipment 645
Modular data centers 646
Outdoor overhead conductors over 1000 volts 395
Radio and Television Equipment 810
Receptacles, cord connectors, and attachment plugs (caps) 406
Wind electric systems 694

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N Article 242 Overvoltage Protection

N 242.8 Listing.
An SPD device shall be a listed device.

N 242.10 Short Circuit-Rating.
The SPD shall be marked with a short-circuit Current Rating and shall not be installed at a point on the system where the available fault current is in excess of that rating. This marking requirement shall not apply to receptacles.

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Article 242 Overvoltage Protection

N 242.12 Uses not permitted.
An SPD device shall not be installed in the following:

(1) Circuits over 1000 volts
(2) On ungrounded systems, impedance grounded systems, or corner grounded delta systems unless listed specifically for use on these systems
(3) Where the rating of the SPD is less than the maximum continuous phase-to-ground voltage at the power frequency available at the point of application

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Article 242 Overvoltage Protection

242.13 Type I SPDs.
Type I SPDs shall be installed in accordance with 242.13 (A) and (B).

242.13 (A) Installation.
Type I SPDs shall be permitted to be connected in accordance with one of the following:
(1) In the supply side of the service disconnect as permitted in 230.82(4)
(2) As specified in 242.14

242.13 (B) At the Service.
When installed at services, Type I SPDs shall be connected to one of the following:
(1) Grounded service conductor
(2) Grounding electrode conductor
(3) Grounding electrode for the service
(4) Equipment grounding terminal in the service equipment

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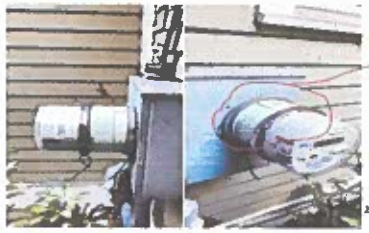
Article 242 Overvoltage Protection

N 242.13 Type I SPDs. Type I SPDs shall be installed in accordance with 242.13 (A) and (B)



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Article 242 Overvoltage Protection

242.13 Type I SPDs. Type I SPDs shall be installed in accordance with 242.13 (A) and (B)

Meter Socket Type One Surge Protector

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Article 242 Overvoltage Protection

242.13 Type I SPDs. Type I SPDs shall be installed in accordance with 242.13 (A) and (B)

Breaker Style Type One Device

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Article 242 Overvoltage Protection

242.14 Type 2 SPDs.
Type 2 SPDs shall be installed in accordance with 242.14 (A) through (C).

242.14 (A) Service-Supplied Building or Structure.
Type 2 SPDs shall be connected anywhere on the load side of a service disconnect overcurrent device required in 230.91 unless installed in accordance with 230.82(8).

242.14 (B) Feeder-Supplied Building or Structure.
Type 2 SPDs shall be connected at the building or structure anywhere on the load side of the first overcurrent device at the building or structure.

242.14 (C) Separately Derived System.
The SPD shall be connected on the load side of the first overcurrent device in a separately derived system.

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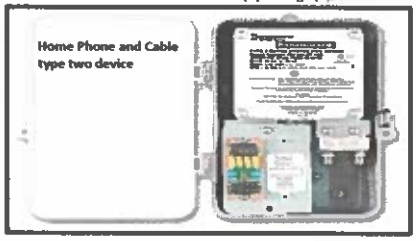
Article 242 Overvoltage Protection

242.14 Type 2 SPDs.
Type 2 SPDs shall be accordance with 242.14 (A) through (C).



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Article 242 Overvoltage Protection

242.14 Type 2 SPDs.

Type 2 SPDs shall be in accordance with 242.14 (A) through (C).

Whole house Type two device

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Article 242 Overvoltage Protection

242.16 Type 3 SPDs.

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Article 242 Overvoltage Protection

242.16 Type 3 SPDs.

Type 3 SPDs shall be permitted to be installed on the load side of branch circuit overcurrent protection up to the equipment served. If included in the manufacturer's instructions, the Type 3 SPD connection shall be a minimum 10m (30ft) of conductor distance from the service or separately derived system disconnect.

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Article 242 Overvoltage Protection

242.18 Type 4 and Other Component Type SPDs.

Type 4 component assemblies and other component type SPSs shall only be installed by the equipment manufacturer.

242.20 Number Required

Where used at a point on a circuit, the SPD shall be connected to each ungrounded conductor.

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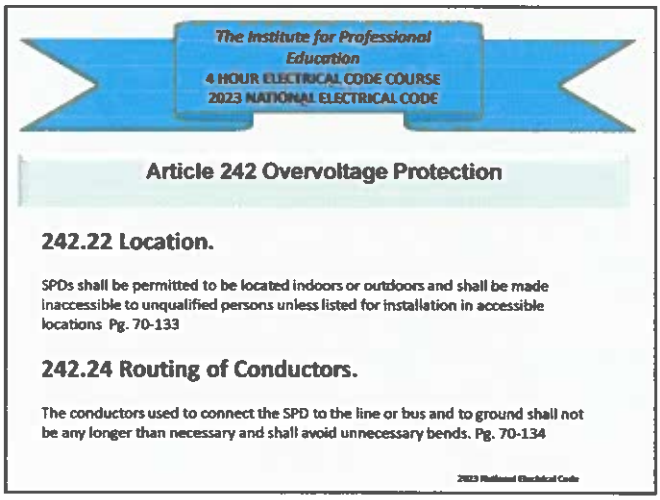
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Article 242 Overvoltage Protection
242.22 Location.
SPDs shall be permitted to be located indoors or outdoors and shall be made inaccessible to unqualified persons unless listed for installation in accessible locations Pg. 70-133
242.24 Routing of Conductors.
The conductors used to connect the SPD to the line or bus and to ground shall not be any longer than necessary and shall avoid unnecessary bends. Pg. 70-134

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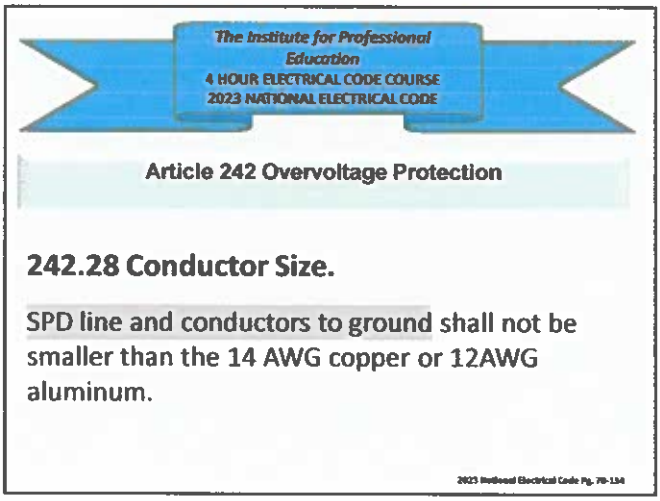
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Article 242 Overvoltage Protection
242.28 Conductor Size.
SPD line and conductors to ground shall not be smaller than the 14 AWG copper or 12AWG aluminum.

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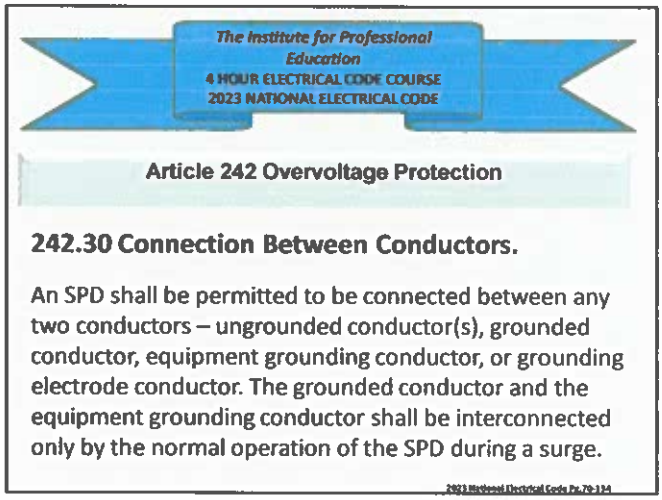
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Article 242 Overvoltage Protection
242.30 Connection Between Conductors.
An SPD shall be permitted to be connected between any two conductors – ungrounded conductor(s), grounded conductor, equipment grounding conductor, or grounding electrode conductor. The grounded conductor and the equipment grounding conductor shall be interconnected only by the normal operation of the SPD during a surge.

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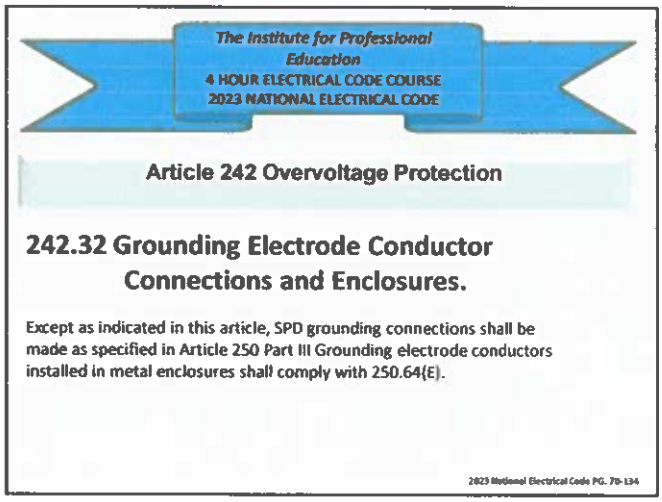
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Article 242 Overvoltage Protection
242.32 Grounding Electrode Conductor Connections and Enclosures.
Except as indicated in this article, SPD grounding connections shall be made as specified in Article 250 Part III Grounding electrode conductors installed in metal enclosures shall comply with 250.64(E).

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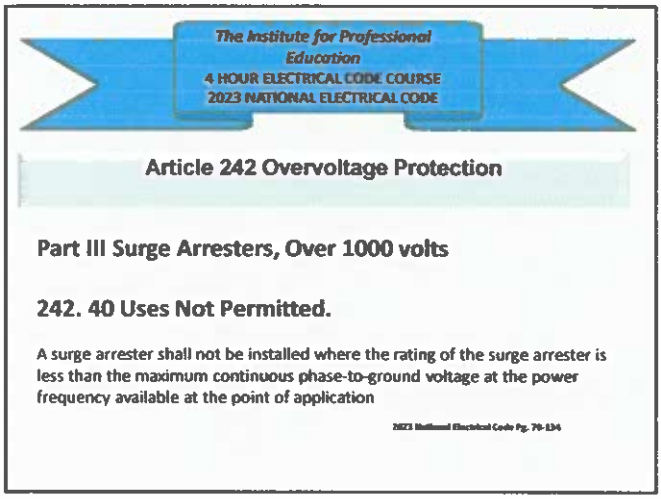
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Article 242 Overvoltage Protection
Part III Surge Arresters, Over 1000 volts
242. 40 Uses Not Permitted.
A surge arrester shall not be installed where the rating of the surge arrester is less than the maximum continuous phase-to-ground voltage at the power frequency available at the point of application
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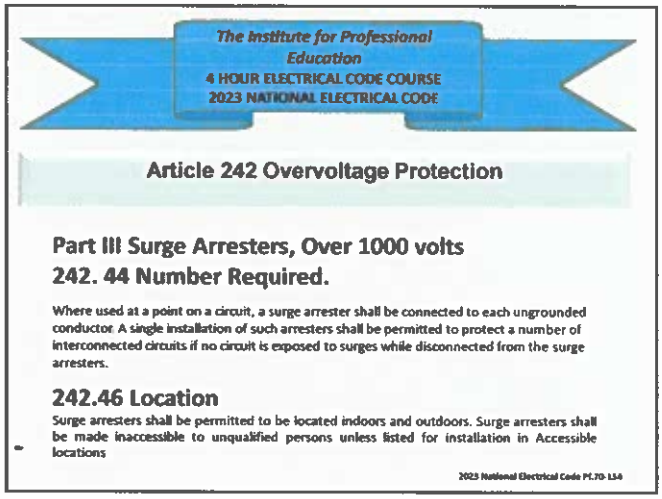
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Article 242 Overvoltage Protection
Part III Surge Arresters, Over 1000 volts
242. 44 Number Required.
Where used at a point on a circuit, a surge arrester shall be connected to each ungrounded conductor. A single installation of such arresters shall be permitted to protect a number of interconnected circuits if no circuit is exposed to surges while disconnected from the surge arresters.
242.46 Location
Surge arresters shall be permitted to be located indoors and outdoors. Surge arresters shall be made inaccessible to unqualified persons unless listed for installation in Accessible locations
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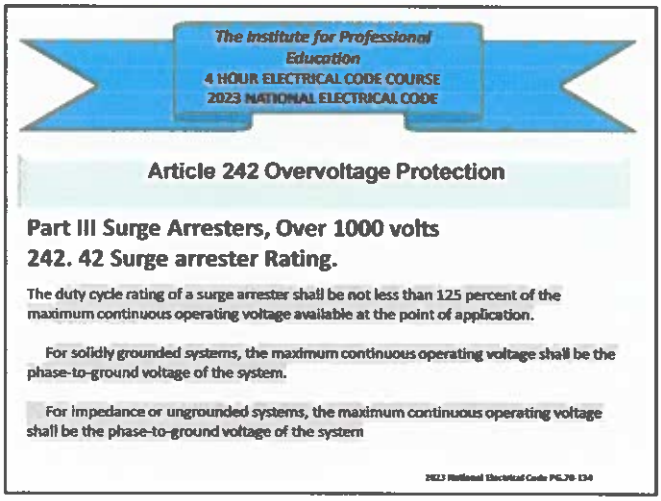
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Article 242 Overvoltage Protection
Part III Surge Arresters, Over 1000 volts
242. 42 Surge arrester Rating.
The duty cycle rating of a surge arrester shall be not less than 125 percent of the maximum continuous operating voltage available at the point of application.
For solidly grounded systems, the maximum continuous operating voltage shall be the phase-to-ground voltage of the system.
For impedance or ungrounded systems, the maximum continuous operating voltage shall be the phase-to-ground voltage of the system
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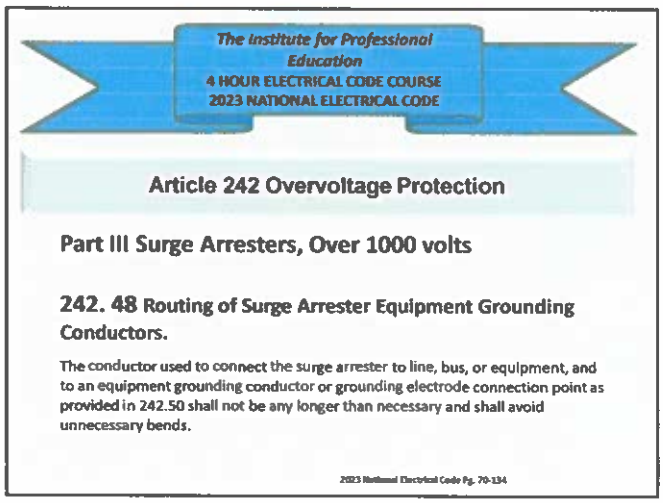
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Article 242 Overvoltage Protection
Part III Surge Arresters, Over 1000 volts
242. 48 Routing of Surge Arrester Equipment Grounding Conductors.
The conductor used to connect the surge arrester to line, bus, or equipment, and to an equipment grounding conductor or grounding electrode connection point as provided in 242.50 shall not be any longer than necessary and shall avoid unnecessary bends.
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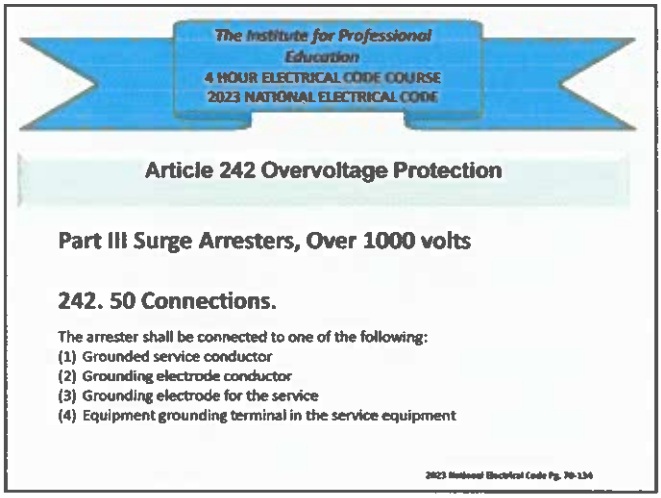
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Article 242 Overvoltage Protection
Part III Surge Arresters, Over 1000 volts
242. 50 Connections.
The arrester shall be connected to one of the following:
(1) Grounded service conductor
(2) Grounding electrode conductor
(3) Grounding electrode for the service
(4) Equipment grounding terminal in the service equipment

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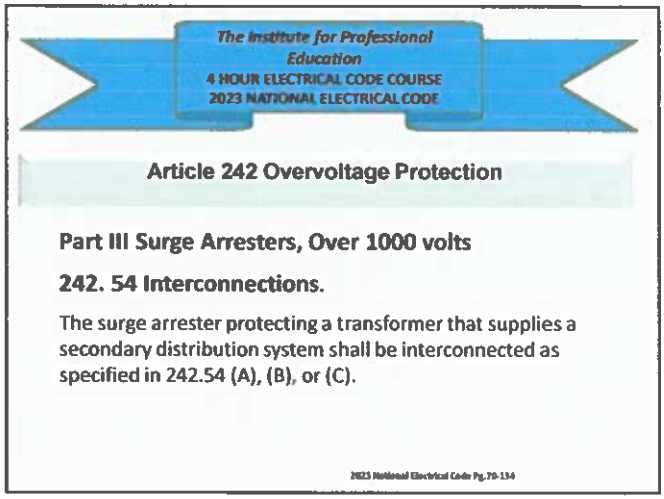
The Institute for Professional Education
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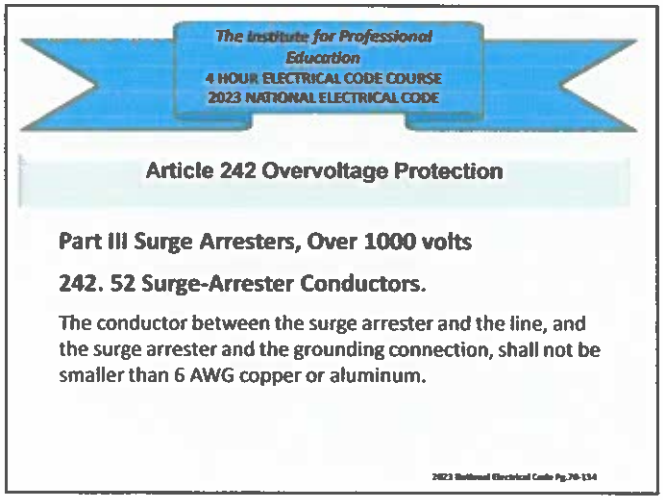
2023 NATIONAL ELECTRICAL CODE
Article 242 Overvoltage Protection
Part III Surge Arresters, Over 1000 volts
242. 54 Interconnections.
The surge arrester protecting a transformer that supplies a secondary distribution system shall be interconnected as specified in 242.54 (A), (B), or (C).

87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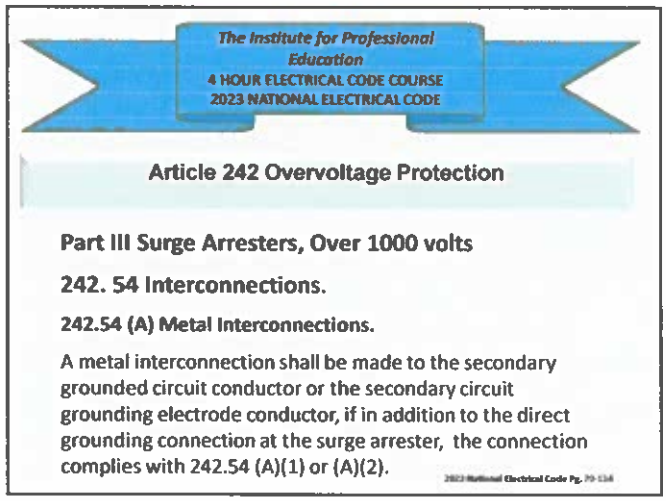
Article 242 Overvoltage Protection
Part III Surge Arresters, Over 1000 volts
242. 52 Surge-Arrester Conductors.
The conductor between the surge arrester and the line, and the surge arrester and the grounding connection, shall not be smaller than 6 AWG copper or aluminum.

86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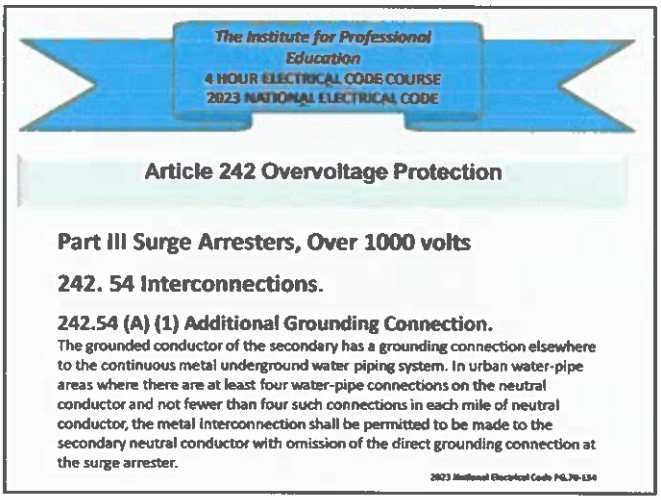
Part III Surge Arresters, Over 1000 volts
242. 54 Interconnections.
242.54 (A) Metal Interconnections.
A metal interconnection shall be made to the secondary grounded circuit conductor or the secondary circuit grounding electrode conductor, if in addition to the direct grounding connection at the surge arrester, the connection complies with 242.54 (A)(1) or (A)(2).

88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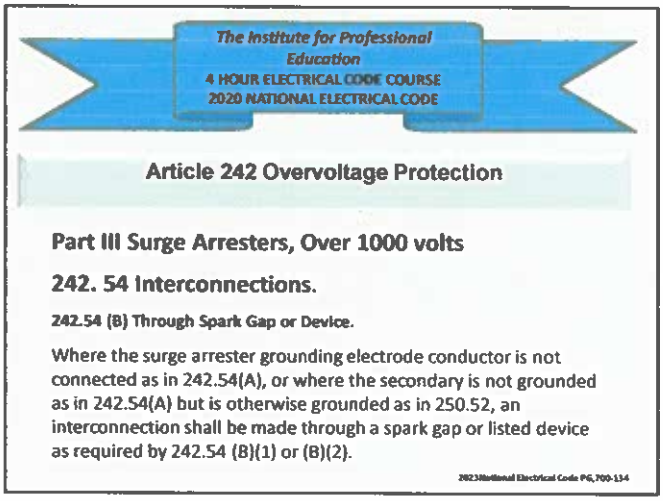
Article 242 Overvoltage Protection
Part III Surge Arresters, Over 1000 volts
242. 54 Interconnections.
242.54 (A) (1) Additional Grounding Connection.
The grounded conductor of the secondary has a grounding connection elsewhere to the continuous metal underground water piping system. In urban water-pipe areas where there are at least four water-pipe connections on the neutral conductor and not fewer than four such connections in each mile of neutral conductor, the metal interconnection shall be permitted to be made to the secondary neutral conductor with omission of the direct grounding connection at the surge arrester.

89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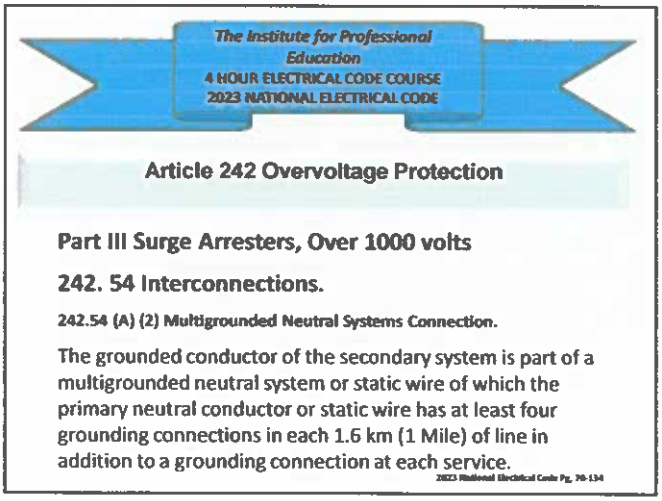
Article 242 Overvoltage Protection
Part III Surge Arresters, Over 1000 volts
242. 54 Interconnections.
242.54 (B) Through Spark Gap or Device.
Where the surge arrester grounding electrode conductor is not connected as in 242.54(A), or where the secondary is not grounded as in 242.54(A) but is otherwise grounded as in 250.52, an interconnection shall be made through a spark gap or listed device as required by 242.54 (B)(1) or (B)(2).

91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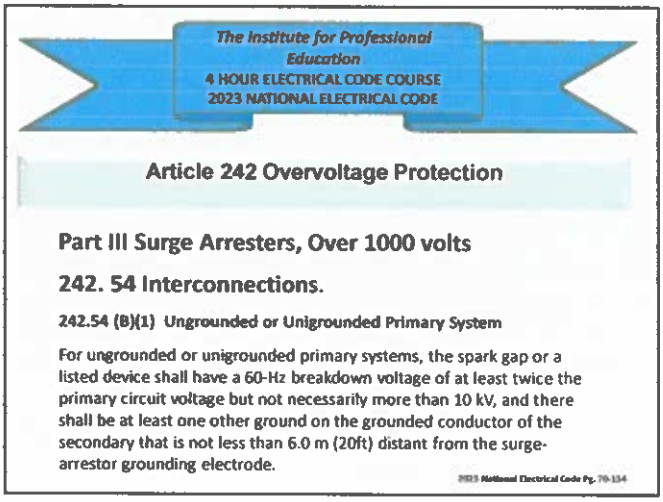
Part III Surge Arresters, Over 1000 volts
242. 54 Interconnections.
242.54 (A) (2) Multigrounded Neutral Systems Connection.
The grounded conductor of the secondary system is part of a multigrounded neutral system or static wire of which the primary neutral conductor or static wire has at least four grounding connections in each 1.6 km (1 Mile) of line in addition to a grounding connection at each service.

90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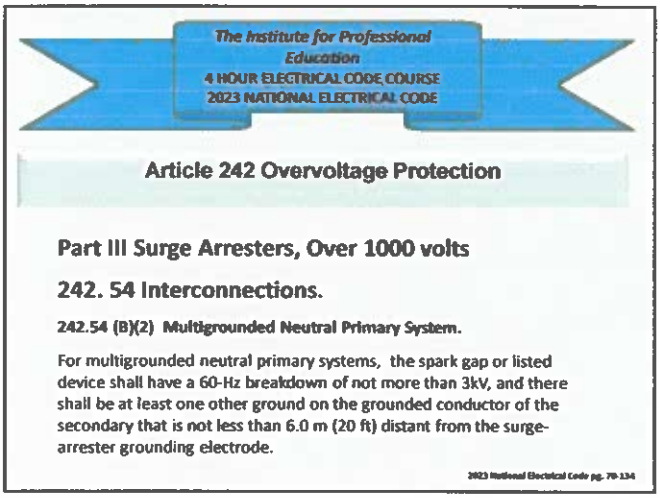
Article 242 Overvoltage Protection
Part III Surge Arresters, Over 1000 volts
242. 54 Interconnections.
242.54 (B)(1) Ungrounded or Unigrounded Primary System
For ungrounded or unigrounded primary systems, the spark gap or a listed device shall have a 60-Hz breakdown voltage of at least twice the primary circuit voltage but not necessarily more than 10 kV, and there shall be at least one other ground on the grounded conductor of the secondary that is not less than 6.0 m (20ft) distant from the surge-arrestor grounding electrode.

92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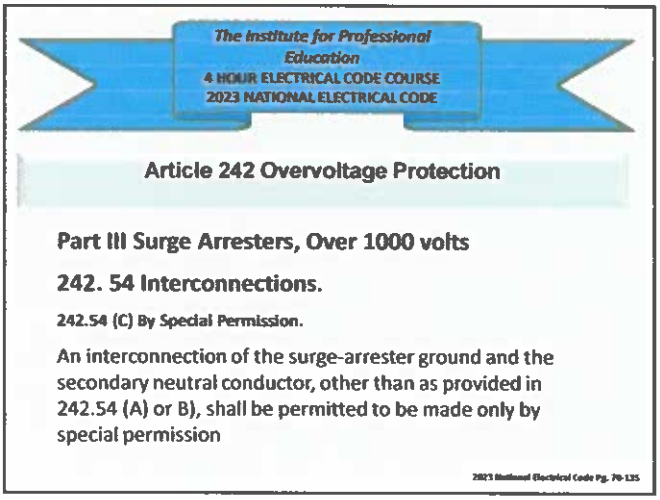
Article 242 Overvoltage Protection
Part III Surge Arresters, Over 1000 volts
242. 54 Interconnections.
242.54 (B)(2) Multigrounded Neutral Primary System.
For multigrounded neutral primary systems, the spark gap or listed device shall have a 60-Hz breakdown of not more than 3kV, and there shall be at least one other ground on the grounded conductor of the secondary that is not less than 6.0 m (20 ft) distant from the surge-arrester grounding electrode.

93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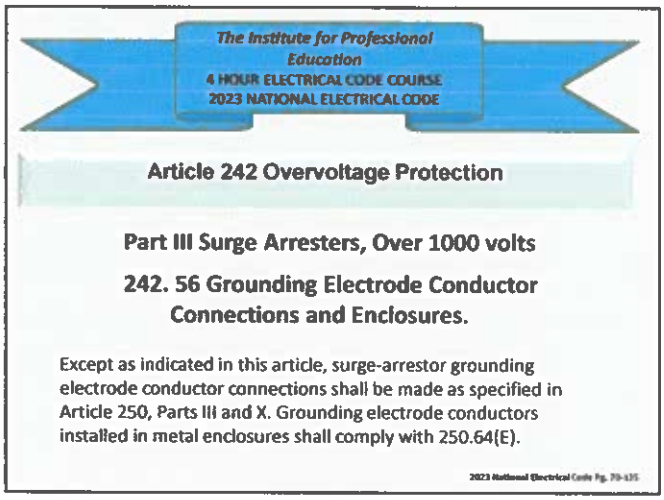
Article 242 Overvoltage Protection
Part III Surge Arresters, Over 1000 volts
242. 54 Interconnections.
242.54 (C) By Special Permission.
An interconnection of the surge-arrester ground and the secondary neutral conductor, other than as provided in 242.54 (A) or B), shall be permitted to be made only by special permission

94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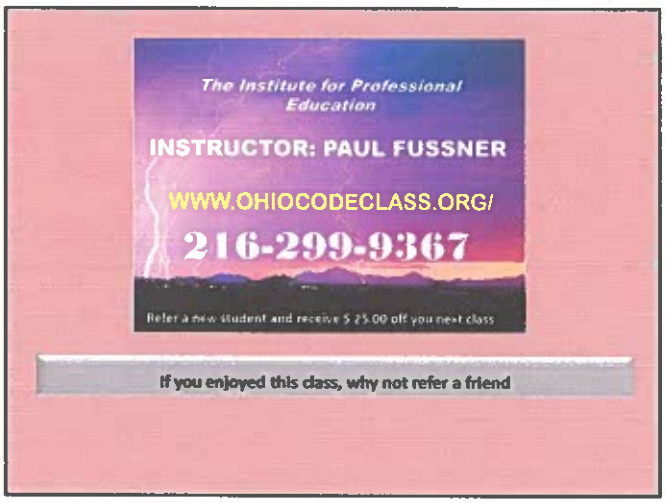
Article 242 Overvoltage Protection
Part III Surge Arresters, Over 1000 volts
242. 56 Grounding Electrode Conductor Connections and Enclosures.
Except as indicated in this article, surge-arrestor grounding electrode conductor connections shall be made as specified in Article 250, Parts III and X. Grounding electrode conductors installed in metal enclosures shall comply with 250.64(E).

95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File Attachments for Item:

ER-3 2023 NEC Articles 230-300 (Institute for Professional Education)

All certifications (8 hours)

Staff Notes:

ESIAC Recommendation:

Committee Recommendation:

Mike DeWine, Governor
Jon Husted, Lt. Governor
Sherri Maxfield, Director

Board of Building Standards

Application for Continuing Education Course Approval

Provider Information:

Name: Paul R. Fussner BBS # 504

Organization: Institute for professional Education

Address: 30508 Ronald Drive, Willowick, Ohio 44095

E-mail: pfussner@paulfussner.onmicrosoft.com Telephone: 216-299-9367

Website: www.ohiocodeclass.org/

Conference Sponsor (if applicable) Elaine's Educational Services, LLC Conference Email: vfussner1955@gmail.com

Check here if Course Renewal: _____ Prior course number _____ *(i.e. BBS2018-429)*

Renewals will only be granted for identical content and certifications, within the current code cycle. Attach a copy of prior course approval letter for confirmation. No further information is required.

New Course Information:

Course title: 8-hour course 2023 National Electrical Code Atricles 230- 300

Course instructor: Paul R. Fussner BBS# 504

Course description: 8-hour Power Point Presentation with questions and answers Covering 2023 NEC Articles 230-300 Ten minute breaks are given at the top of each hour with a 1-hour lunch break given from 12:00 to 1:00 pm

Instructional hours per session: 8-hours Number of Sessions: _____

Course Date(s) and Location: See Attached proposed schedule

Special Content:

Code Administration: _____

Existing Buildings:

Electrical Instruction: X

Plumbing Instruction: _____

Conference Course: course will offered live and on line

Conference Name: See attached proposed locations

Conference location: See attached proposed schedule

Course to be offered online? Yes **On Demand** _____ Virtual Zoom Session

Course Website: _____

Detail online course participation confirmation method *(i.e. test, quizlets, participant activity confirmation)*:
Each student logs in with course link provided after verification of certifications and photo ID , this information reviewed again during sign in or log in on the day of the course

Course applicable for the following certifications

Residential Certifications Only: _____ Commercial Certifications: _____

Administrative Course, All Certifications: X

Application materials included:

- X Course Outline or Course Learning Objectives
- X Presentation Materials/Slides (not required for roundtable courses)
- X Assessment Materials (for online courses)
- X Presenter Bio

Please submit application and materials in .pdf format to: michael.lane@com.ohio.gov or BBS@com.ohio.gov

F 2024 submittial 2023 NEC 8-hr articles 230-300 new course 11 16 2023 pdf

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BOARD OF BUILDING STANDARDS

Paul Robert Fussner, dba

THE INSTITUTE FOR PROFESSIONAL EDUCATION

30508 Ronald Drive
Willowick, Ohio 44095-4341
pfussner@paulfussner.onmicrosoft.com

November 21, 2023

Ohio Board of Building Standards
6606 Tussing Rd
Reynoldsburg, Ohio 43068-9009

REGARDING: Course Syllabus Electrical Contractor. 8-Hour Study of 2023 National Electrical Code Changes Articles 230-300

In-person student classes utilize the normal sign-in method of showing a picture ID and state license before signing the BBS registration sheet, sign-in begins 30 minutes before the session start time.

Classes are to be held online: **Utilizing Zoom Meetings Software**

Computer sign-in and registration(s) begin 30 minutes before the session, utilizing the Zoom login link assigned to each student who has pre-registered by mail or online. Students may log in with a computer, tablet, or smartphone.

8:00	**am**	**Beginning of PowerPoint presentation and review of:**
		Articles 230 through 300 of the 2020 National Electrical Code2019
8:50	**am**	**Ten-minute break.**
		50 minutes per hour of study of the PowerPoint presentation.
12:00	**pm**	**Students will be given a one-hour break for lunch**
1:50	**pm**	**Ten-minute break.**
		50 minutes per hour of study of the PowerPoint presentation
5:00	**pm**	**Student dismissal**

Note: **All eight-hour sessions begin promptly at 8:00 am**

F.2024.BBS.8.hr.online.zoom.course.submittal.2023.NEC.Articles.230-300.syllabus.11.21.2023

Paul Robert Fussner, dba
The Institute for Professional Education
30508 Ronald Drive
Willowick, Ohio 44095-4341
pfussner@paulfussner.onmicrosoft.com

INSTRUCTOR QUALIFICATIONS:

- State Certified Electrical Safety Inspector #504
- State Certified Building Inspector #504
- Building Official #504
- Residential Building Official #504
- Board of Building Standards Instructor, Electrical Safety Inspector Re-certification, established in 1999.
- OCILB Instructor, state-licensed, electrical, plumbing, HVAC, and Hydronics contractors continuing education courses, established in 1999.

50 years of experience in the building and electrical trades, as Founder and President of the Gibson Robert Company, Inc. I expedited all new work including researching and ordering the proper electrical equipment required for a safe, efficient installation, while meeting the requirements of The NFPA 70 Electrical Code, The B.O.C.A. Code, and The Ohio Building Code.

29 years of experience as a State Certified Electrical Safety Inspector, 24 years experience as a State Certified Building Inspector with 12 years of departmental management experience.

14 years as Building Official #504

Former Chairman, Western Reserve Chapter International Association of Electrical Inspectors. Two years as Education Chairman, Western Reserve Chapter of the IAEI.

Owner of The Institute for Professional Education, a State of Ohio Training Agency for the Mandatory Continuing Education Credits for Electrical Safety Inspectors and State Licensed Electrical Contractors. Accredited by the Ohio Board of Building Standards and the Ohio Construction industry licensing board. established 1999.

2024 IN-PERSON and ONLINE ZOOM SESSION(S) SCHEDULE for all OCILB. Contractors and BBS Certifications

TO REGISTER FOR A CLASS, VISIT OUR WEB PAGE:

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January 13	**8-Hr Online Virtual Zoom Session** 2023 NEC Article 250 Understanding Grounding and Bonding	**Course # 3750064**
February 17	**4-hr Online Virtual Zoom Session** 7:45 am-12:00 pm 2023 NEC Articles 90-200	**Course # 3750066**
	4-Hr Online Virtual Zoom Session 1:00 pm - 5:00 pm 2023 NEC Articles 230-242	**Course # 3750060**
	2-Hr Online Virtual Zoom Session 5:00 pm - 7:00 pm 2019 RCO Chapter 113 Existing	**Course # 3750061**
March 23	**8-Hr Online Virtual Zoom Session** 2023 National Electrical Code Article's 230 – 314	**Course # 3750062**
April 27	**4-Hr Online Virtual Zoom Session** 7:45 am-12:00 pm 2023 NEC Articles 90-200	**Course # 3750066**
	4-Hr Online Virtual Zoom Session 1:00 pm - 5:00 pm 2023 NEC Articles 230-242	**Course # 3750060**
	2-Hr Online Virtual Zoom Session 5:00 pm - 7:00 pm 2019 RCO Chapter 3401.1(2)(1)	**Course # 3750065**
May 18	**8-Hr Online Virtual Zoom Session** 2023 National Electrical Code Article's 90 – 210	**Course # 3750063**
June 17	**8-Hr Live in-person session** 2023 NEC Article 250 Understanding Grounding and Bonding	**Course # 3750064**
	Location: Grace Church 36300 Ridge Rd, Willoughby, Ohio 44094 **Rear Lower Level Entrance**	
July 27	**8-Hr Online Virtual Zoom Session** 2023 National Electrical Code Article's 230 – 314	**Course # 3750062**
August 14	**4-Hr Weekday Virtual Zoom Session** 7:45 am-12:00 pm 2023 NEC Articles 90-200	**Course # 3750066**
August 21	**4-Hr Weekday Virtual Zoom Session** 7:45 am-12:00 pm 2023 NEC Articles 230-242	**Course # 3750060**
September 7	**4-Hr Live in Person Session** 7:45 am-12:00 pm 2023 NEC Articles 90-200	**Course # 3750066**
	4-Hr Live in Person Session 1:00 pm - 5:00 pm 2023 NEC Articles 230-242	**Course # 3750060**
	2-Hr Live in Person Session 5:00 pm - 7:00 pm 2019 RCO Chapter 113 Existing	**Course # 3750061**
	Location: Cretan Party Center 13853 W. 168th Street & Lorain Rd, Cleveland, Ohio 44111	
October 19	**4-Hr Live in Person Session** 7:45 am-12:00 pm 2023 NEC Articles 90-200	**Course # 3750066**
	4-Hr Live in Person Session 1:00 pm - 5:00 pm 2023 NEC Articles 230-242	**Course # 3750060**
	2-Hr Live in Person Session 5:00 pm - 7:00 pm 2019 RCO Chapter 3401.1(2)(1)	**Course # 3750065**
	Location: Huntsburg Civic Center 12396 Madison Rd. (Rt,528 & 322) Middlefield, Ohio 44062 Use the rear entrance	
November 16	**8-Hr Online Virtual Zoom Session** 2023 National Electrical Code Article 250 Grounding and Bonding	**Course # 3750064**
December 7	**4-Hr Live in Person Session** 7:45 am-12:00 pm 2023 NEC Articles 90-200	**Course # 3750066**
	4-Hr Live in Person Session 1:00 pm - 5:00 pm 2023 NEC Articles 230-242	**Course # 3750060**
	2-Hr Live in Person Session 5:00 pm - 7:00 pm 2019 RCO Chapter 113 Existing	**Course # 3750061**

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Four Hours of Education	**$ 90.00**
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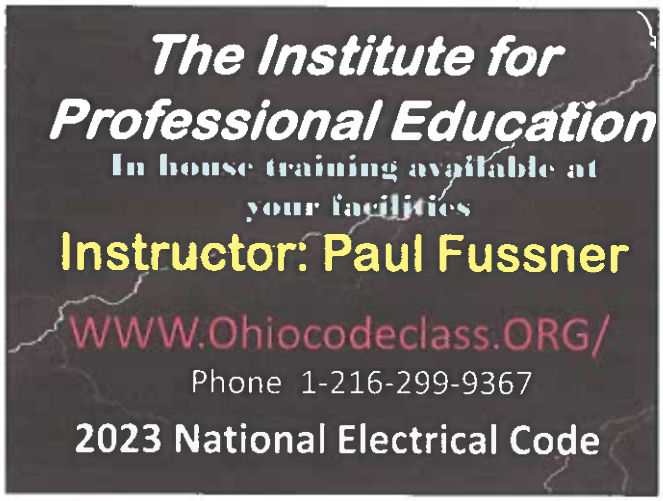
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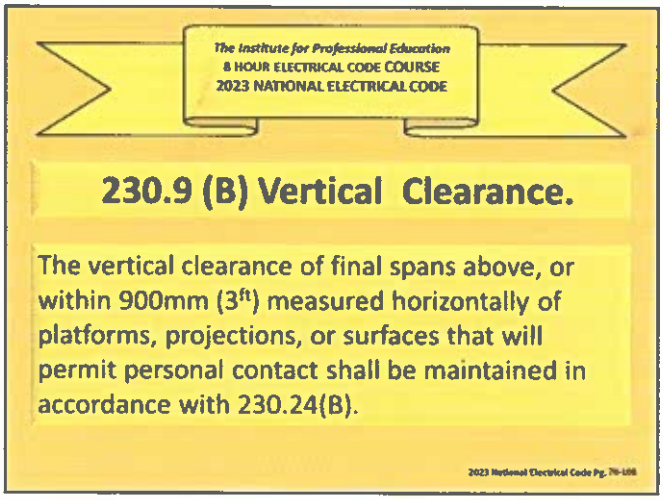
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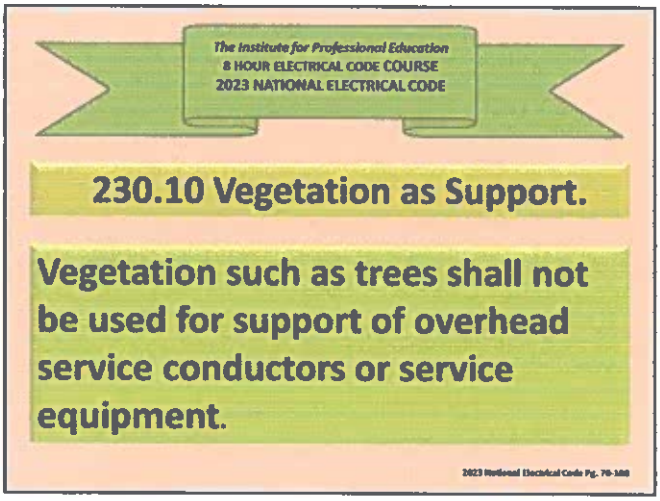
230.9 (B) Vertical Clearance.
The vertical clearance of final spans above, or within 900mm (3ft) measured horizontally of platforms, projections, or surfaces that will permit personal contact shall be maintained in accordance with 230.24(B).

2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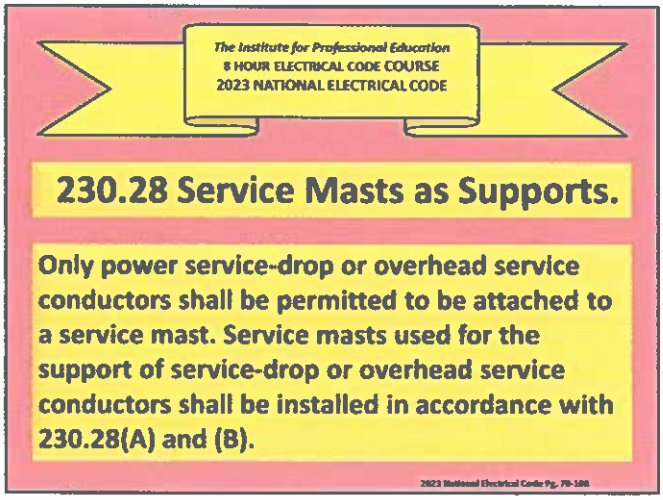
230.10 Vegetation as Support.
Vegetation such as trees shall not be used for support of overhead service conductors or service equipment.

3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230.28 Service Masts as Supports.
Only power service-drop or overhead service conductors shall be permitted to be attached to a service mast. Service masts used for the support of service-drop or overhead service conductors shall be installed in accordance with 230.28(A) and (B).

4

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230.28 Service Masts as Supports.

(A)Strength.

The service mast shall be of adequate strength or be supported by braces or guy wires to withstand safely the strain imposed by the service-drop or overhead service conductors. Hubs intended for use with a conduit that serves as a service mast shall be identified for use with service-entrance equipment.

2020 National Electrical Code Pg. 70-305

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230.28 Service Masts as Supports.

(B) Attachment.

Service-drop or overhead service conductors shall not be attached to a service mast between a weather head or the end of the conduit and a coupling, where the coupling is located above the last point of securement to the building or other structure or is located above the building or other structure.

2023 National Electrical Code Pg. 70-309

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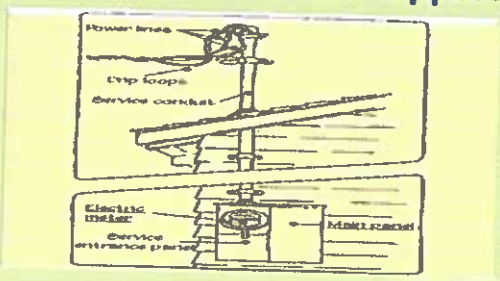

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230.28 Service Masts as Supports.

Support clamps must be listed for use as service equipment

2023 National Electrical Code

8

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230.29 Supports over Buildings.

Service conductors passing over a roof shall be securely supported be substantial structures. For a grounded system, where the substantial structure is metal, it shall be bonded by means of a bonding jumper and listed connector to the grounded overhead service conductor. Where practicable, such supports shall be independent of the building.

2023 National Electrical Code Pg. 70-109

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III. Underground Service Conductors 230.30 (B) Wiring Methods.

230.30(B) Wiring Methods (Underground Service Conductors)

A list of acceptable wiring methods for "Underground Service Conductors" was added at 230.30(B).

Underground service conductors are required to be installed in accordance with the applicable requirements of the *NEC* for the type of wiring method used and shall be limited to the following wiring methods.

(1) Type RMC conduit
(2) Type IMC conduit
(3) Type NUCC conduit
(4) Type HDPE conduit
(5) Type PVC conduit
(11) Type TC-Er Cable where identified for service entrance use and direct burial applications
(6) Type RTRC conduit
(7) Type IGS cable
(8) Type USE conductors or cables
(9) Type MV or Type MC cable identified for direct burial applications
(10) Type MI cable, where suitably protected against physical damage and corrosion

2023 NEC Pg. 70-109

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230.40 Number of Service-Entrance Conductor Sets

Each service drop, set of overhead service conductors, set of underground service conductors or service lateral shall supply only one set of service-entrance conductors.

2023 National Electrical Code Pg. 70-109

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230.40 Number of Service-Entrance Conductor Sets

Exception No.1: A building with more than one occupancy shall be permitted to have one set of service-entrance conductors for each service, as permitted in 230.2, run to each occupancy or group of occupancies. If the number of service disconnect locations for any given classification of service does not exceed six, the requirements of 230.2(E) shall apply at each location. If the number of service disconnect locations exceeds six for any given supply classification, the following conditions shall apply:

(1). All service disconnect locations for all supply characteristics together with any branch circuit or feeder supply sources shall be clearly described using graphics or text, or both, on one or more plaques
(2). The plaques shall be located in an approved, readily accessible location(s) on the building or structure served and as near as practicable to the point(s) of attachment or entry(ies) for each service drop or service lateral and for each set of overhead or underground service conductors.

2023 National Electrical Code Pg. 70-109

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230.28 Service Masts as Supports.

(A)Strength.

The service mast shall be of adequate strength or be supported by braces or guy wires to withstand safely the strain imposed by the service-drop or overhead service conductors. Hubs intended for use with a conduit that serves as a service mast shall be identified for use with service-entrance equipment.

2020 National Electrical Code Pg. 70-108

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230.28 Service Masts as Supports.

(B) Attachment.

Service-drop or overhead service conductors shall not be attached to a service mast between a weather head or the end of the conduit and a coupling, where the coupling is located above the last point of securement to the building or other structure or is located above the building or other structure.

2023 National Electrical Code Pg. 70-109

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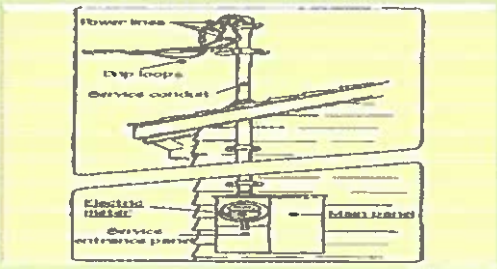
230.28 Service Masts as Supports.



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230.28 Service Masts as Supports.

Support clamps must be listed for use as service equipment

2023 National Electrical Code

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N 230.42 (A)(2) Application of Adjustment or Correction Factors

The minimum service-entrance conductor size shall have an ampacity not less than the maximum load to be served after the application of any adjustment or correction factors.

2023 National Electrical Code Pg. 70-110

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230.43 Wiring Methods for 1000volts, Nominal, or less.

Service-entrance conductors shall be installed in accordance with the applicable requirements of this *code* covering the type of wiring method used and shall be limited to the following methods:

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230.43 Wiring Methods for 1000volts, Nominal, or less.

(1) Open wiring on insulators
(2) Type IGS cable
(3) Rigid metal conduit (RMC)
(4) Intermediate metal conduit (IMC)
(5) Electrical metallic tubing (EMT)
(6) Electrical nonmetallic tubing
(7) Service-entrance cables

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230.43 Wiring Methods for 1000volts, Nominal, or less.

(8) Wireways
(9) Busways
(10) Auxiliary gutters
(11) Rigid polyvinyl chloride conduct (PVC)
(12) Cablebus
(13) Type MC cable
(14) Mineral-insulated, metal-sheathed cable, Type MI

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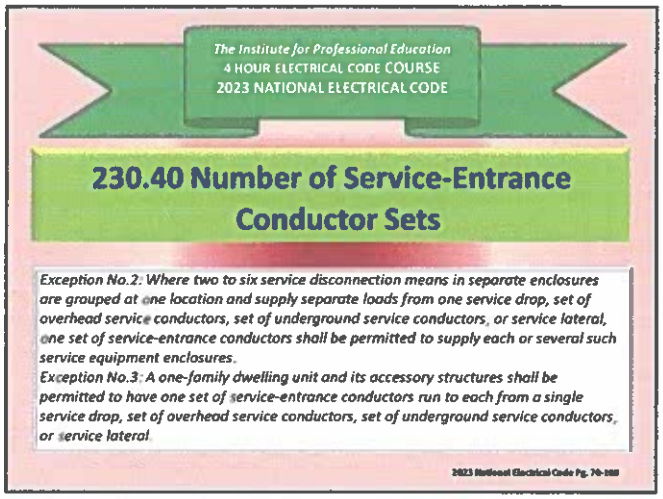
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230.40 Number of Service-Entrance Conductor Sets
Exception No.2: Where two to six service disconnection means in separate enclosures are grouped at one location and supply separate loads from one service drop, set of overhead service conductors, set of underground service conductors, or service lateral, one set of service-entrance conductors shall be permitted to supply each or several such service equipment enclosures.
Exception No.3: A one-family dwelling unit and its accessory structures shall be permitted to have one set of service-entrance conductors run to each from a single service drop, set of overhead service conductors, set of underground service conductors, or service lateral

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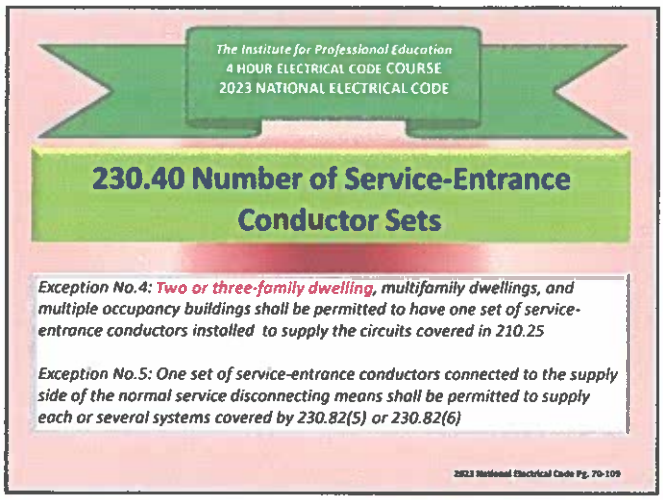
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230.40 Number of Service-Entrance Conductor Sets
Exception No.4: Two or three-family dwelling, multifamily dwellings, and multiple occupancy buildings shall be permitted to have one set of service-entrance conductors installed to supply the circuits covered in 210.25
Exception No.5: One set of service-entrance conductors connected to the supply side of the normal service disconnecting means shall be permitted to supply each or several systems covered by 230.82(5) or 230.82(6)

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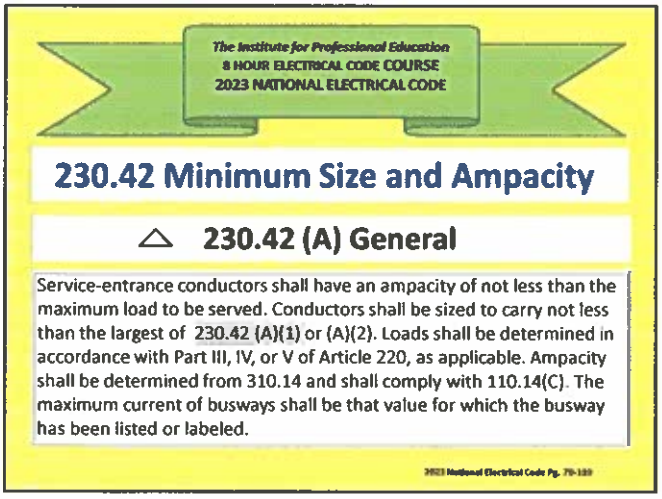
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230.42 Minimum Size and Ampacity
230.42 (A) General
Service-entrance conductors shall have an ampacity of not less than the maximum load to be served. Conductors shall be sized to carry not less than the largest of 230.42 (A)(1) or (A)(2). Loads shall be determined in accordance with Part III, IV, or V of Article 220, as applicable. Ampacity shall be determined from 310.14 and shall comply with 110.14(C). The maximum current of busways shall be that value for which the busway has been listed or labeled.

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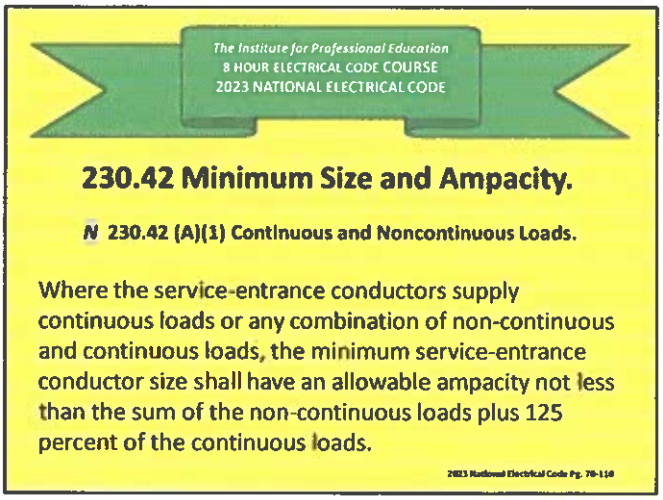
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230.42 Minimum Size and Ampacity.
230.42 (A)(1) Continuous and Noncontinuous Loads.
Where the service-entrance conductors supply continuous loads or any combination of non-continuous and continuous loads, the minimum service-entrance conductor size shall have an allowable ampacity not less than the sum of the non-continuous loads plus 125 percent of the continuous loads.

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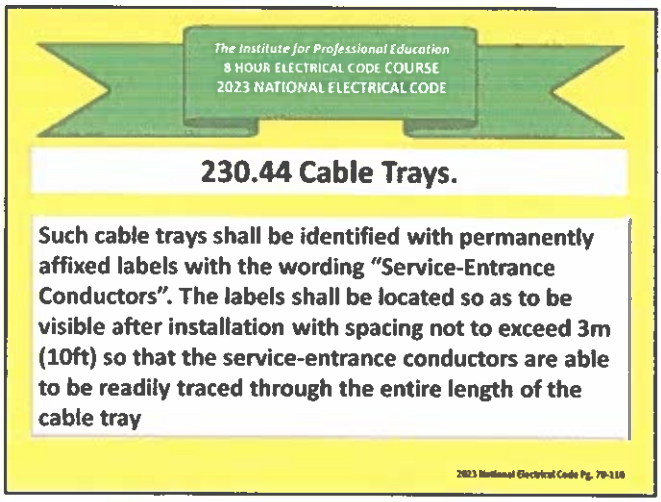
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230.44 Cable Trays.
Such cable trays shall be identified with permanently affixed labels with the wording "Service-Entrance Conductors". The labels shall be located so as to be visible after installation with spacing not to exceed 3m (10ft) so that the service-entrance conductors are able to be readily traced through the entire length of the cable tray

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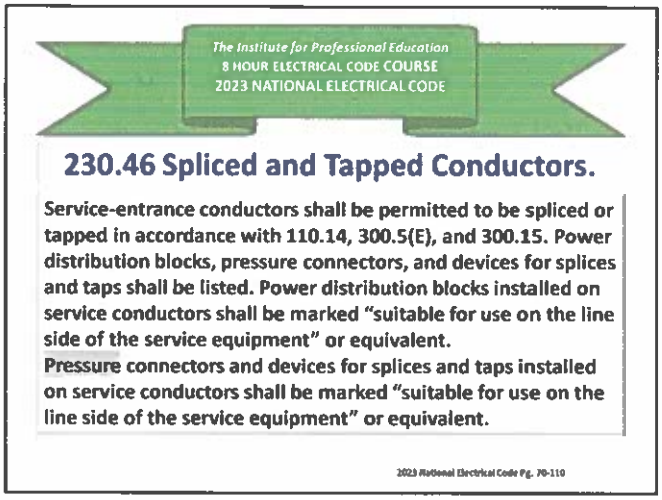
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230.46 Spliced and Tapped Conductors.
Service-entrance conductors shall be permitted to be spliced or tapped in accordance with 110.14, 300.5(E), and 300.15. Power distribution blocks, pressure connectors, and devices for splices and taps shall be listed. Power distribution blocks installed on service conductors shall be marked "suitable for use on the line side of the service equipment" or equivalent.
Pressure connectors and devices for splices and taps installed on service conductors shall be marked "suitable for use on the line side of the service equipment" or equivalent.

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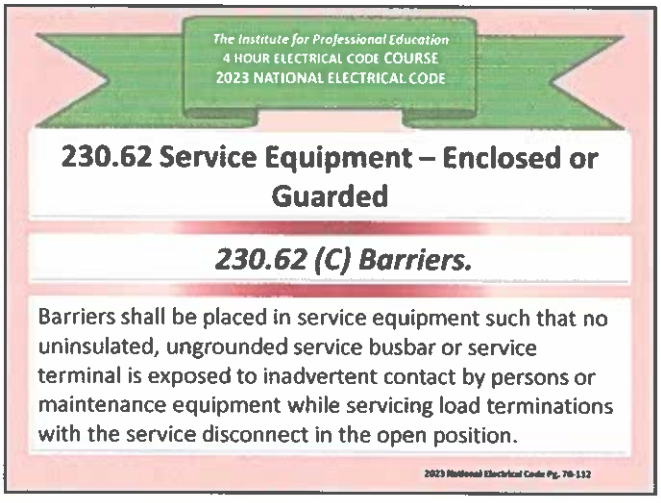
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230.62 Service Equipment – Enclosed or Guarded
230.62 (C) Barriers.
Barriers shall be placed in service equipment such that no uninsulated, ungrounded service busbar or service terminal is exposed to inadvertent contact by persons or maintenance equipment while servicing load terminations with the service disconnect in the open position.

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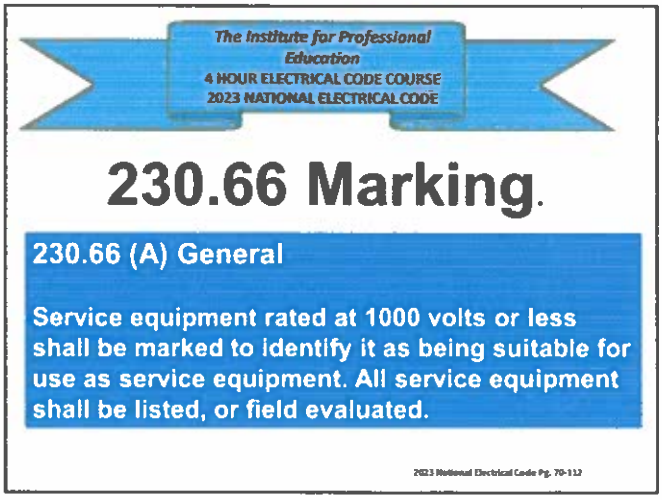
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230.66 Marking.
230.66 (A) General
Service equipment rated at 1000 volts or less shall be marked to identify it as being suitable for use as service equipment. All service equipment shall be listed, or field evaluated.

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230.43 Wiring Methods for 1000volts, Nominal, or less.

(15) Flexible metal conduit (FMC) not over1.8 m (6ft) long or liquidtight flexible metal conduit (LFMC) not over 1.8m (6ft) long between a raceway, or between a raceway and service equipment, with a supply-side bonding jumper routed with the flexible metal conduit (LFMC) according to 250.102(A), (B),(C), and (E).

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230.43 Wiring Methods for 1000volts, Nominal, or less.

(16) Liquidtight flexible nonmetallic conduit (LFNC)
(17) High density polyethylene conduit (HDPE)
(18) Nonmetallic underground conduit with conductors (NUCC)
(19) Reinforced thermosetting resin conduit (RTRC)
(20) Type TC-ER cables where identified for use as service entrance conductors
(21) Flexible bus systems

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230.44 Cable Trays.

Cable tray systems shall be permitted to support service-entrance conductors. Cable trays used to support service-entrance conductors shall contain only service-entrance conductors and shall be limited to the following methods:

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230.44 Cable Trays.

(1) Type SE cable
(2) Type MC cable
(3) Type MI cable
(4) Type IGS cable
(5) Single conductors 1/0 and larger that are listed for use in cable tray
(6) Type TC-ER cable

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230.70 General

Means shall be provided to disconnect all ungrounded conductors in a building or other structure from the service conductors.

(A) Location. The service disconnecting means shall be installed accordance with 230.70 (A)(1), (A)(2), and (A)(3).

(A)(1) Readily Accessible Location. The service disconnecting means shall be installed at a readily accessible location either outside of the building or structure or inside nearest the point of entrance of the service conductors

(A)(2) Bathrooms. Service disconnection means shall not be installed in bathrooms.

(A)(3) Remote Control. Where a remote-control device(s) is used to activate the service disconnection means, the service disconnection means shall be located in accordance with 230.70 (A)(1).

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230.70 General

Means shall be provided to disconnect all *ungrounded* conductors in a building or other structure from the service conductors.

(B) Marking.
Each service disconnecting means shall be permanently marked to identify it as a service disconnect

△ **(C) Suitable for use.**
Each service disconnecting means shall be suitable for the prevailing conditions. Service equipment installed in hazardous (classified) locations shall comply with the hazardous location requirements.

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230.71 Maximum Number of Disconnects.

230.71 Each service shall have only one disconnection means unless the requirements of 230.71 (B) are met.

△ **230.71 (A) General.**
For the purpose of this section, disconnecting means installed as part of listed equipment and used solely for the hollowing shall not be considered a service disconnection means:
(1) Power monitoring equipment
(2) Surge-protective device(s)
(3) Control circuit of the ground-fault protection system
(4) Power-operable service disconnection means

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230.71 Maximum Number of Disconnects.

230.71 Each service shall have only one disconnection means unless the requirements of 230.71 (B) are met.

△ **230.71 (b) Two to Six Service Disconnection Means.**
Two to six service disconnects shall be permitted for each service permitted by 230.2 or for each set of service-entrance conductors permitted by 230.40. Exception No 1, 3, 4, or 5. The two to six disconnection means shall be permitted to consist of a combination of any of the following:
(1) Separate enclosures with a main service disconnection means in each enclosure
(2) Panelboards with a main service disconnection means in each panelboard enclosure
(3) Switchboard(s) where there is only one service disconnect in each separate vertical section where there are barriers separating each vertical section

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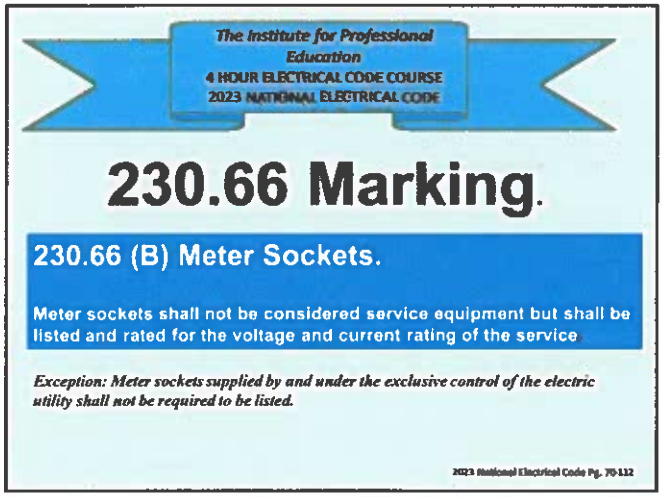
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230.66 Marking.
230.66 (B) Meter Sockets.
Meter sockets shall not be considered service equipment but shall be listed and rated for the voltage and current rating of the service
Exception: Meter sockets supplied by and under the exclusive control of the electric utility shall not be required to be listed.
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230.67 Surge Protection.
230.67 (A) Surge-Protective Device.
All services supplying the following occupancies shall be provided with a surge-protective device (SPD):
(1) Dwelling units
(2) Dormitory units
(3) Guest rooms and guest suites of hotels and motels
(4) Areas of nursing homes and limited-care facilities used exclusively as patient sleeping rooms
Information Note: See 517.10 (B)(2)
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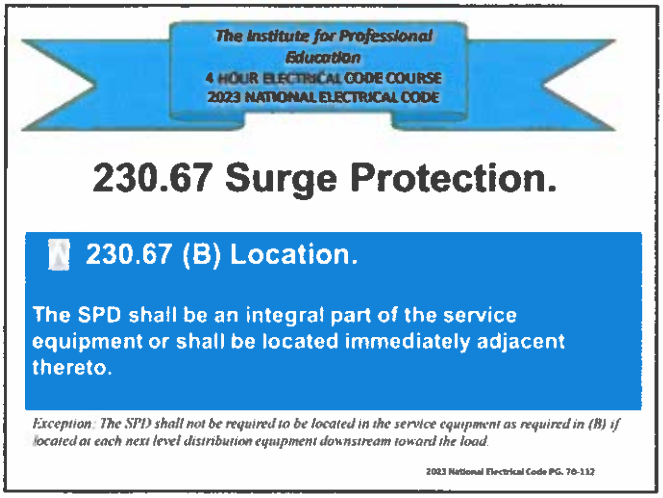
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230.67 Surge Protection.
230.67 (B) Location.
The SPD shall be an integral part of the service equipment or shall be located immediately adjacent thereto.
Exception: The SPD shall not be required to be located in the service equipment as required in (B) if located at each next level distribution equipment downstream toward the load.
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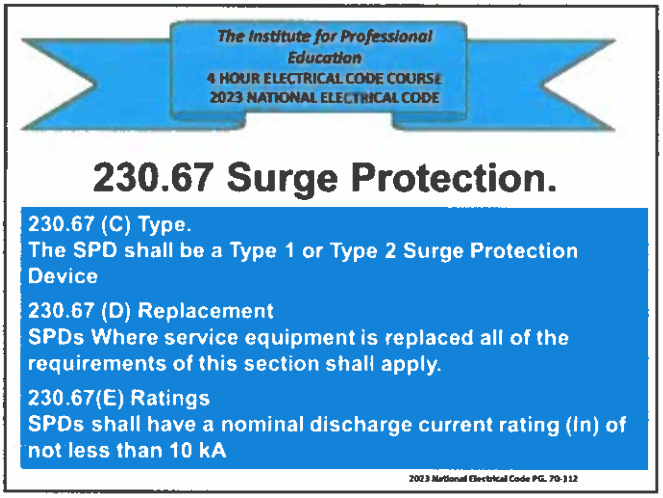
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230.67 Surge Protection.
230.67 (C) Type.
The SPD shall be a Type 1 or Type 2 Surge Protection Device
230.67 (D) Replacement
SPDs Where service equipment is replaced all of the requirements of this section shall apply.
230.67(E) Ratings
SPDs shall have a nominal discharge current rating (In) of not less than 10 kA
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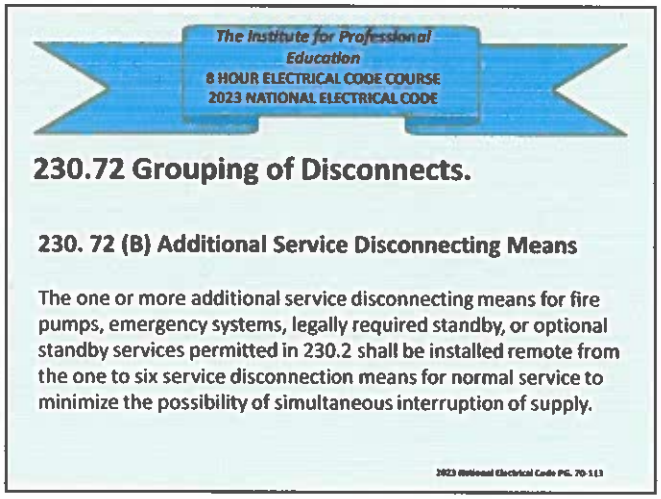
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230.72 Grouping of Disconnects.
230. 72 (B) Additional Service Disconnecting Means
The one or more additional service disconnecting means for fire pumps, emergency systems, legally required standby, or optional standby services permitted in 230.2 shall be installed remote from the one to six service disconnection means for normal service to minimize the possibility of simultaneous interruption of supply.

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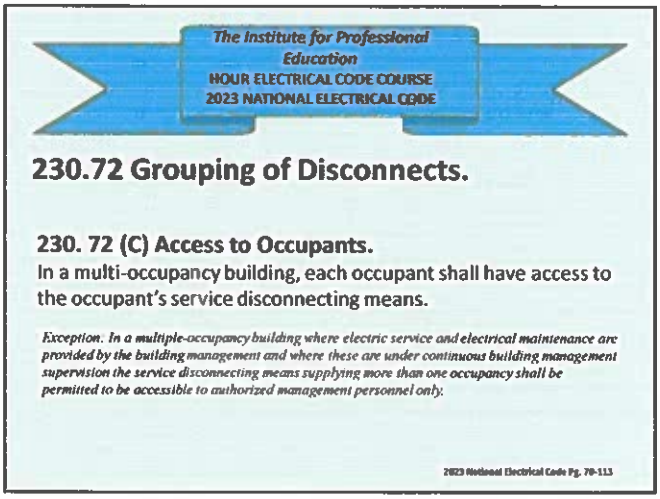
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230.72 Grouping of Disconnects.
230. 72 (C) Access to Occupants.
In a multi-occupancy building, each occupant shall have access to the occupant's service disconnecting means.
Exception: In a multiple-occupancy building where electric service and electrical maintenance are provided by the building management and where these are under continuous building management supervision the service disconnecting means supplying more than one occupancy shall be permitted to be accessible to authorized management personnel only.

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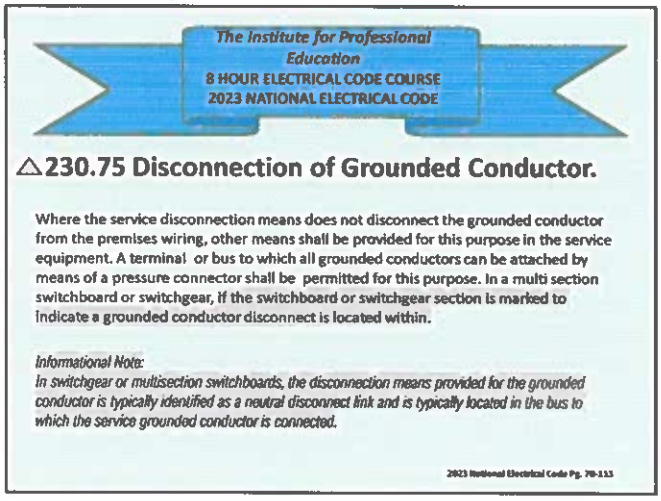
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△230.75 Disconnection of Grounded Conductor.
Where the service disconnection means does not disconnect the grounded conductor from the premises wiring, other means shall be provided for this purpose in the service equipment. A terminal or bus to which all grounded conductors can be attached by means of a pressure connector shall be permitted for this purpose. In a multi section switchboard or switchgear, if the switchboard or switchgear section is marked to indicate a grounded conductor disconnect is located within.
Informational Note:
In switchgear or multisection switchboards, the disconnection means provided for the grounded conductor is typically identified as a neutral disconnect link and is typically located in the bus to which the service grounded conductor is connected.

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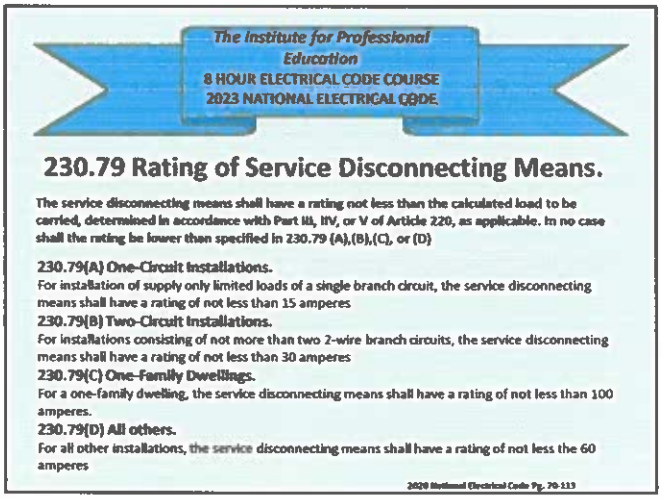
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230.79 Rating of Service Disconnecting Means.
The service disconnecting means shall have a rating not less than the calculated load to be carried, determined in accordance with Part III, IIV, or V of Article 220, as applicable. In no case shall the rating be lower than specified in 230.79 (A),(B),(C), or (D)
230.79(A) One-Circuit Installations.
For installation of supply only limited loads of a single branch circuit, the service disconnecting means shall have a rating of not less than 15 amperes
230.79(B) Two-Circuit Installations.
For installations consisting of not more than two 2-wire branch circuits, the service disconnecting means shall have a rating of not less than 30 amperes
230.79(C) One-Family Dwellings.
For a one-family dwelling, the service disconnecting means shall have a rating of not less than 100 amperes.
230.79(D) All others.
For all other installations, the service disconnecting means shall have a rating of not less the 60 amperes

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230.71 Maximum Number of Disconnects.

230.71 Each service shall have only one disconnection means unless the requirements of 230.71 (B) are met.

230.71 (B) Two to Six Service Disconnection Means.
The two to six disconnection means shall be permitted to consist of a combination of any of the following:

(4) Service disconnects in switchgear or metering center where each disconnect is located in a separate compartment.
(5) Metering centers with a main service disconnecting means in each metering center
(6) Motor control center(s) where there is only one service disconnect in a motor control center unit and a maximum of two service disconnects provided in a single motor control center with barriers provided between each motor control center unit or compartment containing a service disconnect to maintain the inadvertent contact protection required in 230.2 based on access from adjacent motor control center unit(s) or compartment(s)

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230.71 Maximum Number of Disconnects.

230.71 Each service shall have only one disconnection means unless the requirements of 230.71 (B) are met.

230.71 (B) Two to Six Service Disconnection Means.
The two to six disconnection means shall be permitted to consist of a combination of any of the following:

Exception to (2),(3),(4),(5),(6): Existing service equipment, installed in compliance with previous editions of the Code that permitted multiple service disconnecting means in a single enclosure, section, or compartment, shall be permitted to contain a maximum of six service disconnecting means.

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230.71 Maximum Number of Disconnects.

230.71 Each service shall have only one disconnection means unless the requirements of 230.71 (B) are met.

Informational Note No. 1: See UL 67 , *Standards for Panelboards* for information on metering centers

Informational Note No 2. :
Examples of separate enclosures with a main service disconnection means in each enclosure include but are not limited to motor control centers, fused disconnects, circuit breaker enclosures, and transfer switches that are suitable for use as service equipment.
Informational Note No. 3:
Transfer switches are provided with one service disconnect or multiple service disconnects in separate compartments.

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230.72 Grouping of Disconnects.

230. 72 (A) General
The two to six disconnects, if permitted in 230.71 shall be grouped. Each disconnect shall be marked to indicate the load served.

Exception One of the two to six service disconnecting means permitted in 230.71, where used for a water pump also intended to provide fire protection, shall be permitted to be located remote from the other disconnecting means. If remotely installed in accordance with this exception, a plaque shall be posted at the location of the remaining grouped disconnects denoting its location.

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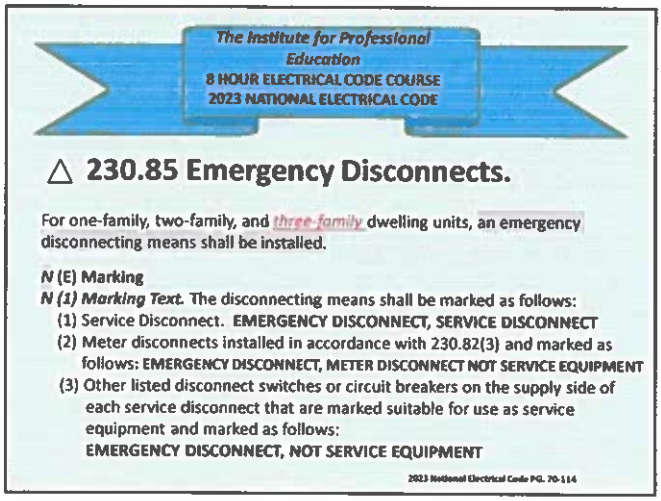
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△ 230.85 Emergency Disconnects.
For one-family, two-family, and three-family dwelling units, an emergency disconnecting means shall be installed.
N (E) Marking
N (1) Marking Text. The disconnecting means shall be marked as follows:
(1) Service Disconnect. EMERGENCY DISCONNECT, SERVICE DISCONNECT
(2) Meter disconnects installed in accordance with 230.82(3) and marked as follows: EMERGENCY DISCONNECT, METER DISCONNECT NOT SERVICE EQUIPMENT
(3) Other listed disconnect switches or circuit breakers on the supply side of each service disconnect that are marked suitable for use as service equipment and marked as follows:
EMERGENCY DISCONNECT, NOT SERVICE EQUIPMENT
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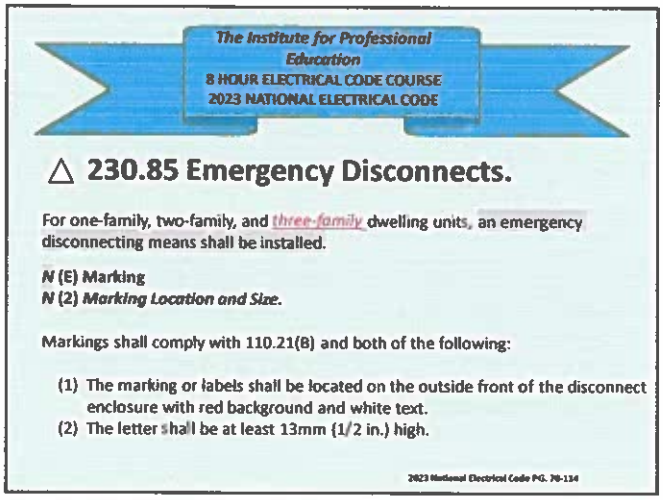
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△ 230.85 Emergency Disconnects.
For one-family, two-family, and three-family dwelling units, an emergency disconnecting means shall be installed.
N (E) Marking
N (2) Marking Location and Size.
Markings shall comply with 110.21(B) and both of the following:
(1) The marking or labels shall be located on the outside front of the disconnect enclosure with red background and white text.
(2) The letter shall be at least 13mm (1/2 in.) high.
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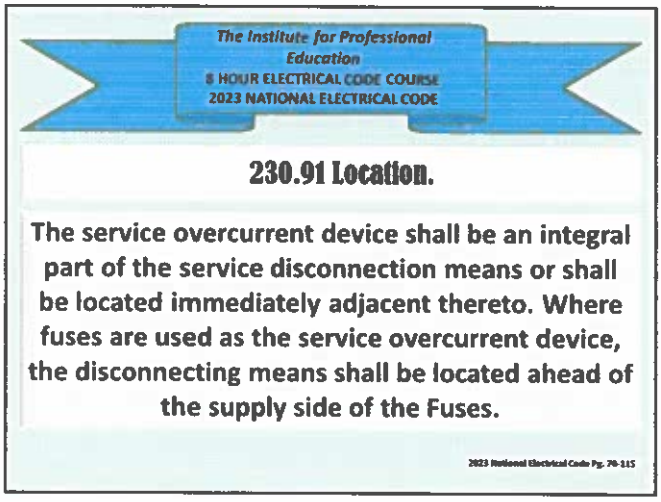
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230.91 Location.
The service overcurrent device shall be an integral part of the service disconnection means or shall be located immediately adjacent thereto. Where fuses are used as the service overcurrent device, the disconnecting means shall be located ahead of the supply side of the Fuses.
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230.92 Locked Service Overcurrent Devices.
Where the service overcurrent devices are locked or sealed or are not readily accessible to the occupant, branch-circuit or feeder overcurrent devices shall be installed on the load side, shall be mounted in a readily accessible location, and shall be of lower ampere rating than the service overcurrent device.
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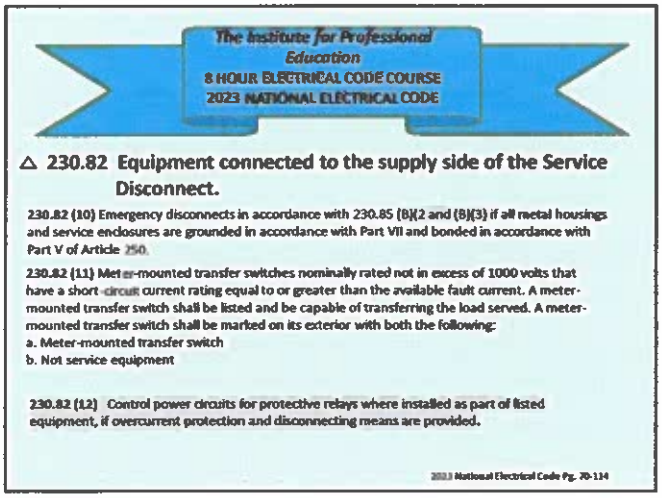
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△ 230.82 Equipment connected to the supply side of the Service Disconnect.
230.82 (10) Emergency disconnects in accordance with 230.85 (B)(2 and (B)(3) if all metal housings and service enclosures are grounded in accordance with Part VII and bonded in accordance with Part V of Article 250.
230.82 (11) Meter-mounted transfer switches nominally rated not in excess of 1000 volts that have a short-circuit current rating equal to or greater than the available fault current. A meter-mounted transfer switch shall be listed and be capable of transferring the load served. A meter-mounted transfer switch shall be marked on its exterior with both the following:
a. Meter-mounted transfer switch
b. Not service equipment
230.82 (12) Control power circuits for protective relays where installed as part of listed equipment, if overcurrent protection and disconnecting means are provided.
2023 National Electrical Code Pg. 70-114

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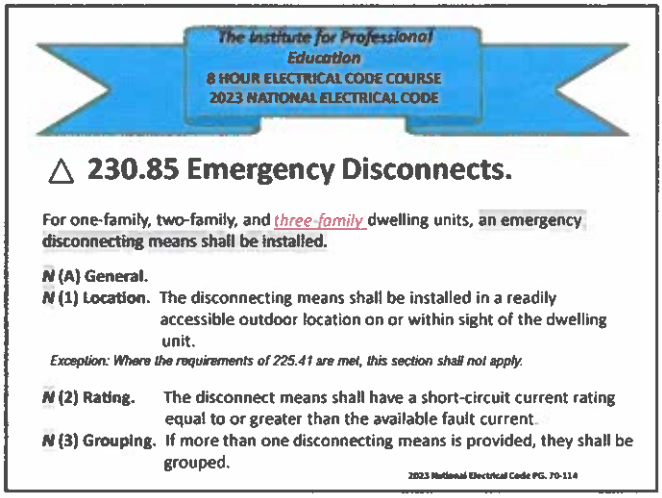
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2023 NATIONAL ELECTRICAL CODE
△ 230.85 Emergency Disconnects.
For one-family, two-family, and three-family dwelling units, an emergency disconnecting means shall be installed.
N (A) General.
N (1) Location. The disconnecting means shall be installed in a readily accessible outdoor location on or within sight of the dwelling unit.
Exception: Where the requirements of 225.41 are met, this section shall not apply.
N (2) Rating. The disconnect means shall have a short-circuit current rating equal to or greater than the available fault current.
N (3) Grouping. If more than one disconnecting means is provided, they shall be grouped.
2023 National Electrical Code PG. 70-114

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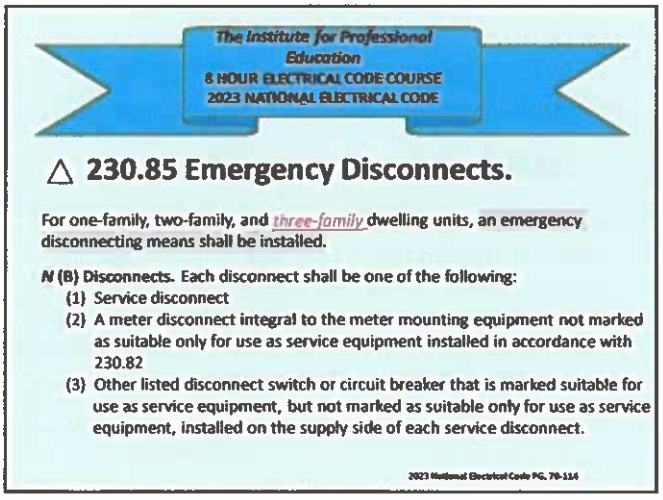
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△ 230.85 Emergency Disconnects.
For one-family, two-family, and three-family dwelling units, an emergency disconnecting means shall be installed.
N (B) Disconnects. Each disconnect shall be one of the following:
(1) Service disconnect
(2) A meter disconnect integral to the meter mounting equipment not marked as suitable only for use as service equipment installed in accordance with 230.82
(3) Other listed disconnect switch or circuit breaker that is marked suitable for use as service equipment, but not marked as suitable only for use as service equipment, installed on the supply side of each service disconnect.
2023 National Electrical Code PG. 70-114

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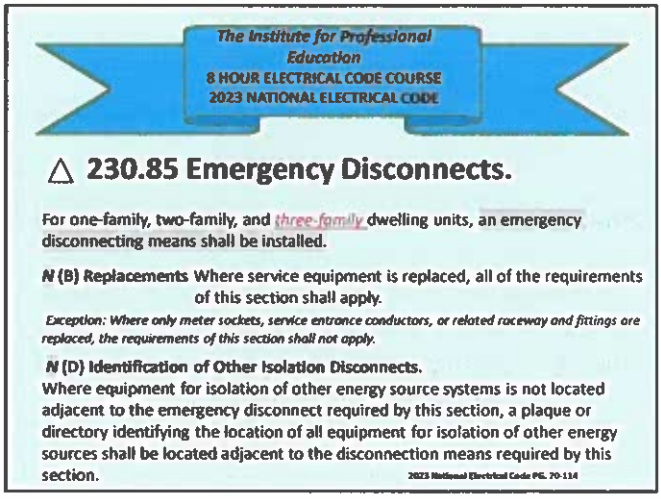
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△ 230.85 Emergency Disconnects.
For one-family, two-family, and three-family dwelling units, an emergency disconnecting means shall be installed.
N (B) Replacements Where service equipment is replaced, all of the requirements of this section shall apply.
Exception: Where only meter sockets, service entrance conductors, or related raceway and fittings are replaced, the requirements of this section shall not apply.
N (D) Identification of Other Isolation Disconnects.
Where equipment for isolation of other energy source systems is not located adjacent to the emergency disconnect required by this section, a plaque or directory identifying the location of all equipment for isolation of other energy sources shall be located adjacent to the disconnection means required by this section.
2023 National Electrical Code PG. 70-114

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240.4 Protection of Conductors

240.4 (D)(4) 14 AWG Copper 15 amperes
240.4 (D)(5) 12 AWG Aluminum and Copper-Clad Aluminum 15 amperes
240.4 (D)(6) 12 AWG Copper 20 amperes
240.4 (D)(7) 10 AWG Aluminum and Copper-Clad Aluminum 25 Amperes
240.4 (D)(8) 10 AWG Copper 30 amperes

2023 National Electrical Code Pg.70-123

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240.4 Protection of Conductors

N 240.4 (H) Dwelling Unit Service and Feeder Conductors.

Dwelling unit service and feeder conductors shall be permitted to be protected against overcurrent at the ampacity values in 310.12

2023 National Electrical Code Pg.70-123 for 310.12 turn to PG. 70-183

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240.6 Standard Ampere Ratings.

240.6(A) Fuses and Fixed-Trip Breakers.

The standard ampere ratings for fuses and inverse time circuit breakers shall be considered as shown in Table 240.6 (A). Additional standard ampere ratings for fuses shall be 1, 3, 6, and 601. The use of fuses and inverse time circuit breakers with nonstandard ampere ratings shall be permitted.

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N Table 240.6(A) Standard Ampere Ratings for Fuses and Inverse Time Circuit Breakers

Standard Ampere Ratings				
10	15	20	25	30
35	40	45	50	60
70	80	90	100	110
125	150	175	200	225
250	300	350	400	450
500	600	700	800	1000
1200	1600	2000	7500	3000
4000	5000	6000	—	—

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N 240.7 Listing Requirements

(1) Branch-Circuit overcurrent protective Devices

(2) Relays and circuit breakers providing ground-fault protection of equipment.

(3) Ground-fault circuit interrupter devices

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N 240.11 Selective Coordination.

If one or more feeder overcurrent protective devices are required to be selectively coordinated with a service overcurrent protective device by other requirements in this *code*, all feeder overcurrent protective devices supplied directly by the service overcurrent protective device shall be selectively coordinated with the service overcurrent protective device.

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N 240.16 Interrupting Ratings.

Branch-circuit overcurrent protective devices shall have an interrupting rating no less than 5000 amperes.

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Part IV. Disconnecting and Guarding

240.40 Disconnecting Means for Fuses.

Cartridge fuses in circuits of any voltage, and all fuses in circuits over 150 volts to ground, shall be provided with a disconnecting means on their supply side so that each circuit containing fuses can be independently disconnected from the source of power. A cable limiter without a disconnecting means shall be permitted on the supply side of more than one set of fuses as permitted on the supply side of the serviced disconnecting means as permitted by 230.82. A single disconnecting shall be permitted on the supply side of more than one set of fuses as permitted by 430.112, exception, for group operation of motors, 424.22(C) for fixed resistance and electrode industrial process heating equipment, and 425.22(C) for fixed resistance and electrode industrial process heating equipment or where specifically permitted elsewhere in this *code*.

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230.95 Ground-Fault Protection of Equipment.

230.95 (C) Performance Testing.

The ground-fault protection system shall be performance tested when first installed onsite. This testing shall be conducted by a qualified person(s) using a test process of primary current injection, in accordance with instructions that shall be provided with the equipment. A written record of this testing shall be made and shall be available to the authority having jurisdiction.

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N 240.2 Reconditioned Equipment.

N 240.2(A) Reconditioning Not Permitted The following equipment shall not be reconditioned:
(1) Equipment providing ground-fault protection of equipment
(2) Ground-fault circuit interrupters
(3) Low-voltage fuse holders and low-voltage nonrenewable fusses
(4) Molded-case circuit breakers
(5) Low-voltage power circuit breakers electronic trip units

N 240.2 (B) Reconditioning Permitted. The following equipment shall be permitted to be reconditioned:
(1) Low-voltage power circuit breakers
(2) Electromechanical protective relays and current transformers
Reconditioned equipment shall be listed as reconditioned and comply with 110.21(A)(2).

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240.4 Protection of Conductors

240.4 (D) Small Conductors

Unless specifically permitted in 240.4(E) or (G), the overcurrent protection shall not exceed that required by 240.4 (D)(1) through (D)(8) after any correction factors for ambient temperature and number of conductors have been applied.

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240.4 Protection of Conductors

N 240.4 (D)(3) 14 AWG Copper-Clad-Aluminum

10 amperes, provided all of the following conditions are met:
(1) Continuous loads do not exceed 8 amperes
(2) Overcurrent protection is provided by one of the following :

a. Branch-circuit breakers are listed and marked for use with 14 AWG copper-clad aluminum conductor.
b. Branch-circuit-rated fuses are listed and marked for use with 14 AWG copper-clad aluminum conductor.

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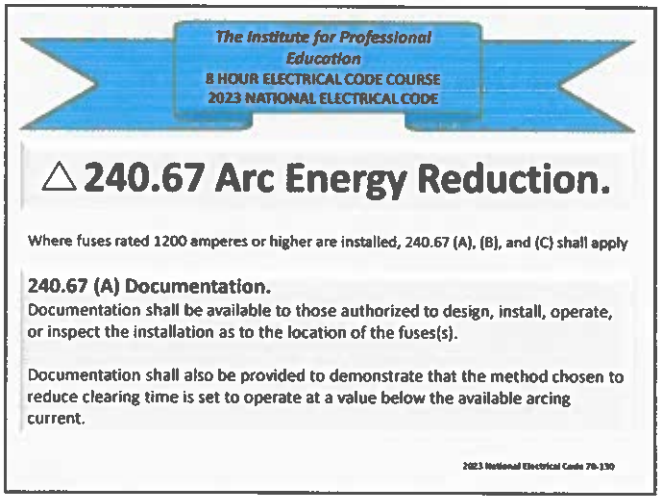
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△240.67 Arc Energy Reduction.
Where fuses rated 1200 amperes or higher are installed, 240.67 (A), (B), and (C) shall apply
240.67 (A) Documentation.
Documentation shall be available to those authorized to design, install, operate, or inspect the installation as to the location of the fuses(s).
Documentation shall also be provided to demonstrate that the method chosen to reduce clearing time is set to operate at a value below the available arcing current.

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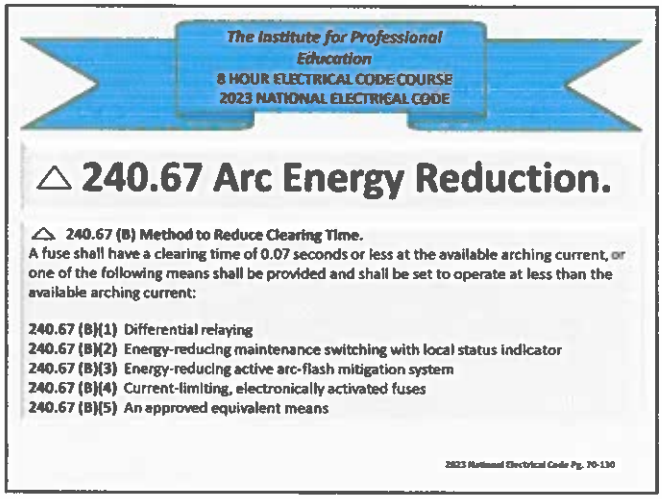
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△240.67 Arc Energy Reduction.
△ 240.67 (B) Method to Reduce Clearing Time.
A fuse shall have a clearing time of 0.07 seconds or less at the available arching current, or one of the following means shall be provided and shall be set to operate at less than the available arching current:
240.67 (B)(1) Differential relaying
240.67 (B)(2) Energy-reducing maintenance switching with local status indicator
240.67 (B)(3) Energy-reducing active arc-flash mitigation system
240.67 (B)(4) Current-limiting, electronically activated fuses
240.67 (B)(5) An approved equivalent means

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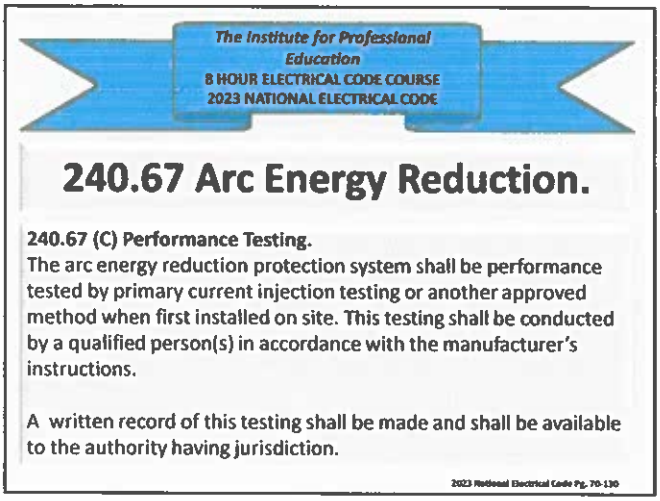
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2023 NATIONAL ELECTRICAL CODE
240.67 Arc Energy Reduction.
240.67 (C) Performance Testing.
The arc energy reduction protection system shall be performance tested by primary current injection testing or another approved method when first installed on site. This testing shall be conducted by a qualified person(s) in accordance with the manufacturer's instructions.
A written record of this testing shall be made and shall be available to the authority having jurisdiction.

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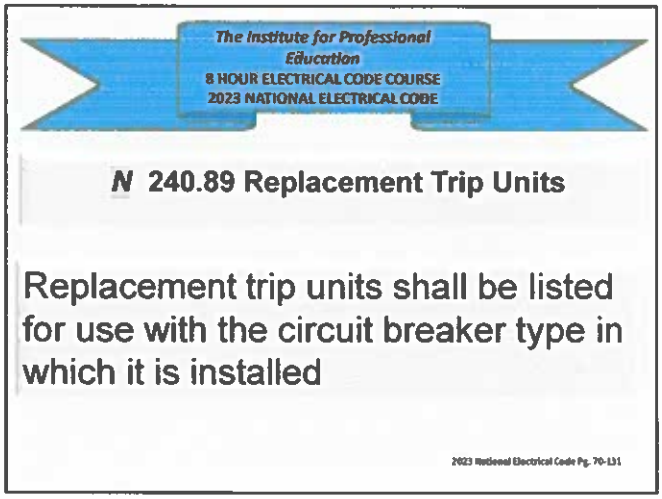
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N 240.89 Replacement Trip Units
Replacement trip units shall be listed for use with the circuit breaker type in which it is installed

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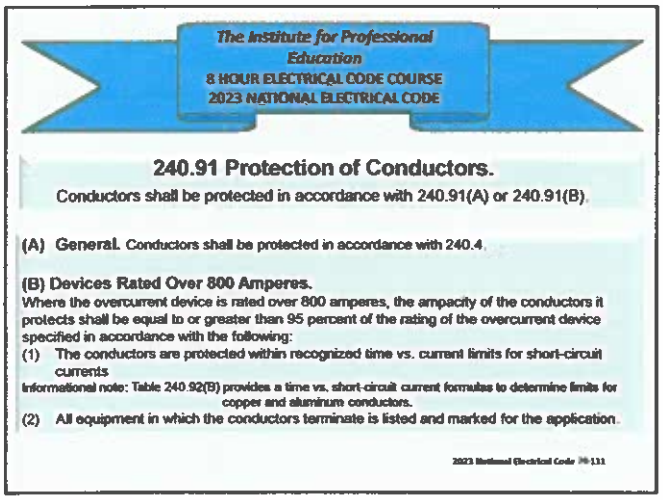
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240.91 Protection of Conductors.
Conductors shall be protected in accordance with 240.91(A) or 240.91(B).
(A) General. Conductors shall be protected in accordance with 240.4.
(B) Devices Rated Over 800 Amperes.
Where the overcurrent device is rated over 800 amperes, the ampacity of the conductors it protects shall be equal to or greater than 95 percent of the rating of the overcurrent device specified in accordance with the following:
(1) The conductors are protected within recognized time vs. current limits for short-circuit currents
Informational note: Table 240.92(B) provides a time vs. short-circuit current formulas to determine limits for copper and aluminum conductors.
(2) All equipment in which the conductors terminate is listed and marked for the application.
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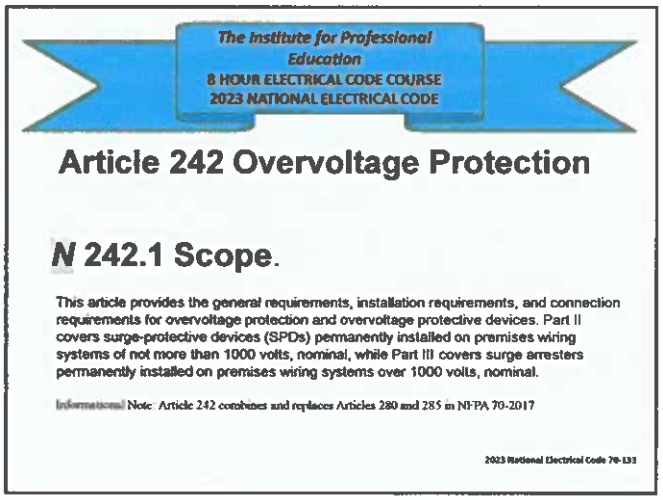
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Article 242 Overvoltage Protection
N 242.1 Scope.
This article provides the general requirements, installation requirements, and connection requirements for overvoltage protection and overvoltage protective devices. Part II covers surge-protective devices (SPDs) permanently installed on premises wiring systems of not more than 1000 volts, nominal, while Part III covers surge arresters permanently installed on premises wiring systems over 1000 volts, nominal.
Informational Note: Article 242 combines and replaces Articles 280 and 285 in NFPA 70-2017
2023 National Electrical Code 70-133

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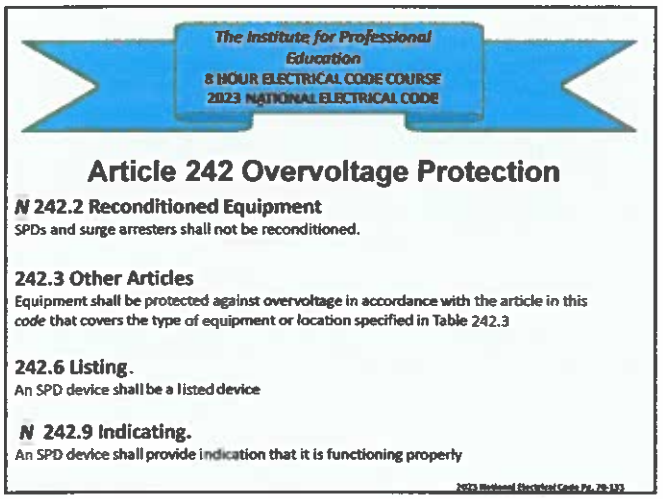
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Article 242 Overvoltage Protection
N 242.2 Reconditioned Equipment
SPDs and surge arresters shall not be reconditioned.
242.3 Other Articles
Equipment shall be protected against overvoltage in accordance with the article in this code that covers the type of equipment or location specified in Table 242.3
242.6 Listing.
An SPD device shall be a listed device
N 242.9 Indicating.
An SPD device shall provide indication that it is functioning properly
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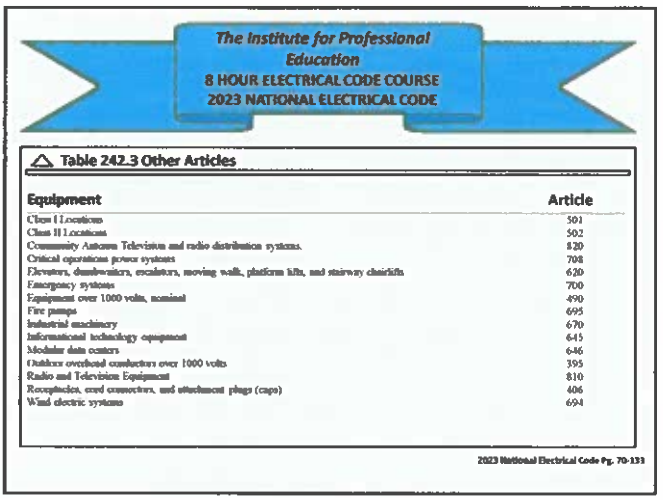
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Table 242.3 Other Articles
Equipment
Article
Class I Locations 501
Class II Locations 502
Community Antenna Television and radio distribution systems. 820
Critical operations power systems 708
Elevators, dumbwaiters, escalators, moving walk, platform lift, and stairway chairlifts 620
Emergency systems 700
Equipment over 1000 volts, nominal 490
Fire pumps 695
Industrial machinery 670
Informational technology equipment 645
Modular data centers 646
Outdoor overhead conductors over 1000 volts 395
Radio and Television Equipment 810
Receptacles, cord connectors, and attachment plugs (caps) 406
Wind electric systems 694
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Article 242 Overvoltage Protection

N 242.12 Uses Not Permitted

An SPD device shall not be installed the following:

(1) Circuits over 1000 volts
(2) On ungrounded systems, impedance grounded systems, or corner grounded delta systems unless listed specifically for use on these systems
(3) Where the rating of the SPD is less than the maximum continuous phase-to -ground voltage at the power frequency available at the point of application

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Article 242 Overvoltage Protection

242.13 Type 1 SPDs.

Type 1 SPDs shall be installed in accordance with 242.13(A) and (B).

242.13(A) Installation. Type 1 SPDs shall be permitted to be connected in accordance with one of the following:
(1) The supply side of the service disconnect as permitted in 230.82(4)
(2) As specified in 242.14

242.13(B) At the Service. When installed in services, Type 1 SPDs shall be connected to one of the following:
(1) Grounded service conductor
(2) Grounding electrode conductor
(3) Grounding electrode for the service
(4) Equipment grounding terminal in the service equipment

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Article 242 Overvoltage Protection

242.13 Type I SPDs. Type I SPDs shall be installed in accordance with 242.13 (A)

Meter socket Type one SPD

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Article 242 Overvoltage Protection

242.13 Type I SPDs. Type I SPDs shall be installed in accordance with 242.13 (A)

Meter Socket Type One Surge Protector

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Article 242 Overvoltage Protection

242.13 Type I SPDs. Type I SPDs shall be installed in accordance with 242.13 (A) and (B)

Breaker Style Type One Device

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Article 242 Overvoltage Protection

242.14 Type 2 SPDs.
Type 2 SPDs shall be in accordance with 242.14 (A) through (C).

242.14 (A) Service-Supplied Building or Structure.
Type 2 SPDs shall be connected anywhere on the load side of a service disconnect overcurrent device required in 230.91 unless installed in accordance with 230.82(8).

242.14 (B) Feeder-Supplied Building or Structure.
Type 2 SPDs shall be connected at the building or structure anywhere on the load side of the first overcurrent device at the building or structure.

242.14 (C) Separately Derived System.
The SPD shall be connected on the load side of the first overcurrent device in a separately derived system.

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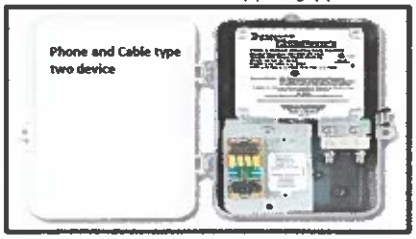
Article 242 Overvoltage Protection

242.14 Type 2 SPDs.
Type 2 SPDs shall be accordance with 242.14 (A) through (C).



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Article 242 Overvoltage Protection

242.14 Type 2 SPDs.
Type 2 SPDs shall be accordance with 242.14 (A) through (C).

Whole house type two device

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Article 242 Overvoltage Protection

242.16 Type 3 SPDs.

Type 3 SPDs shall be permitted to be installed on the load side of branch-circuit overcurrent protection up to the equipment served. If included in the manufacturer's instructions, the Type 3 SPD connection shall be a minimum 10m (30ft) of conductor distance from the service or separately derived system disconnect.

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Article 242 Overvoltage Protection

242.16 Type 3 SPDs.

Phase to Phase type three Surge Protective Device

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Article 242 Overvoltage Protection

242.18 Type 4 and Other Component Type SPDs.

Type 4 component assemblies and other component type SPSs shall only be installed by the equipment manufacturer.

242.20 Number Required

Where used at a point on a circuit, the SPD shall be connected to each ungrounded conductor.

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Article 242 Overvoltage Protection

242.22 Location.

SPDs shall be permitted to be located indoors or outdoors and shall be made inaccessible to unqualified persons unless listed for installation inaccessible locations Pg.70-133

242.24 Routing of Connections.

The conductors used to connect the SPD to the line or bus and to ground shall not be any longer than necessary and shall avoid unnecessary bends. Pg. 70-134

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2023 NATIONAL ELECTRICAL CODE

Article 242 Overvoltage Protection

242.28 Conductor Size.
Line and grounding conductors shall not be smaller than 14 AWG copper or 12 AWG aluminum.

242.30 Connection Between Conductors.
An SPD shall be permitted to be connected between any two conductors ungrounded conductor(s), grounded conductor, equipment grounding conductor, or grounding electrode conductor. The grounded conductor and the equipment grounding conductor shall be interconnected only by the normal operation of the SPD during a surge.

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Article 242 Overvoltage Protection

242.32 Grounding Electrode Conductor Connections and Enclosures.

Except as indicated in this article, SPD grounding connections shall be made as specified in Article 250 Part III. Grounding electrode conductors installed in metal enclosures shall comply with 250.64(E).

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Article 242 Overvoltage Protection

Part III Surge Arresters, Over 1000 volts

242. 40 Uses Not Permitted.

A surge arrester shall not be installed where the rating of the surge arrester is less than the maximum continuous phase-to-ground voltage at the power frequency available at the point of application

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Article 242 Overvoltage Protection

Part III Surge Arresters, Over 1000 volts
242. 42 Surge arrester Rating.

The duty cycle rating of a surge arrester shall be not less than 125 percent of the maximum continuous operating voltage available at the point of application.

For solidly grounded systems, the maximum continuous operating voltage shall be the phase-to-ground voltage of the system.

For impedance or ungrounded systems, the maximum continuous operating voltage shall be the phase-to-ground voltage of the system

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Article 242 Overvoltage Protection

Part III Surge Arresters, Over 1000 volts

242. 44 Number Required.

Where used at a point on a circuit, a surge arrester shall be connected to each ungrounded conductor. A single installation of such arresters shall be permitted to protect a number of interconnected circuits if no circuit is exposed to surges while disconnected from the surge arresters.

242.46 Location

Surge arresters shall be permitted to be located indoors and outdoors. Surge arresters shall be made inaccessible to unqualified persons unless listed for installation in Accessible locations

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Article 242 Overvoltage Protection

Part III Surge Arresters, Over 1000 volts

242.48 Routing of Surge Arrester Equipment Grounding Conductors.

The conductor used to connect the surge arrester to line, bus, or equipment and to an equipment grounding conductor or grounding electrode connection point as provided in 242.50 shall not be any longer than necessary and shall avoid unnecessary bends.

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Article 242 Overvoltage Protection

Part III Surge Arresters, Over 1000 volts

242. 50 Connections.

The arrester shall be connected to one of the following:
(1) Grounded service conductor
(2) Grounding electrode conductor
(3) Grounding electrode for the service
(4) Equipment grounding terminal in the service equipment

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Article 242 Overvoltage Protection

Part III Surge Arresters, Over 1000 volts

242. 52 Surge-Arrester Conductors.

The conductor between the surge arrester and the line, and the surge arrester and the grounding connection, shall not be smaller than 6 AWG copper or aluminum.

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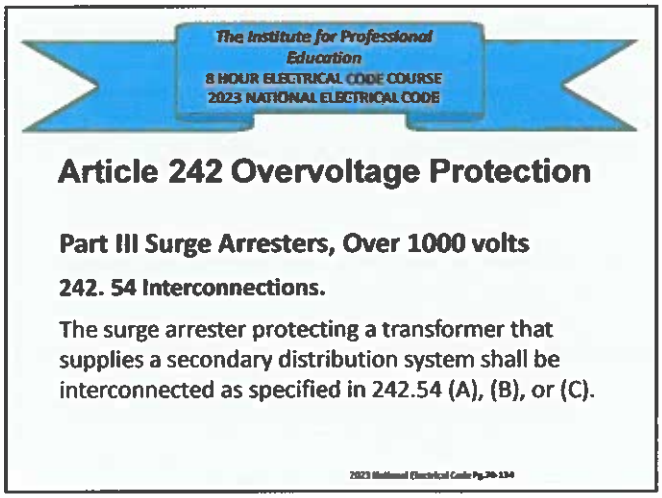
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8 HOUR ELECTRICAL CODE COURSE
2023 NATIONAL ELECTRICAL CODE
Article 242 Overvoltage Protection
Part III Surge Arresters, Over 1000 volts
242. 54 Interconnections.
The surge arrester protecting a transformer that supplies a secondary distribution system shall be interconnected as specified in 242.54 (A), (B), or (C).

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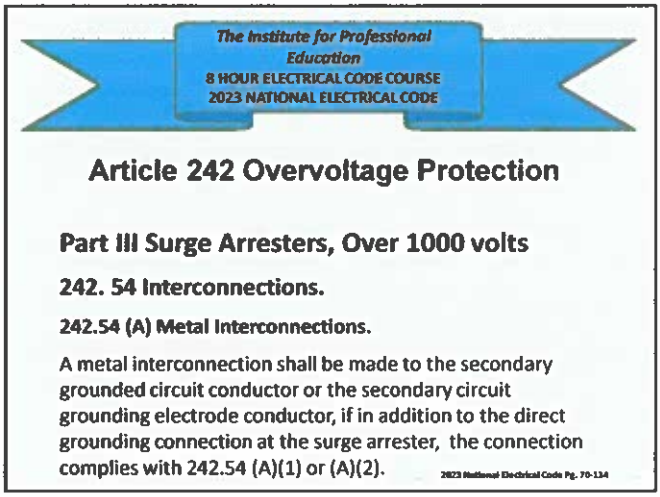
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Article 242 Overvoltage Protection
Part III Surge Arresters, Over 1000 volts
242. 54 Interconnections.
242.54 (A) Metal Interconnections.
A metal interconnection shall be made to the secondary grounded circuit conductor or the secondary circuit grounding electrode conductor, if in addition to the direct grounding connection at the surge arrester, the connection complies with 242.54 (A)(1) or (A)(2).

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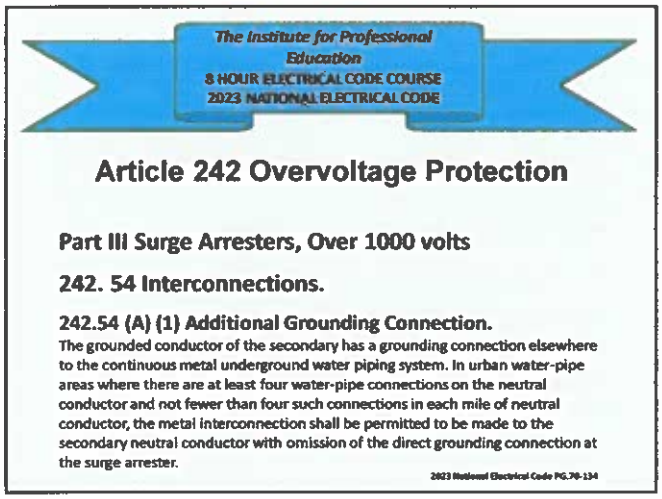
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Article 242 Overvoltage Protection
Part III Surge Arresters, Over 1000 volts
242. 54 Interconnections.
242.54 (A) (1) Additional Grounding Connection.
The grounded conductor of the secondary has a grounding connection elsewhere to the continuous metal underground water piping system. In urban water-pipe areas where there are at least four water-pipe connections on the neutral conductor and not fewer than four such connections in each mile of neutral conductor, the metal interconnection shall be permitted to be made to the secondary neutral conductor with omission of the direct grounding connection at the surge arrester.

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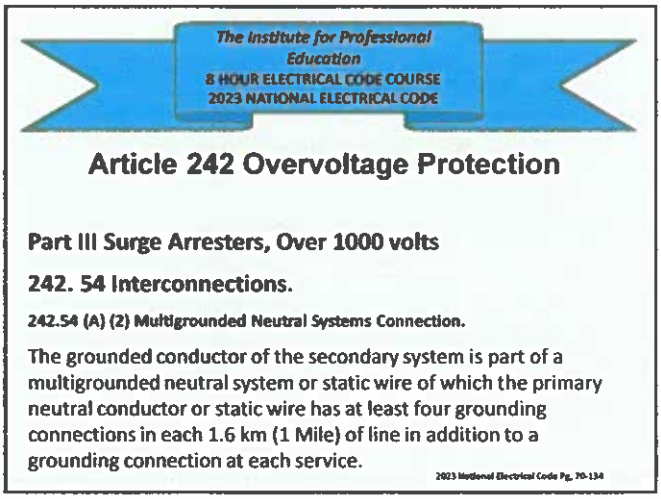
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Part III Surge Arresters, Over 1000 volts
242. 54 Interconnections.
242.54 (A) (2) Multigrounded Neutral Systems Connection.
The grounded conductor of the secondary system is part of a multigrounded neutral system or static wire of which the primary neutral conductor or static wire has at least four grounding connections in each 1.6 km (1 Mile) of line in addition to a grounding connection at each service.

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Article 242 Overvoltage Protection

Part III Surge Arresters, Over 1000 volts

242. 54 Interconnections.

242.54 (B) Through Spark Gap or Device.

Where the surge arrester grounding electrode conductor is not connected as in 242.54(A), or where the secondary is not grounded as in 242.54(A) but is otherwise grounded as in 250.52, an interconnection shall be made through a spark gap or listed device as required by 242.54 (B)(1) or (B)(2).

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Article 242 Overvoltage Protection

Part III Surge Arresters, Over 1000 volts

242. 54 Interconnections.

242.54 (B)(1) Ungrounded or Unigrounded Primary System

For ungrounded or unigrounded primary systems. The spark gap for a listed device shall have a 60-Hz breakdown voltage of at least twice the primary circuit voltage but not necessarily more than 10 Kv, and there shall be at least one other ground on the grounded conductor of the secondary that is not less than 6.0 m (20ft) distant from the surge-arrestor grounding electrode.

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Article 242 Overvoltage Protection

Part III Surge Arresters, Over 1000 volts

242. 54 Interconnections.

242.54 (B)(2) Multigrounded Neutral Primary System.

For multigrounded neutral primary systems, the spark gap or listed device shall have a 60-Hz breakdown of not more than 3Kv, and there shall be at least one other ground on the grounded conductor of the secondary that is not less than 6.0 m (20 ft) distant from the surge-arrester grounding electrode.

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Article 242 Overvoltage Protection

Part III Surge Arresters, Over 1000 volts

242. 54 Interconnections.

242.54 (C) By Special Permission.

An interconnection of the surge-arrester ground and the secondary neutral conductor, other than as provided in 242.54 (A) or B), shall be permitted to be made only by special permission

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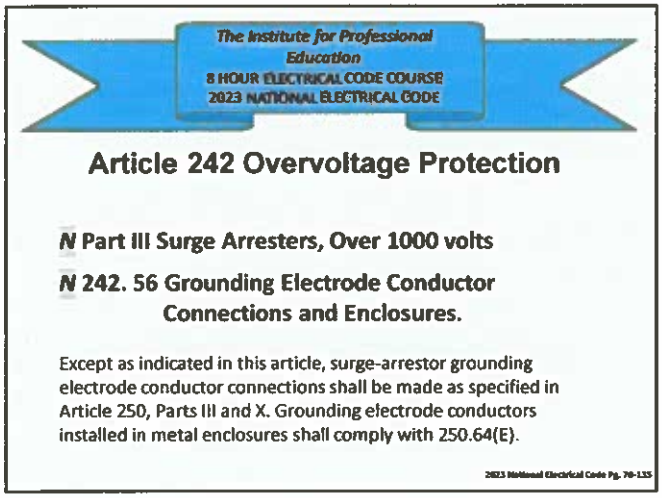

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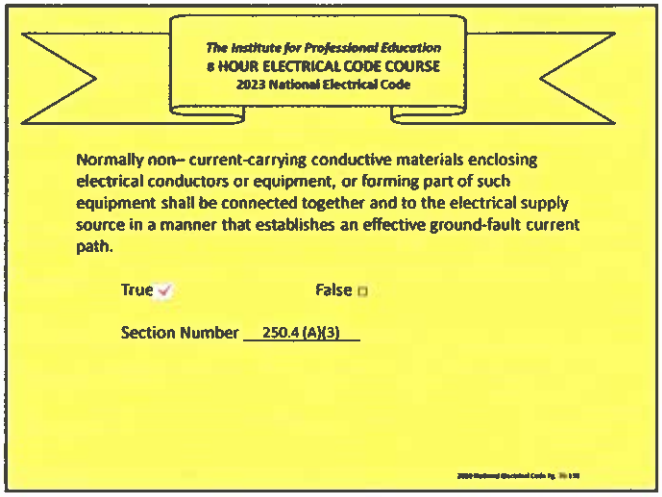

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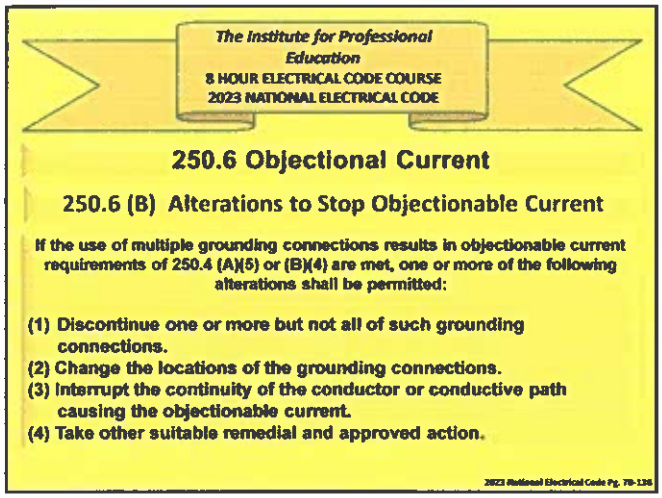

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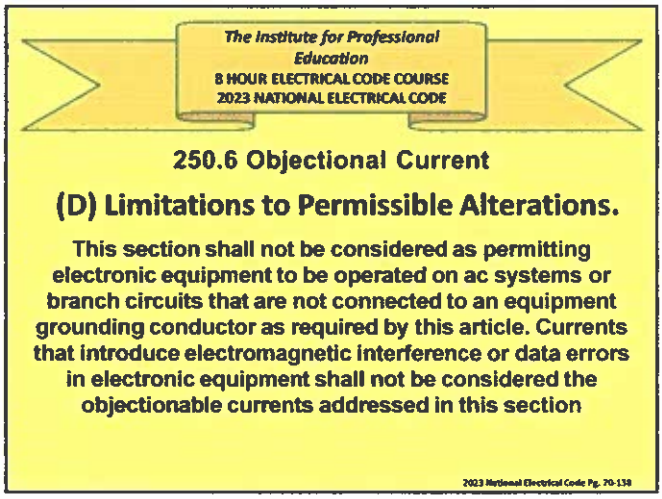

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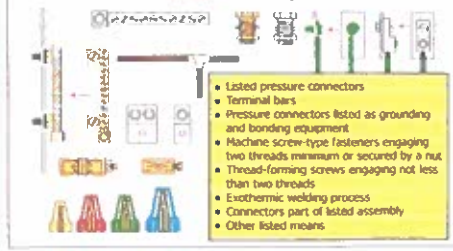
Article 250 2023 National Electrical Code

250.8 Grounding and Bonding Connections

(A) Permitted Methods. Equipment grounding conductors, grounding electrode conductors, and bonding jumpers shall be connected by one or more of the following means:



- Listed pressure connectors
- Terminal bars
- Pressure connectors listed as grounding and bonding equipment
- Machine screw-type fasteners engaging two threads minimum or secured by a nut
- Thread-forming screws engaging not less than two threads
- Exothermic welding process
- Connectors part of listed assembly
- Other listed means

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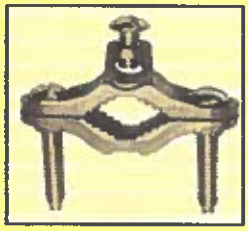
250.10 Protection of Ground Clamps and Fittings.

Ground clamps or other fittings exposed to physical damage shall be enclosed in metal, wood, or equivalent protective covering.



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△ Article 250.12 Clean Surfaces

Nonconductive coating (such as paint, lacquer, and enamel) on equipment to be grounded or bonded shall be removed from threads and other contact surfaces to ensure good electrical continuity or shall be connected by means of fittings designed so as to make such removal unnecessary.

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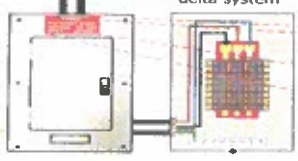
250.21(C) Marking - Ungrounded Systems

Ungrounded systems shall be legibly marked "Caution Ungrounded System Operating ___ Volts Between Conductors" at the source or first disconnecting means of the system.

The marking shall be of sufficient durability to withstand the environment involved.

Ungrounded three-phase, three-wire delta system



Marking requirements are required for ungrounded systems to indicate an ungrounded system

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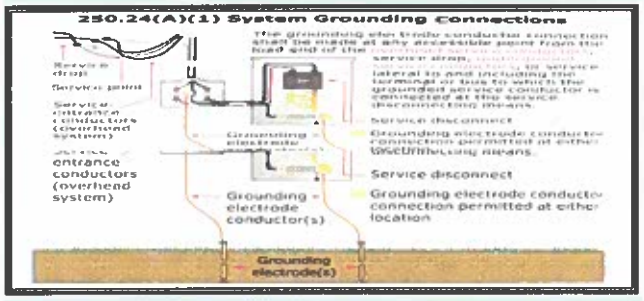
250.24 Grounding of Service-Supplied Alternating-Current Systems.



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△ 250.24(C) Main Bonding Jumper

For a grounded system, an unspliced main bonding jumper shall be used to connect the equipment grounding conductor(s) and the service-disconnect enclosure to the grounded conductor within the enclosure for each service disconnect in accordance with 250.28

Exception No. 2: Impedance grounded systems shall be permitted to be connected in Accordance with 250.36 and 250.187.

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△ 250.24(D) Grounded Conductor Brought to Service Equipment.

If an ac system is operating at 1000 volts or less is grounded at any point, the grounded conductor(s) shall be routed with the ungrounded conductors to each service disconnection means and shall be connected to each disconnecting means grounded conductor(s) terminal bar or buss. A main bonding jumper shall connect the grounded conductor(s) to each service disconnecting means enclosure. The grounded conductors(s) shall be installed in accordance with 250.24(C)(1) and 250.24 (D)(1) through (D)(4)

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△ 250.24(D) Grounded Conductor Brought to Service Equipment.

Exception: If two or more service disconnection means are located in a single assembly listed for use as service equipment, it shall be permitted to connect the grounded conductor(s) to the assembly common grounded conductor(s) terminal or bus. The assembly shall include a main bonding jumper for connecting the grounded conductor(s) to the assembly enclosure.

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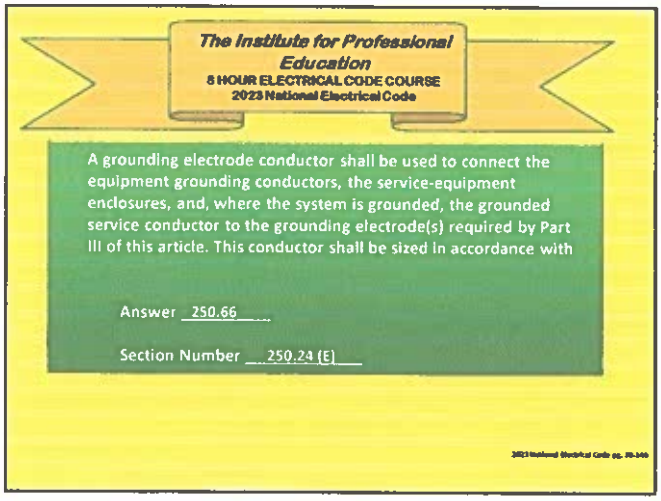

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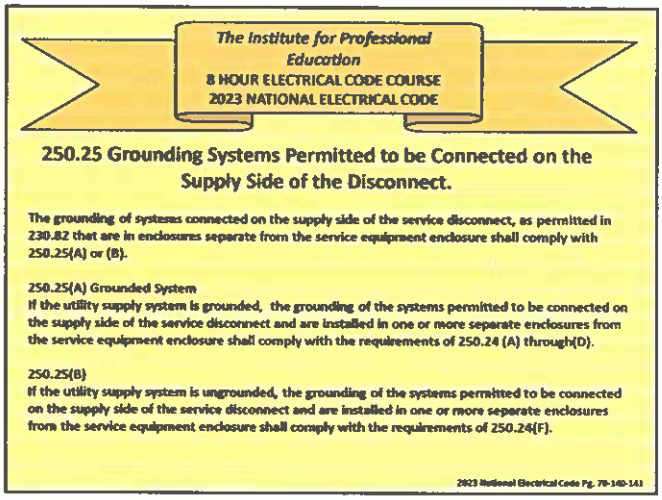

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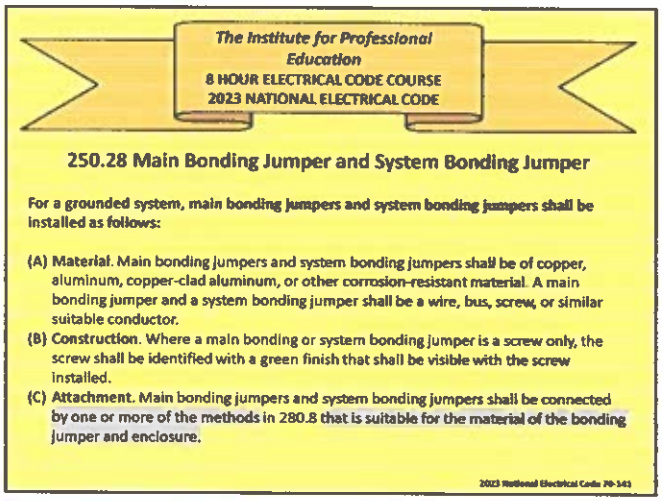

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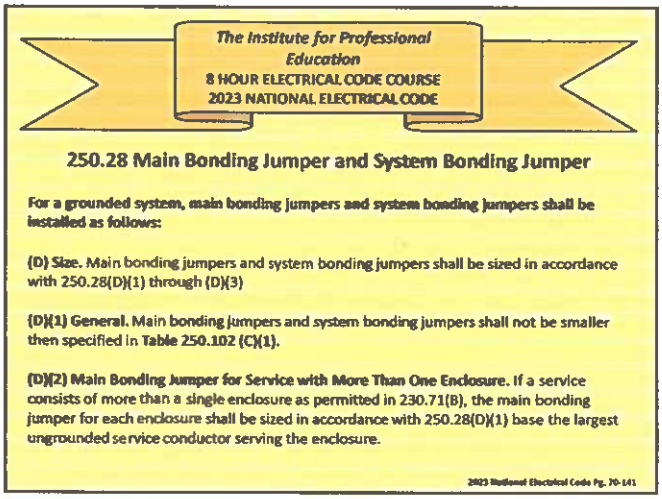

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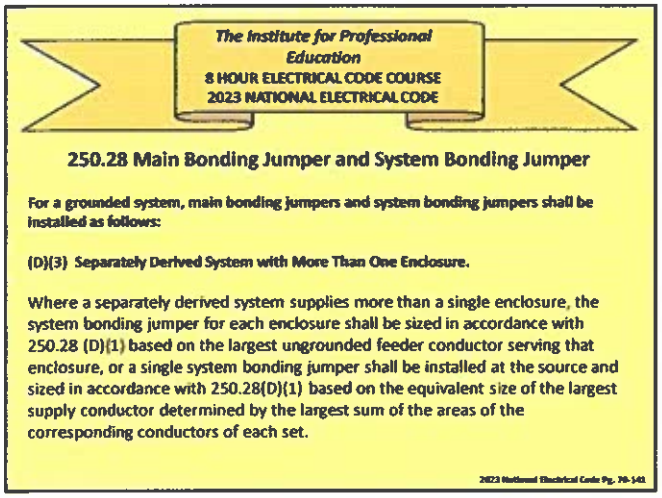

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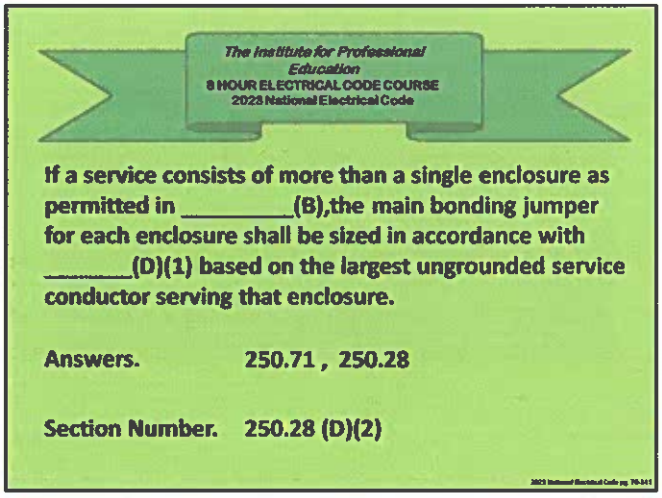

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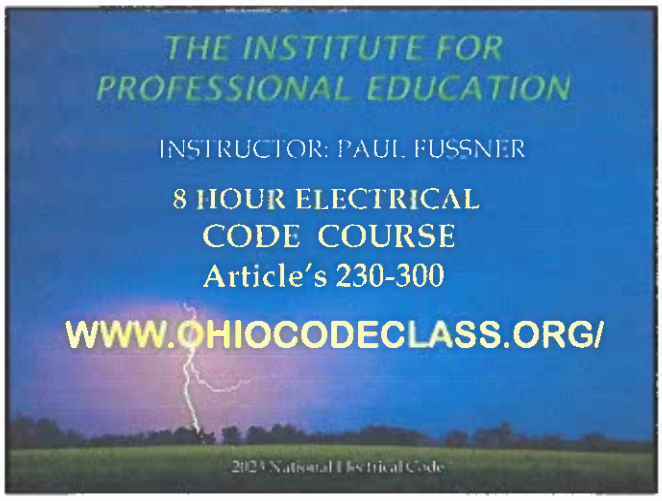

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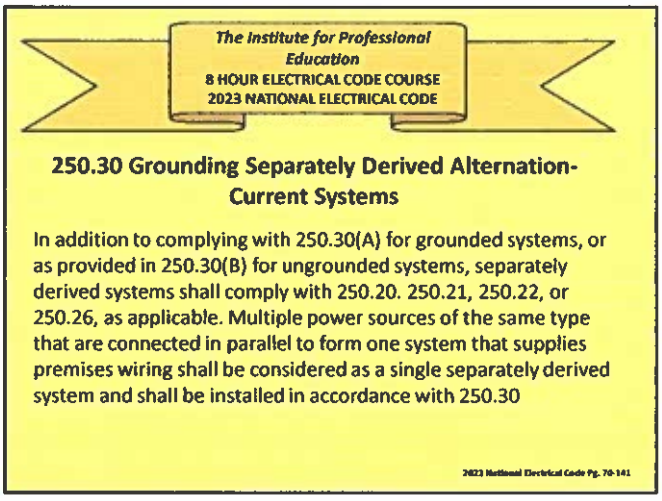

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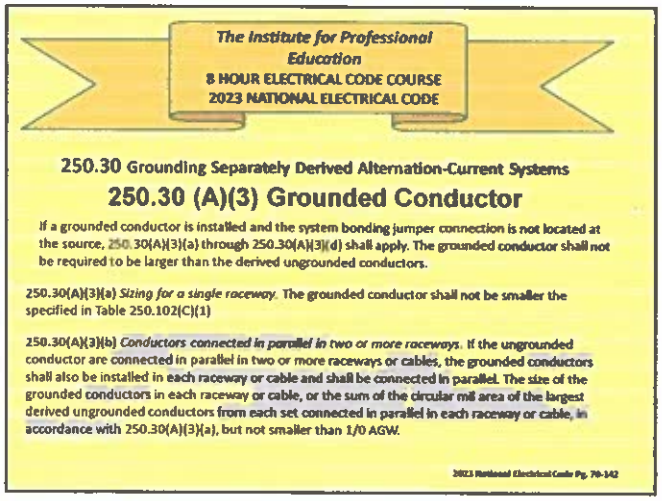

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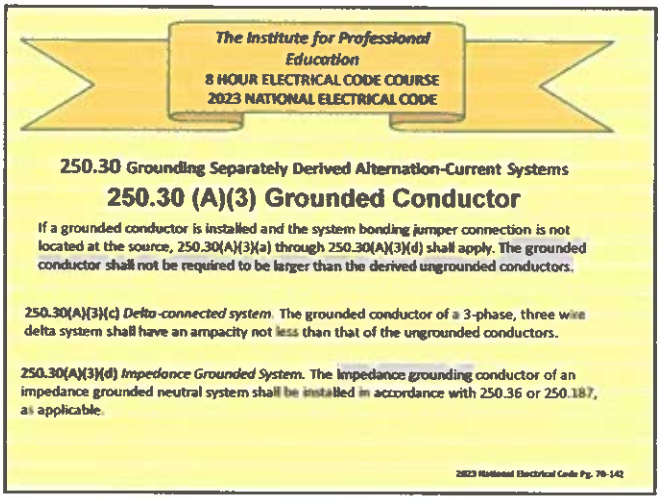

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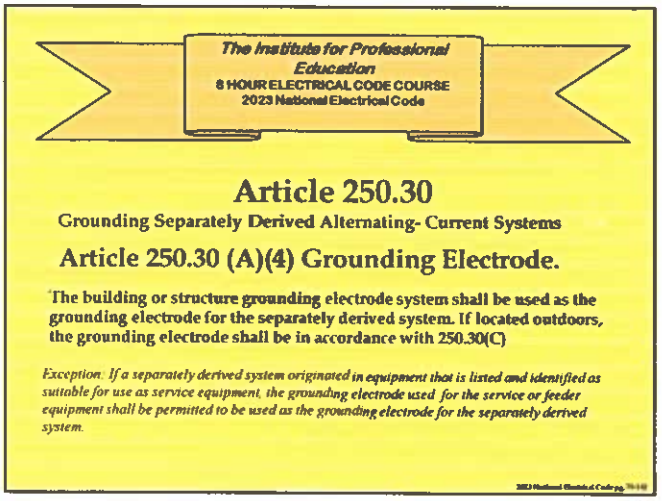

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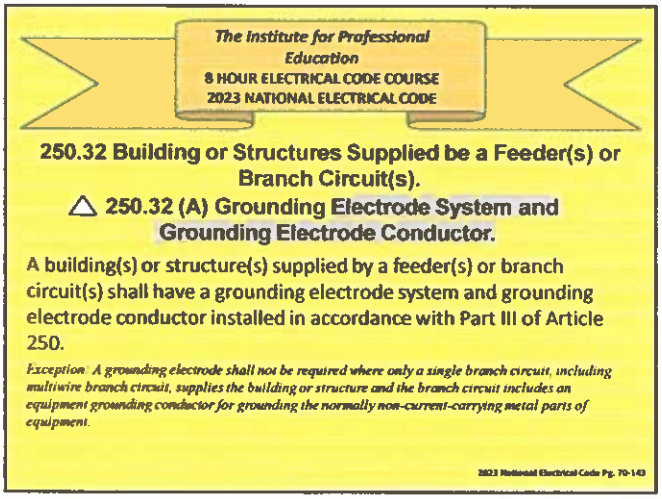

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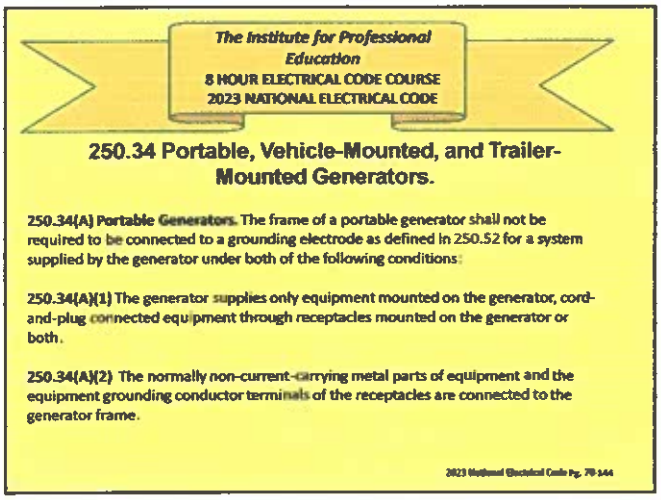

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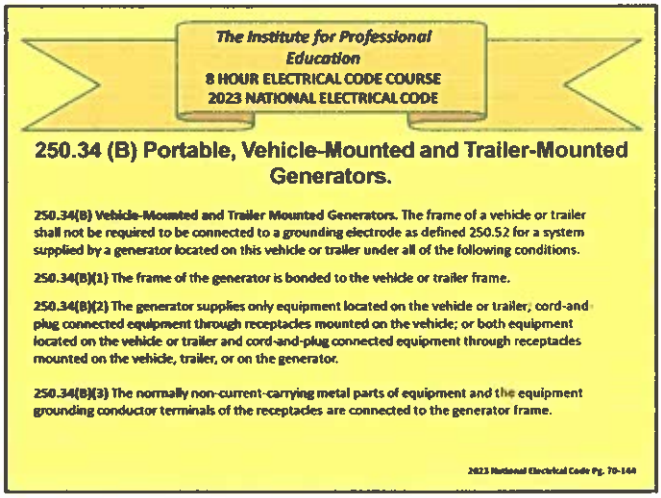

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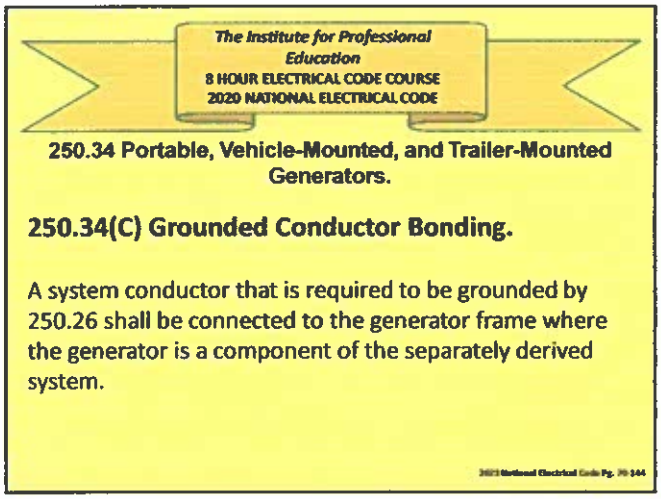

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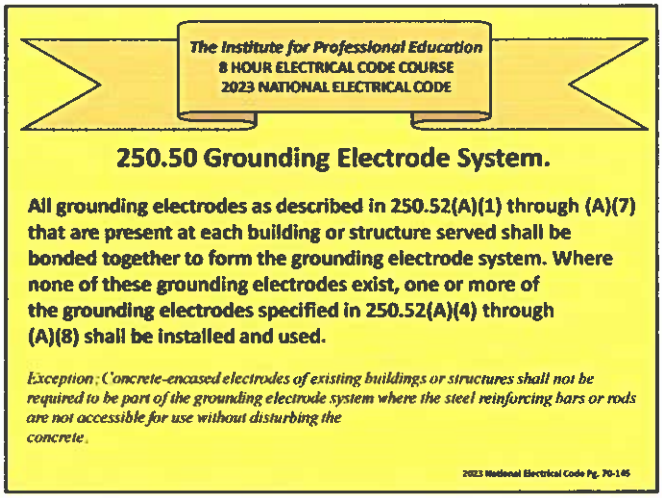

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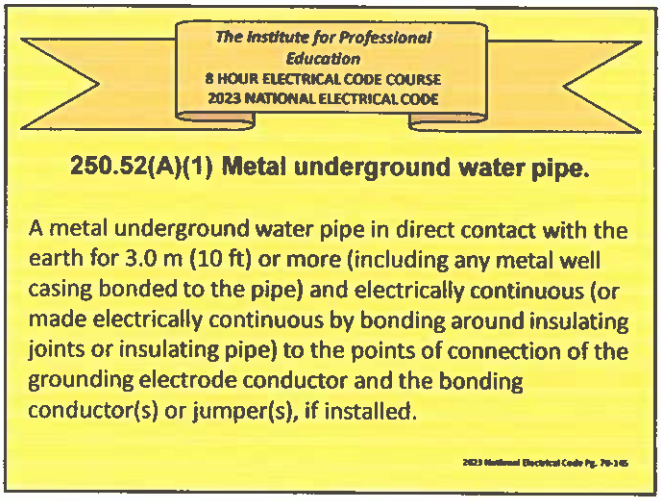

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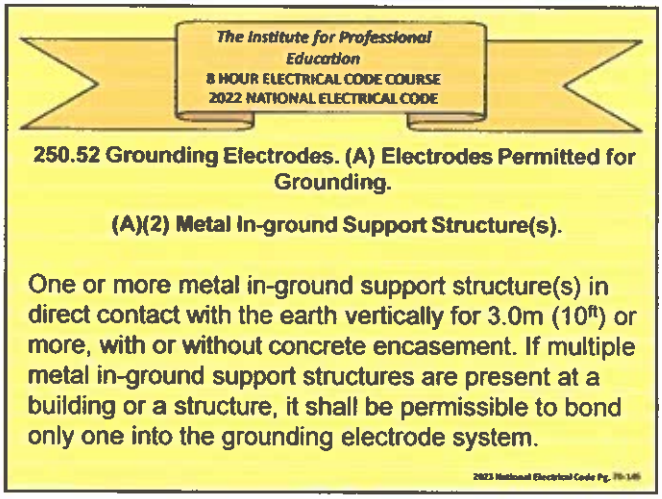

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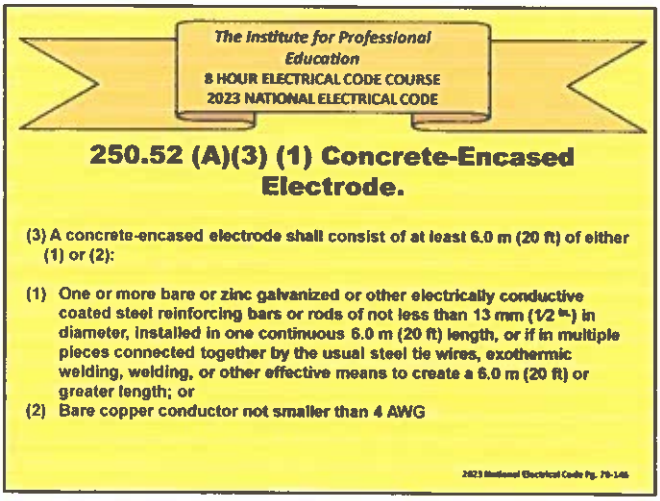

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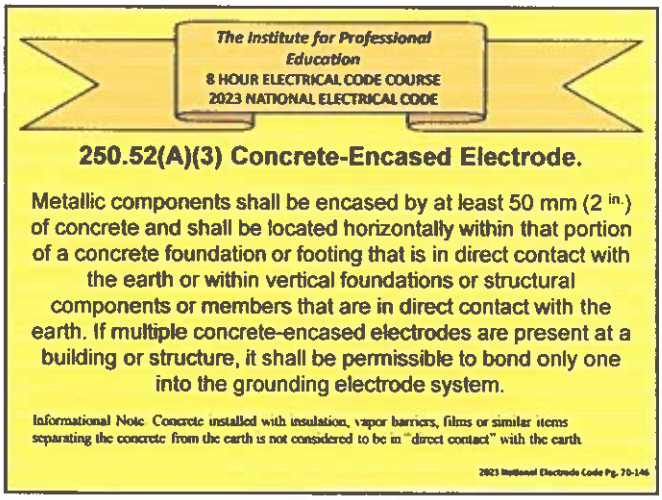

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250.52(A)(4) Ground Ring.

A ground ring encircling the building or structure, in direct contact with the earth, consisting of at least 6.0 m (20ft) of bare copper conductor not smaller than 2 AWG.

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250.52(A)(5) Rod and Pipe Electrodes.

Rod and pipe electrodes shall not be less than 2.44 m (8 ft) in length and shall consist of the following materials.

(a) Grounding electrodes of pipe or conduit shall not be smaller than metric designator 21 (trade size 3/4) and, where of steel, shall have the outer surface galvanized or otherwise metal-coated for corrosion protection.

(b) Rod-type grounding electrodes of stainless steel and copper or zinc coated steel shall be at least 15.87 mm (5/8 in.) in diameter, unless listed.

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250.52(A)(6) (6) Other Listed Electrodes.

Other listed grounding electrodes shall be permitted.

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250.52(A)(7) Plate Electrodes.

Each plate electrode shall expose not less than 0.186 m2 (2 ft^2) of surface to exterior soil. Electrodes of bare or electrically conductive coated iron or steel plates shall be at least 6.4 mm (1/4 in.) in thickness. Solid, uncoated electrodes of nonferrous metal shall be at least 1.5 mm (0.06 in.) in thickness.

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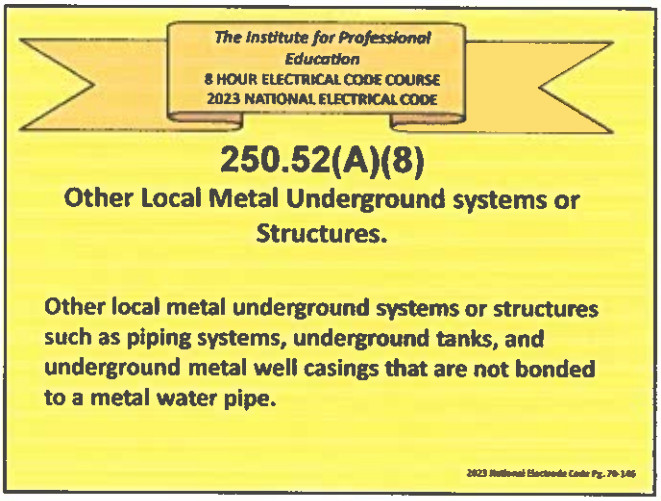

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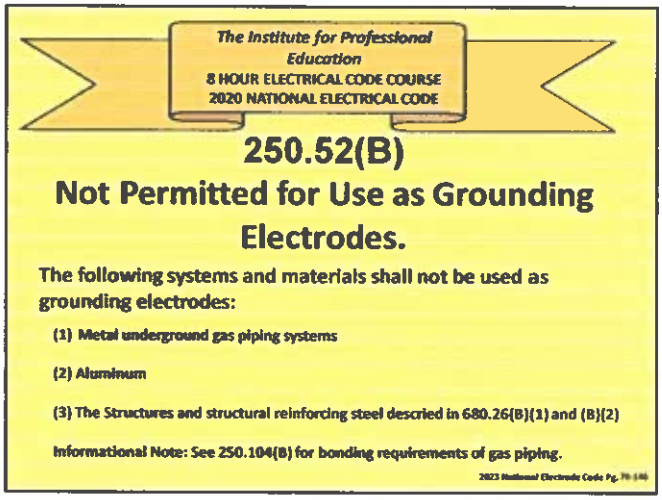

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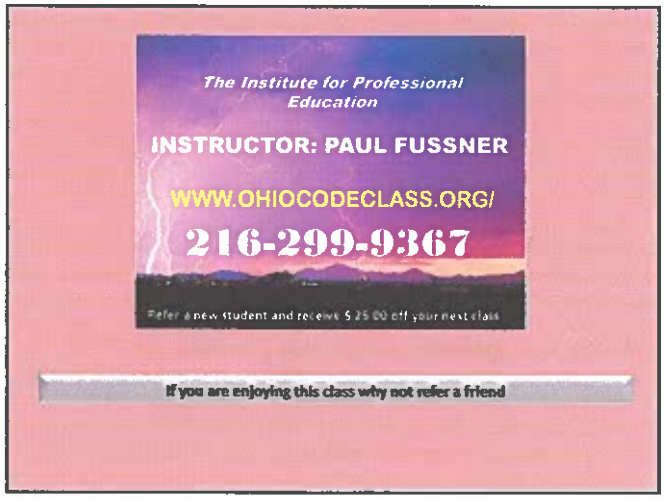

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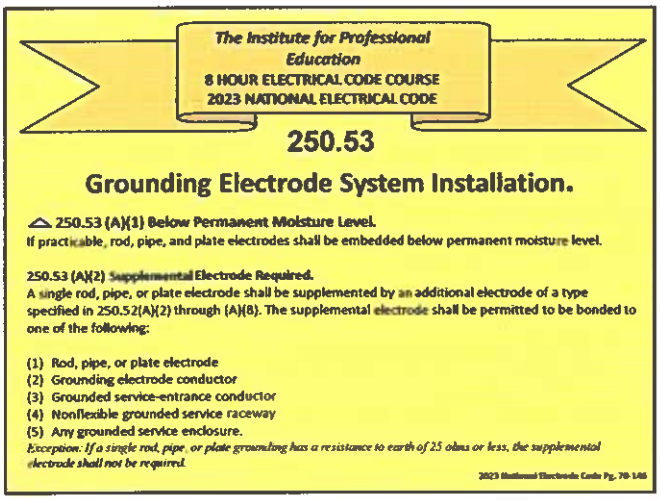

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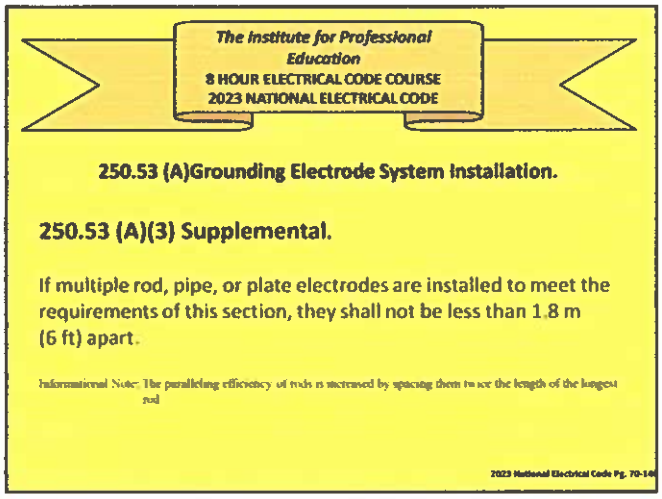

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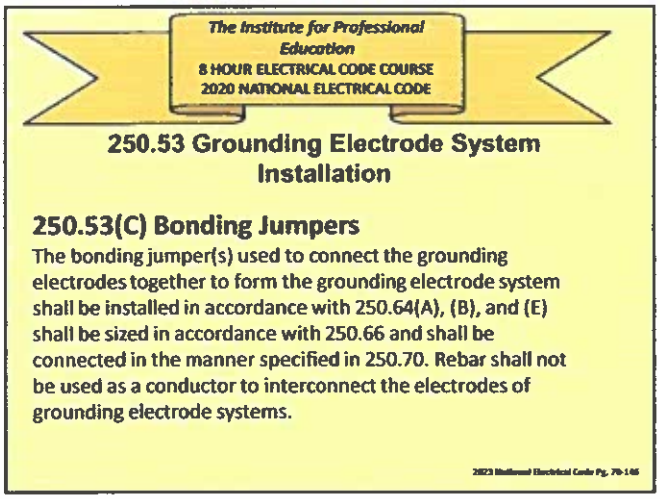

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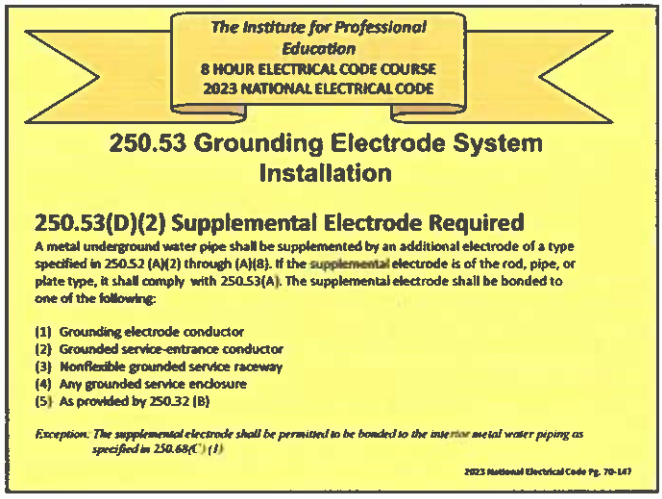

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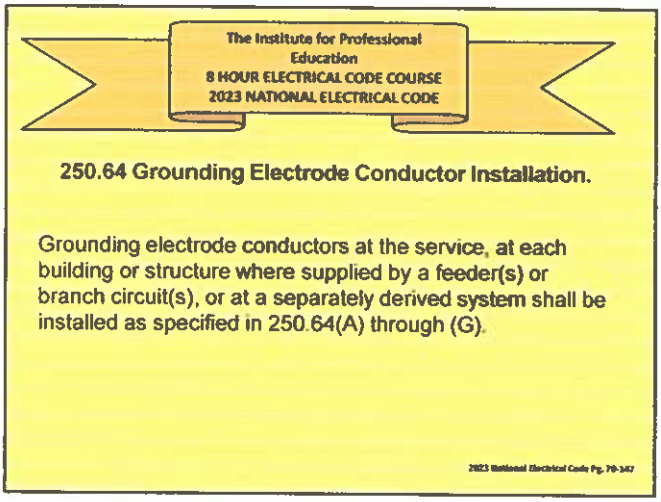

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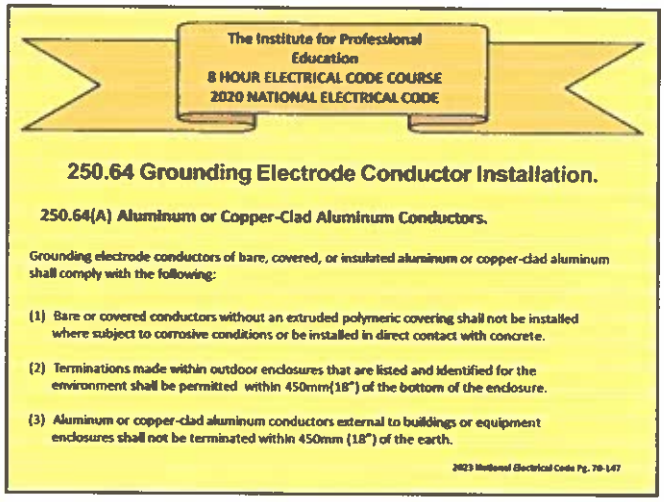

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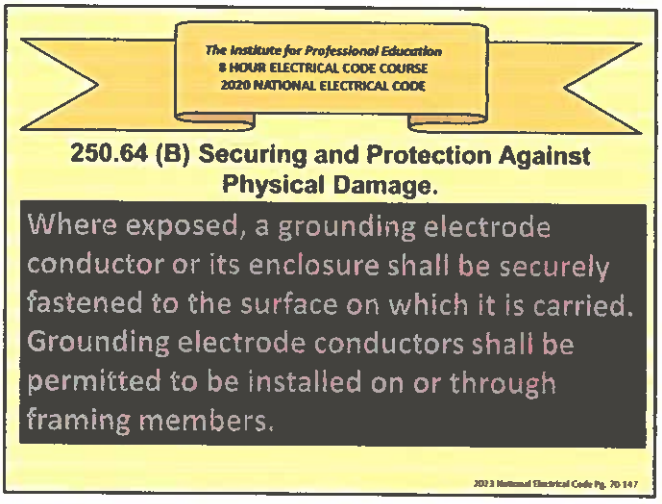

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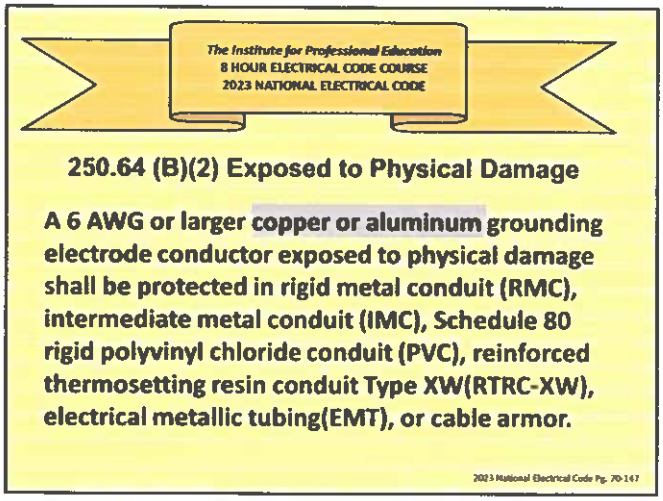

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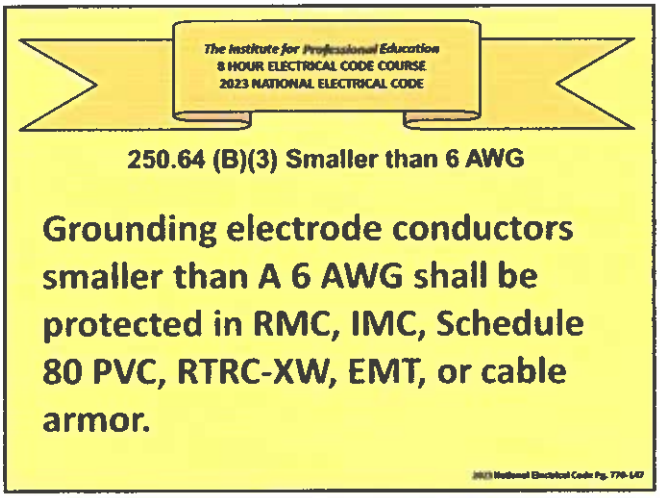

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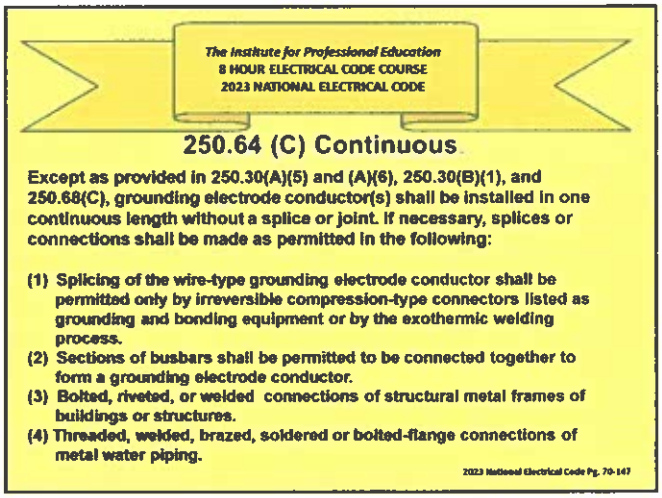

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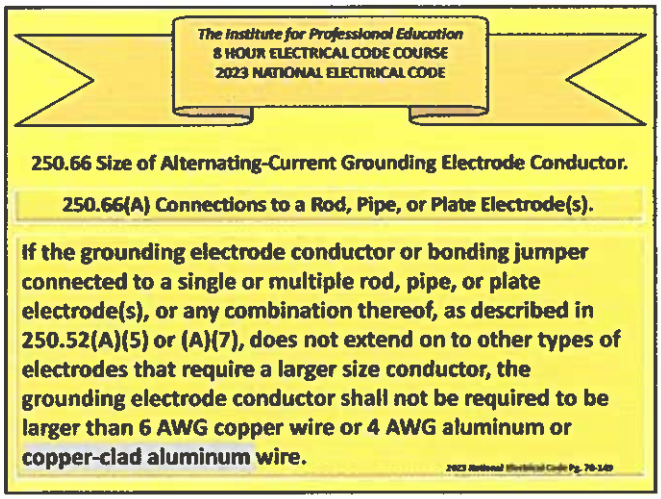

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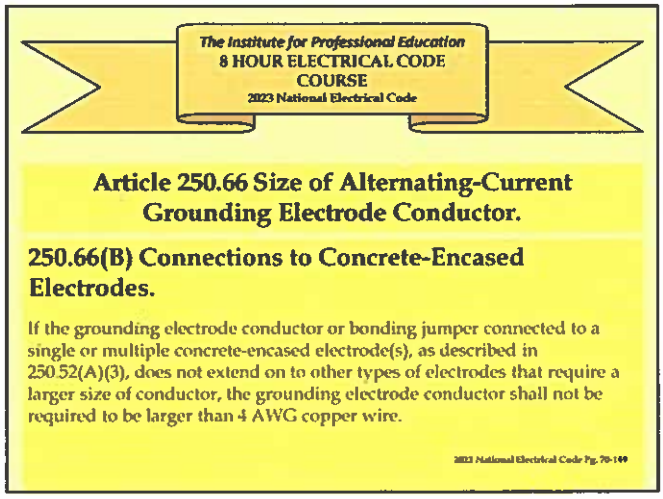

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The Institute for Professional Education
8 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code

The contractor has installed a replacement 240-volt water heater and utilized die-electric union to make his connection to the water lines. What does the *Code* require the contractor to do to meet the requirements of grounding/bonding of the water piping system? What article of the *Code* requires this grounding/bonding?

The contractor must provide a bonding jumper from the hot water pipe to the cold water pipe, the bonding jumper shall be of sufficient length to permit removal of such equipment while retaining the integrity of the bond.

Section Number. 250.68 (B)

2023 National Electrical Code Pg. 70-148

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The Institute for Professional Education
8 HOUR ELECTRICAL CODE COURSE
2020 National Electrical Code

Article 250.68 Grounding Electrode Conductor and Bonding Jumper Connection to Grounding Electrodes.

The connection of a grounding electrode conductor at the service, at each building or structure where supplied by a feeder(s) or branch circuit(s) or at a separately derived system and associated bonding jumper(s), shall be made as specified in 250.68 (A) through(C)

2023 National Electrical Code Pg. 70-149

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The Institute for Professional Education
8 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code

Article 250.68 Grounding Electrode Conductor and Bonding Jumper Connection to Grounding Electrodes.

△ 250.68(C) Grounding Electrode Conductor Connections.

250.68(C)(1) Interior Metal water piping that is electrically continuous with a metal underground water pipe electrode and is located not more than 1.52m (5ft) from the point of entrance to the building **as measured along the water piping** shall be permitted to extend the connection to an electrode(s). Interior metal water piping located more than 1.52m(5ft) from the point of entrance to the building, **as measured along the water piping,** shall not be used as a conductor to interconnect electrodes of the grounding system.

2023 National Electrical Code Pg. 70-149

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The Institute for Professional Education
8 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code

Article 250.68 Grounding Electrode Conductor and Bonding Jumper Connection to Grounding Electrodes.

250.68(C)(1) ***Exception***

In industrial, commercial, and institutional buildings or structures, if conditions of maintenance and supervision ensure that only qualified persons service the installation, interior metal water piping located more than 1.52m (5ft) from the point of entrance to the building shall be permitted as a bonding conductor to interconnect electrodes that are part of the grounding electrode system or as a grounding electrode conductor, if the entire length other than short sections passing perpendicularly through walls, floors, or ceilings, of the interior metal water pipe that is being used for the conductor is exposed.

2023 National Electrical Code Pg. 70-149

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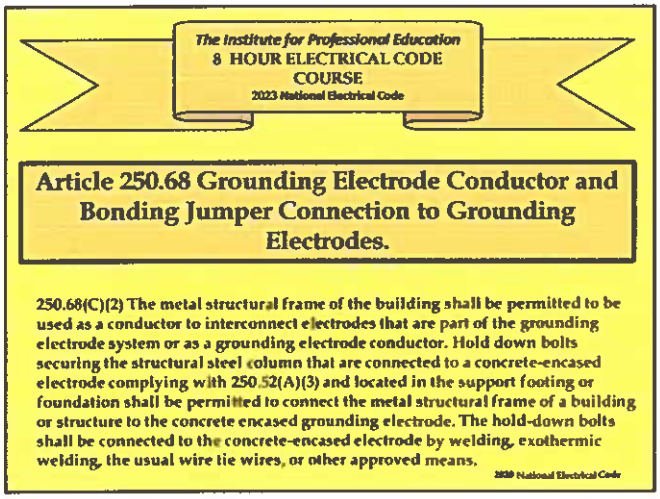

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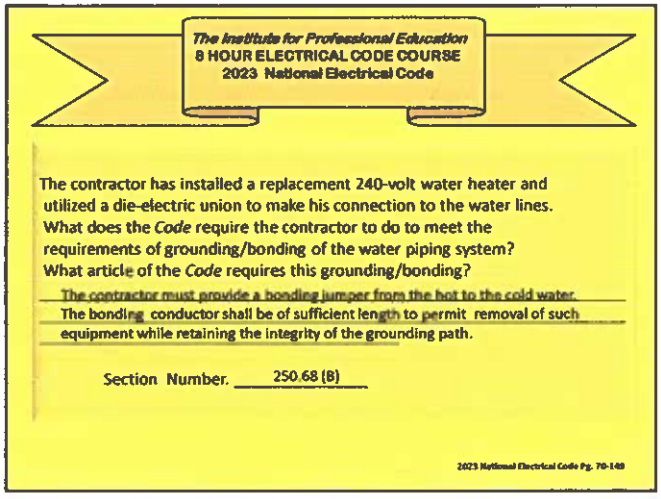

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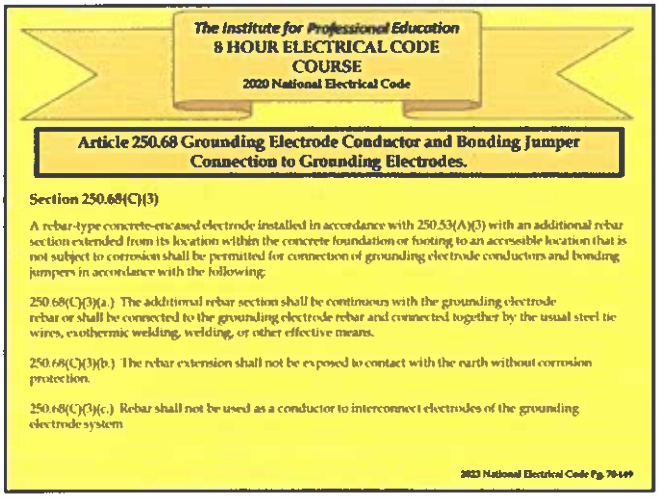

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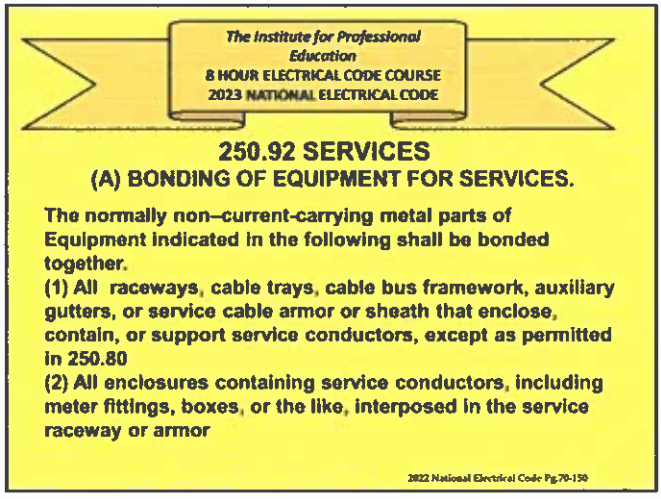

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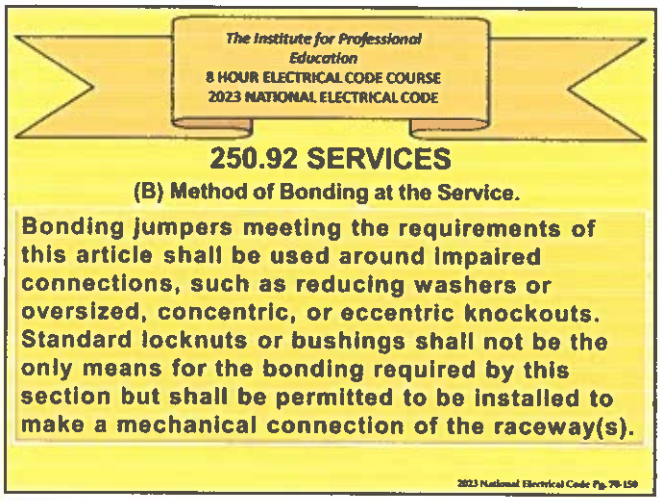

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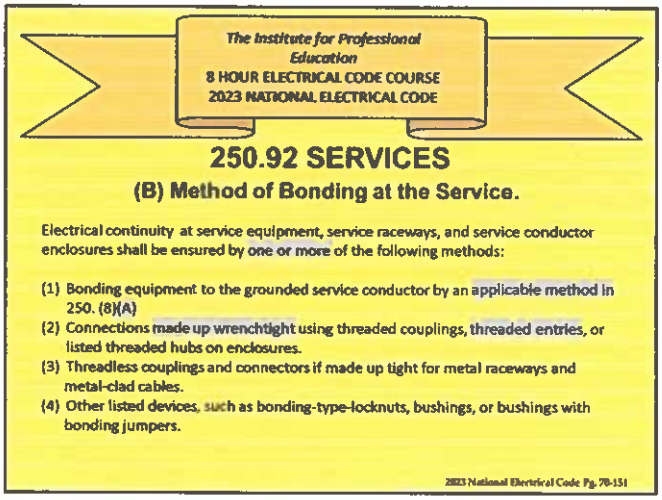

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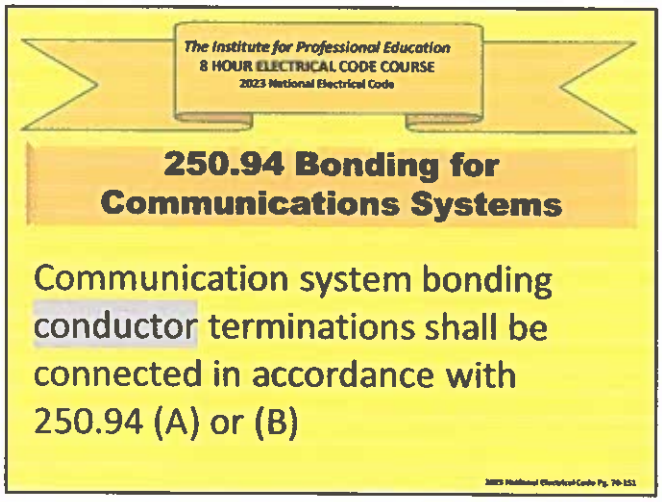

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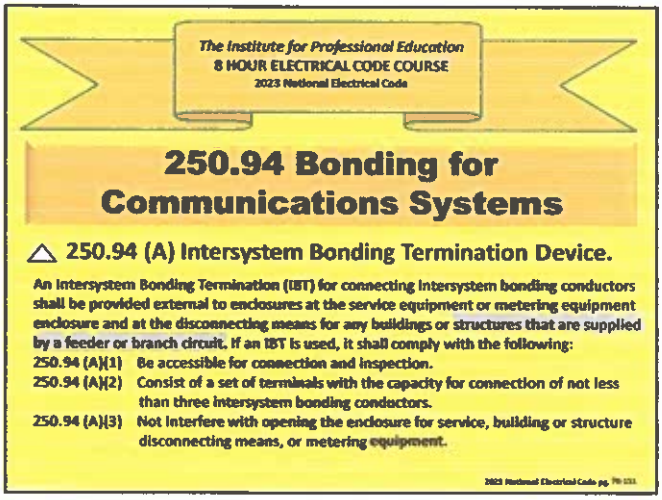

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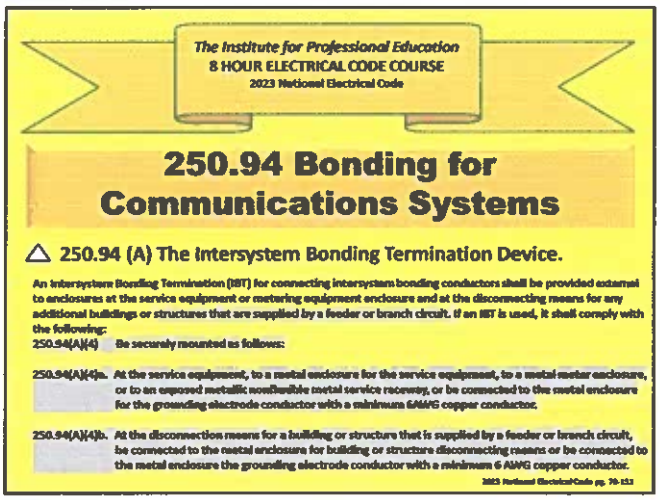

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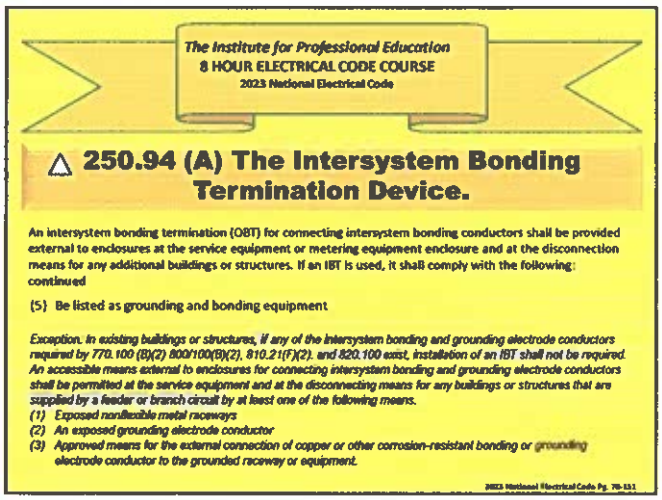

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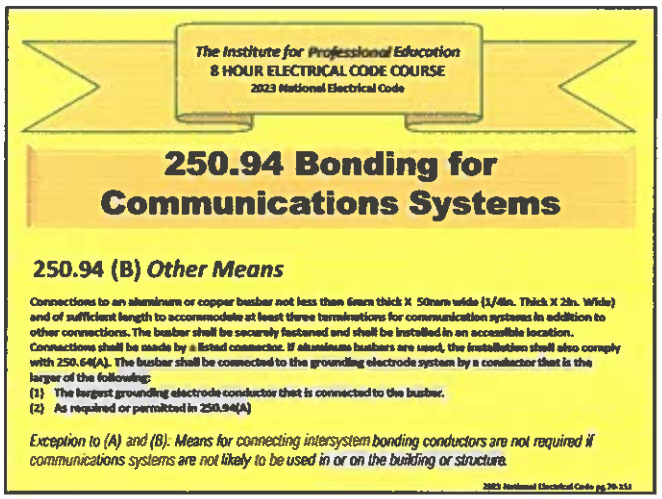

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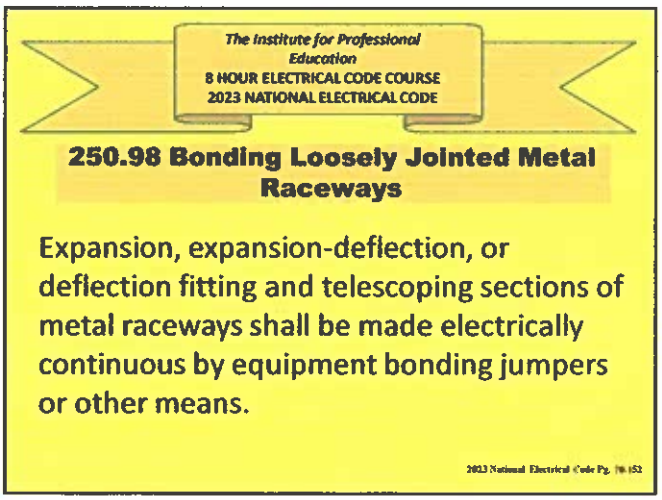

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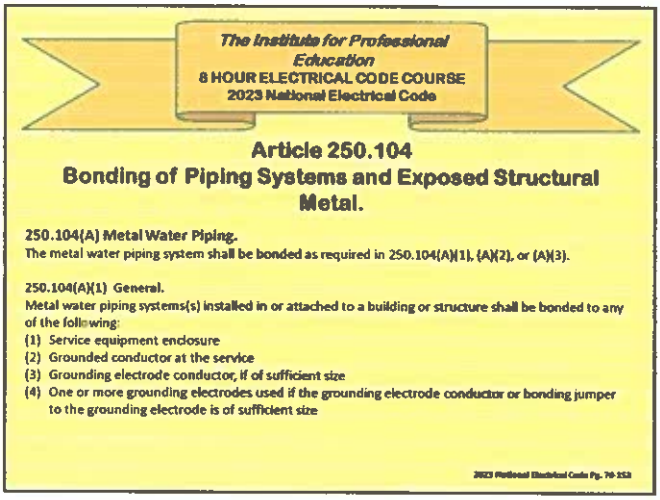

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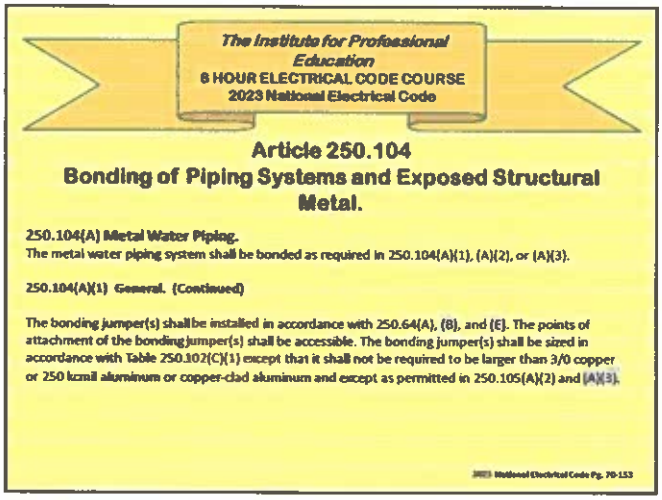

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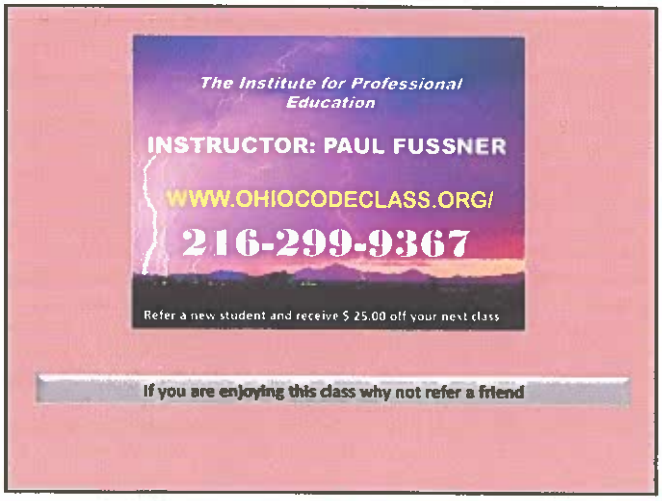

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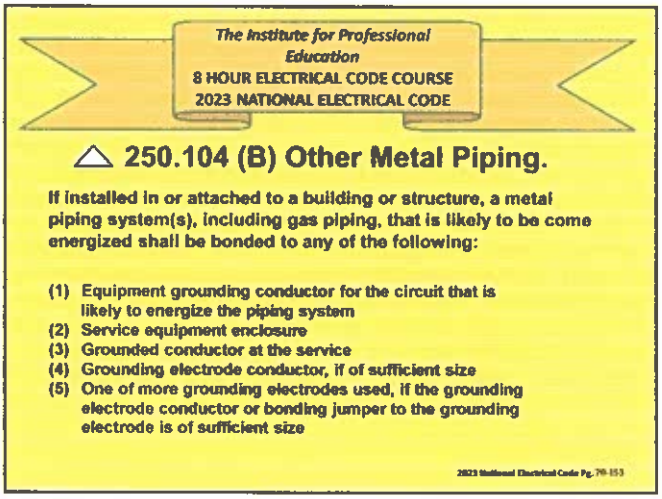

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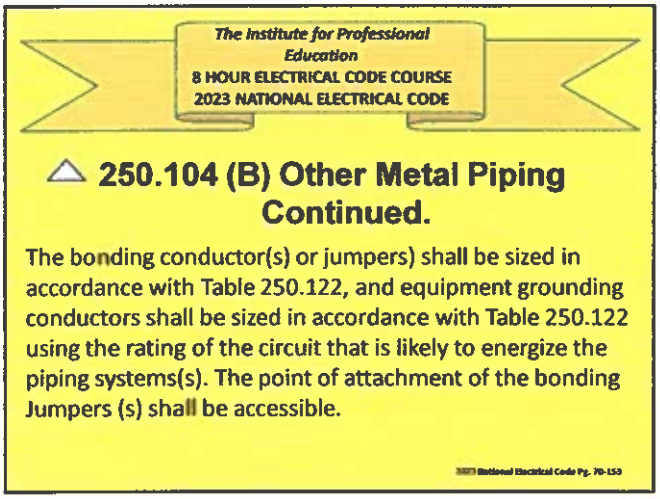

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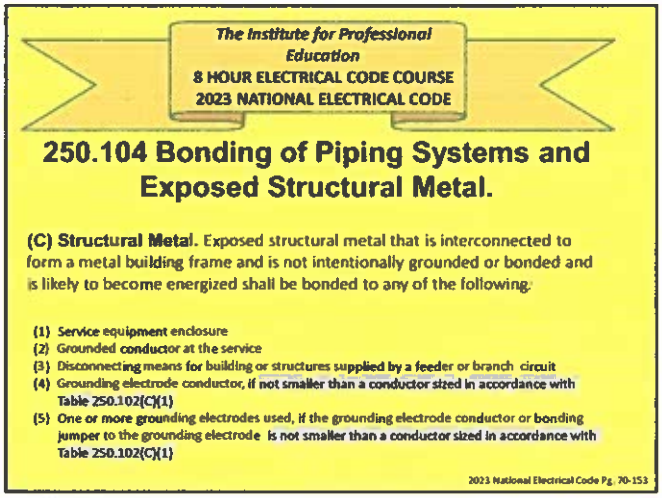

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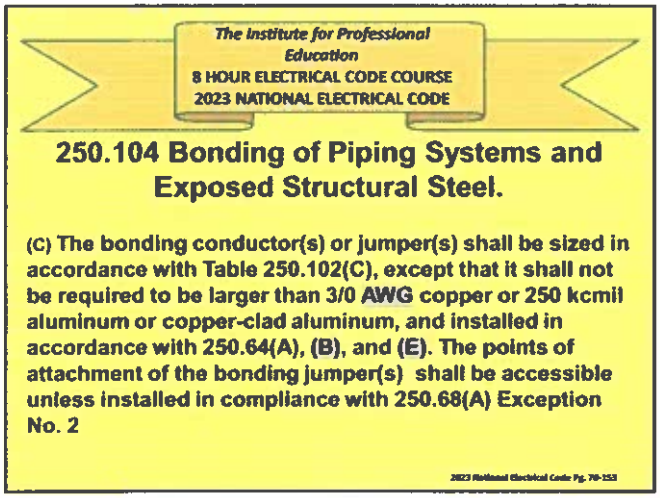

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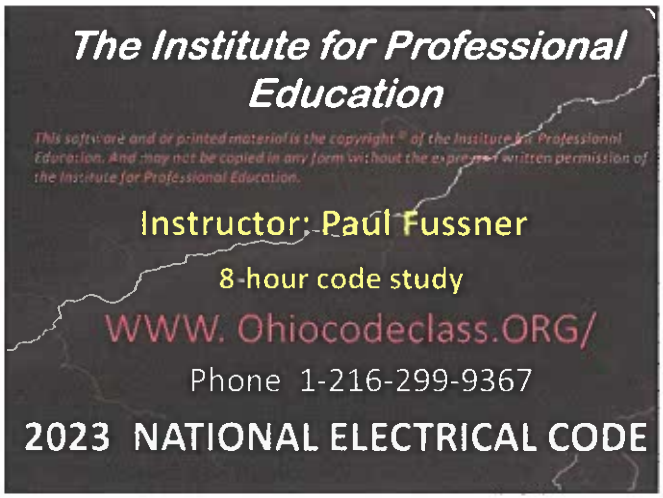

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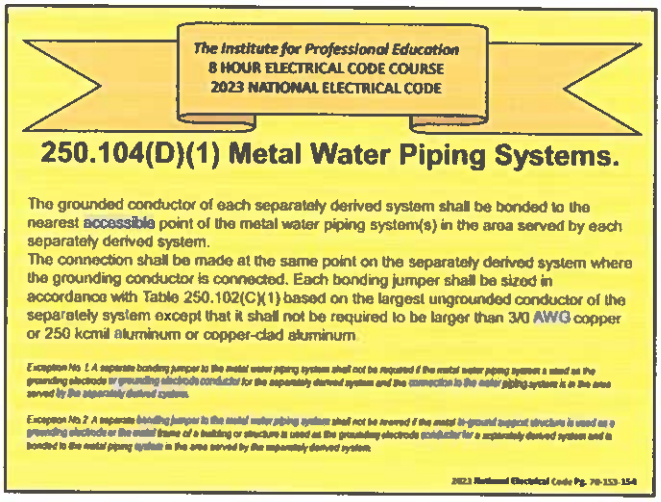

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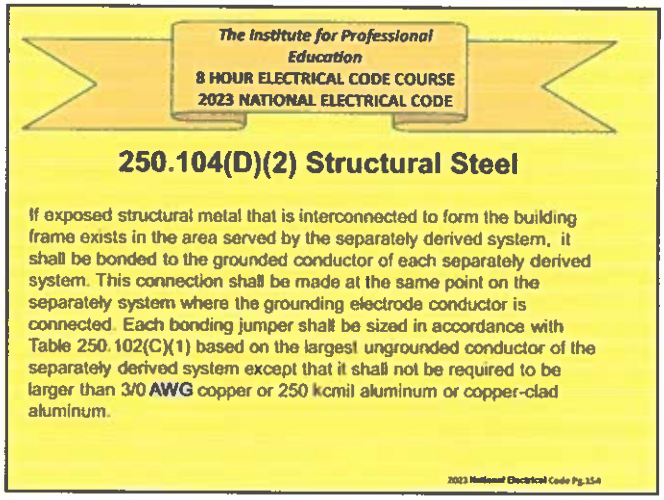

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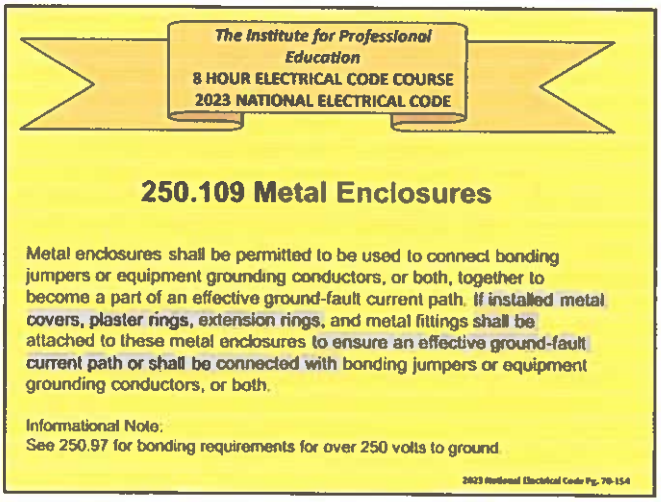

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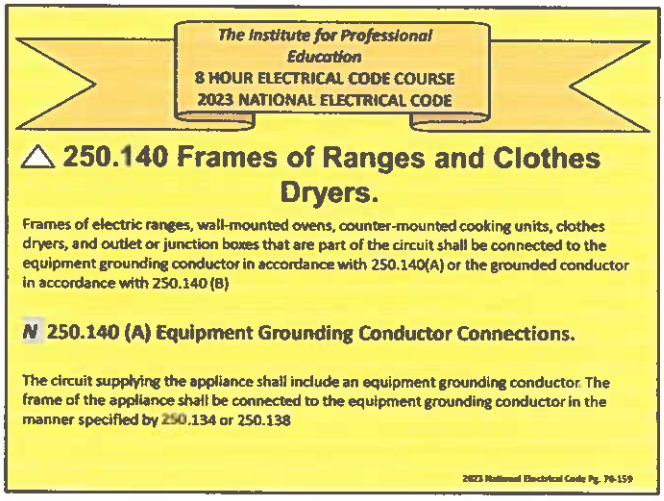

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The Institute for Professional Education
8 HOUR ELECTRICAL CODE COURSE
2023 NATIONAL ELECTRICAL CODE

△ 250.140 Frames of Ranges and Clothes Dryers.

N 250.140 (B) Grounded Conductor Connections.

For existing branch-circuit installations only, an equipment grounding conductor is not present in the outlet or junction box the frame of the appliance shall be permitted to be connected to the grounded conductor if all the conditions in the following list items (1), (2), and (3) are met and the grounded conductor complies with either list item(4) or (5):

(1) The supply circuit is 120/240-volt single-phase, 3-wire; or 208Y/120-volt derived from a 3-phase, 4-wire, wye-connected system.
(2) The grounded conductor is not small than 10 AWG copper or 8 AWG aluminum or copper-clad aluminum.
(3) Grounding contacts of receptacles furnished as part of the equipment are bonded to the equipment.
(4) The grounded conductor is insulated, or the grounded conductor is insulated and part of a Type SE service-entrance cable and the branch circuit originates at the service equipment.
(5) The grounded conductor is part of a Type SE service-entrance cable that originates in equipment other than a service. The grounded conductor shall be insulated or field covered within the supply enclosure with listed insulating materials, such as tape or sleeving to prevent contact of the uninsulated conductor with any normally non-current-carrying metal parts.

2023 National Electrical Code Pg. 70-160

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The Institute for Professional Education
8 HOUR ELECTRICAL CODE COURSE
2023 NATIONAL ELECTRICAL CODE

250.146 Connecting Receptacle Grounding Terminal to an Equipment Grounding Conductor.

An equipment bonding jumper shall be used to connect the grounding terminal of a grounding-type receptacle to a metal box that is connected to an equipment grounding conductor, except as permitted in 250.146 (A) through(D). The equipment bonding jumper shall be sized in accordance with Table 250.122

2023 National Electrical Code Pg. 70-160

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The Institute for Professional Education
8 HOUR ELECTRICAL CODE COURSE
2023 NATIONAL ELECTRICAL CODE

250.146 Connecting Receptacle Grounding Terminal to an Equipment Grounding Conductor.

△ 250.146(A) Surface-Mounted Box.

If a metal box is mounted on the surface, the direct metal-to-metal contact between the device yoke or strap to the box shall be permitted to provide the required effective ground-fault current path. At least one of the insulation washers shall be removed from receptacles that do not have a contact yoke or device to ensure direct metal-to-metal contact. Direct metal-to-metal contact for providing continuity applies to cover-mounted receptacles if the box and cover combination are listed as satisfactory continuity between the box and the receptacle. A listed exposed work cover shall be permitted to be the grounding and bonding means under both of the following conditions:

2023 National Electrical Code 70-160

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The Institute for Professional Education
8 HOUR ELECTRICAL CODE COURSE
2023 NATIONAL ELECTRICAL CODE

250.146 Connecting Receptacle Grounding Terminal to an Equipment Grounding Conductor.

250.146(A)(1)
The device is attached to the cover with at least two fasteners that are permanent (such as a rivet) or have a tread locking or screw or nut locking means

250.146(A)(2)
The cover mounting holes are located on a flat non-raised portion of the cover

2023 National Electrical Code Pg. 70-160

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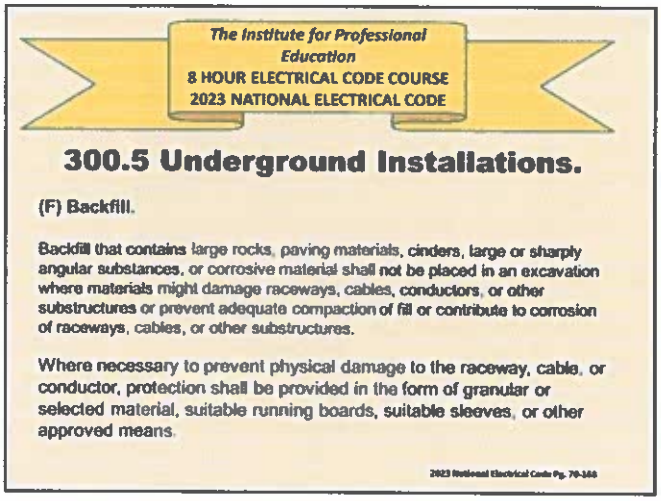

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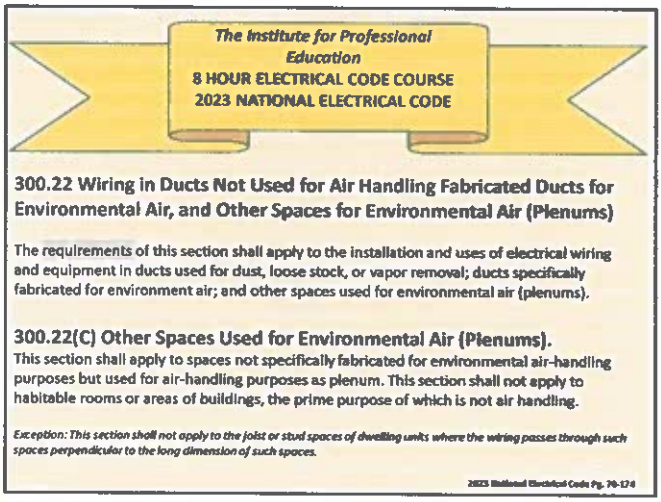

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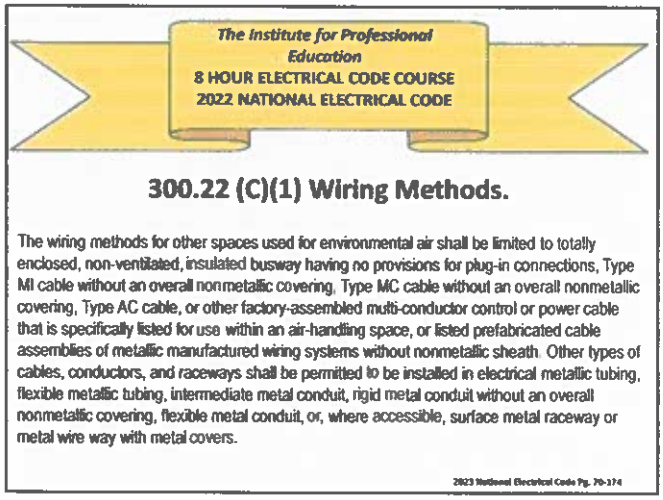

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In house training available at your facilities
Instructor: Paul Fussner
WWW. Ohiocodeclass.ORG/
Phone 1-216-299-9367
2023 National Electrical Code

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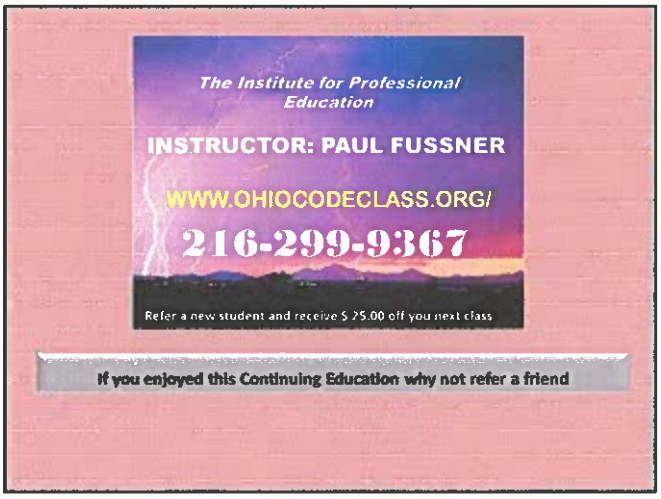
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File Attachments for Item:

ER-4 2023 NEC Articles 230-314 (Institute for Professional Education)

All certifications (8 hours)

Staff Notes:

ESIAC Recommendation:

Committee Recommendation:

Mike DeWine, Governor
Jon Husted, Lt. Governor
Sherry Maxfield, Director

Board of Building Standards

Application for Continuing Education Course Approval

Provider Information:

Name: Paul R. Fussner BBS # 504
Organization: Institute for professional Education
Address: 30508 Ronald Drive, Willowick, Ohio 44095
E-mail: pfussner@paulfussner.onmicrosoft.com Telephone: 216-299-9367
Website: www.ohiocodeclass.org/
Conference Sponsor (if applicable) Elaine's Educational Services, LLC Conference Email: vfussner1955@gmail.com

Check here if Course Renewal: _____ Prior course number _____ *(i.e. BBS2018-429)*
Renewals will only be granted for identical content and certifications, within the current code cycle.
Attach a copy of prior course approval letter for confirmation. No further information is required.

New Course Information:

Course title: 8-Hour Presentation of 2023 National Electrical Code Articles 230-314
Course instructor: Paul R. Fussner BBS # 504
Course description: 8-Hour Power Point Presentation with questions and answers, 10 minute breaks will be taken at the top pf each hour, and a one hour lunch break will be given form 12:00 to 1:00 pm. Course will be offered throughout the calender year, option # one will be virtual online Zoom sessions, option # two live session's at various locations as noted in the attached proposed schedule.
Instructional hours per session: 8-hours Number of Sessions: _____
Course Date(s) and Location: See attached proposed schedule

Special Content:

Code Administration: _____
Existing Buildings: _____
Electrical Instruction: _____
Plumbing Instruction: _____

Conference Course: Being offered live and Virtual online
Conference Name: 8-hour Power Point Presentation 2023 NED Articles 230-314
Conference location: See attached Proposed schedule

Course to be offered online? yes **On Demand** _____ **Webinar** Virtual Zoom classes on line
Course Website: _____
Detail online course participation confirmation method *(i.e. test, quizlets, participant activity confirmation)*:
Each student logs in with course link provided after verification of certifications and photo ID , this information reviewed again during sign in or log in on the day of the course

Course applicable for the following certifications

Residential Certifications Only: _____ Commercial Certifications: _____
Administrative Course, All Certifications: X

Application materials included:

X Course Outline or Course Learning Objectives as described in above
_____ Presentation Materials/Slides (not required for roundtable courses) Power Point Presentation
_____ Assessment Materials (for online courses)
_____ Presenter Bio

Please submit application and materials in .pdf format to: michael.lane@com.ohio.gov or BBS@com.ohio.gov

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BOARD OF BUILDING STANDARDS

Paul Robert Fussner, dba

THE INSTITUTE FOR PROFESSIONAL EDUCATION

30508 Ronald Drive
Willowick, Ohio 44095-4341
pfussner@paulfussner.onmicrosoft.com

November 21, 2023

Ohio Board of Building Standards
6606 Tussing Rd
Reynoldsburg, Ohio 43068-9009

REGARDING: Course Syllabus Electrical Contractor. 8-Hour Study of 2023 National Electrical Code Changes Articles 230-314

In-person student classes utilize the normal sign-in method of showing a picture ID and state license before signing the BBS registration sheet, sign-in begins 30 minutes before the session start time.

Classes are to be held online: **Utilizing Zoom Meetings Software**

Computer sign-in and registration(s) begin 30 minutes before the session, utilizing the Zoom login link assigned to each student who has pre-registered by mail or online. Students may log in with a computer, tablet, or smartphone.

Class Schedule

8:00	**am**	**Beginning of PowerPoint presentation and review of: Articles 230 through 314 of the 2023 National Electrical Code**
8:50	**am**	**Ten-minute break. 50 minutes per hour of study of the PowerPoint presentation.**
12:00	**pm**	**Students will be given a one-hour break for lunch**
1:50	**pm**	**Ten-minute break. 50 minutes per hour of study of the PowerPoint presentation**
5:00	**pm**	**Students dismissal**

Note: **All eight-hour sessions begin promptly at 8:00 am**

Paul Robert Fussner, dba
The Institute for Professional Education
30508 Ronald Drive
Willowick, Ohio 44095-4341
pfussner@paulfussner.onmicrosoft.com

INSTRUCTOR QUALIFICATIONS:

- State Certified Electrical Safety Inspector #504
- State Certified Building Inspector #504
- Building Official #504
- Residential Building Official #504
- Board of Building Standards Instructor, Electrical Safety Inspector Re-certification, established in 1999.
- OCILB Instructor, state-licensed, electrical, plumbing, HVAC, and Hydronics contractors continuing education courses, established in 1999.

50 years of experience in the building and electrical trades, as Founder and President of the Gibson Robert Company, Inc. I expedited all new work including researching and ordering the proper electrical equipment required for a safe, efficient installation, while meeting the requirements of The NFPA 70 Electrical Code, The B.O.C.A. Code, and The Ohio Building Code.

29 years of experience as a State Certified Electrical Safety Inspector, 24 years experience as a State Certified Building Inspector with 12 years of departmental management experience.

14 years as Building Official #504

Former Chairman, Western Reserve Chapter International Association of Electrical Inspectors. Two years as Education Chairman, Western Reserve Chapter of the IAEI.

Owner of The Institute for Professional Education, a State of Ohio Training Agency for the Mandatory Continuing Education Credits for Electrical Safety Inspectors and State Licensed Electrical Contractors. Accredited by the Ohio Board of Building Standards and the Ohio Construction industry licensing board. established 1999.

2024 IN-PERSON and ONLINE ZOOM SESSION(S) SCHEDULE for all OCILB. Contractors and BBS Certifications

TO REGISTER FOR A CLASS, VISIT OUR WEB PAGE:

WWW.OHIOCODECLASS.ORG / OR CALL 216-299-9367

January 13	**8-Hr Online Virtual Zoom Session** 2023 NEC Article 250 Understanding Grounding and Bonding		**Course # 3750064**
February 17	**4-hr Online Virtual Zoom Session** 7:45 am-12:00 pm 2023 NEC Articles 90-200		**Course # 3750066**
	4-Hr Online Virtual Zoom Session 1:00 pm - 5:00 pm 2023 NEC Articles 230-242		**Course # 3750060**
	2-Hr Online Virtual Zoom Session 5:00 pm - 7:00 pm 2019 RCO Chapter 113 Existing		**Course # 3750061**
March 23	**8-Hr Online Virtual Zoom Session** 2023 National Electrical Code Article's 230 – 314		**Course # 3750062**
April 27	**4-Hr Online Virtual Zoom Session** 7:45 am-12:00 pm 2023 NEC Articles 90-200		**Course # 3750066**
	4-Hr Online Virtual Zoom Session 1:00 pm - 5:00 pm 2023 NEC Articles 230-242		**Course # 3750060**
	2-Hr Online Virtual Zoom Session 5:00 pm - 7:00 pm 2019 RCO Chapter 3401.1(2)(1)		**Course # 3750065**
May 18	**8-Hr Online Virtual Zoom Session** 2023 National Electrical Code Article's 90 – 210		**Course # 3750063**
June 17	8-Hr Live in-person session 2023 NEC Article 250 Understanding Grounding and Bonding		**Course # 3750064**
	Location: Grace Church 36300 Ridge Rd, Willoughby, Ohio 44094 **Rear Lower Level Entrance**		
July 27	**8-Hr Online Virtual Zoom Session** 2023 National Electrical Code Article's 230 – 314		**Course # 3750062**
August 14	4-Hr Weekday **Virtual Zoom Session** 7:45 am-12:00 pm 2023 NEC Articles 90-200		Course # 3750066
August 21	4-Hr Weekday **Virtual Zoom Session** 7:45 am-12:00 pm 2023 NEC Articles 230-242		Course # 3750060
September 7	4-Hr Live in Person Session	7:45 am-12:00 pm 2023 NEC Articles 90-200	**Course # 3750066**
	4-Hr Live in Person Session	1:00 pm - 5:00 pm 2023 NEC Articles 230-242	**Course # 3750060**
	2-Hr Live in Person Session	5:00 pm - 7:00 pm 2019 RCO Chapter 113 Existing	**Course # 3750061**
	Location: Cretan Party Center 13853 W. 168th Street & Lorain Rd, Cleveland, Ohio 44111		
October 19	4-Hr Live in Person Session	7:45 am-12:00 pm 2023 NEC Articles 90-200	**Course # 3750066**
	4-Hr Live in Person Session	1:00 pm - 5:00 pm 2023 NEC Articles 230-242	**Course # 3750060**
	2-Hr Live in Person Session	5:00 pm - 7:00 pm 2019 RCO Chapter 3401.1(2)(1)	**Course # 3750065**
	Location: Huntsburg Civic Center 12396 Madison Rd. (Rt,528 & 322) Middlefield, Ohio 44062 Use the rear entrance		
November 16	**8-Hr Online Virtual Zoom Session** 2023 National Electrical Code Article 250 Grounding and Bonding		**Course # 3750064**
December 7	4-Hr Live in Person Session	7:45 am-12:00 pm 2023 NEC Articles 90-200	**Course # 3750066**
	4-Hr Live in Person Session	1:00 pm - 5:00 pm 2023 NEC Articles 230-242	**Course # 3750060**
	2-Hr Live in Person Session	5:00 pm - 7:00 pm 2019 RCO Chapter 113 Existing	**Course # 3750061**

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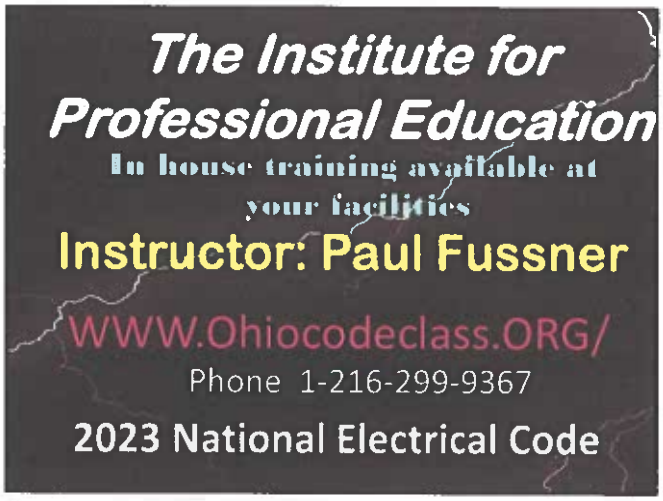

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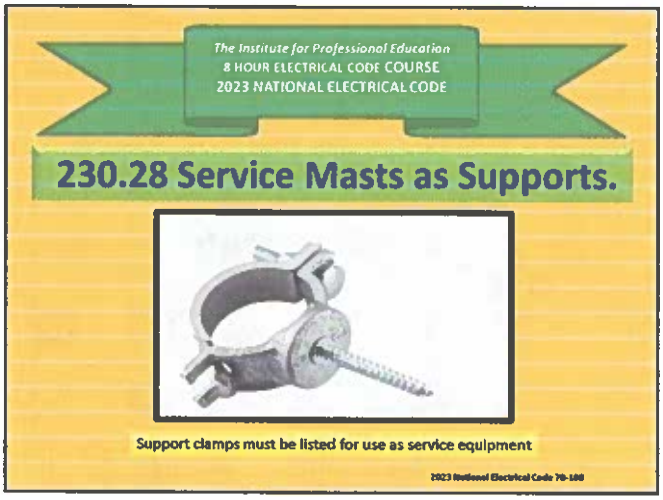

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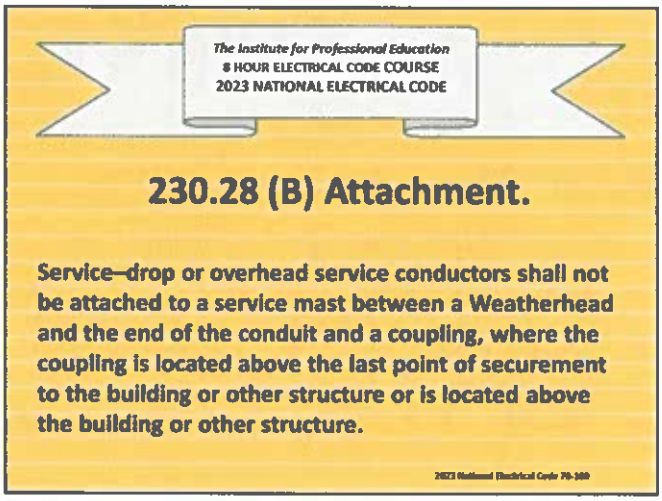

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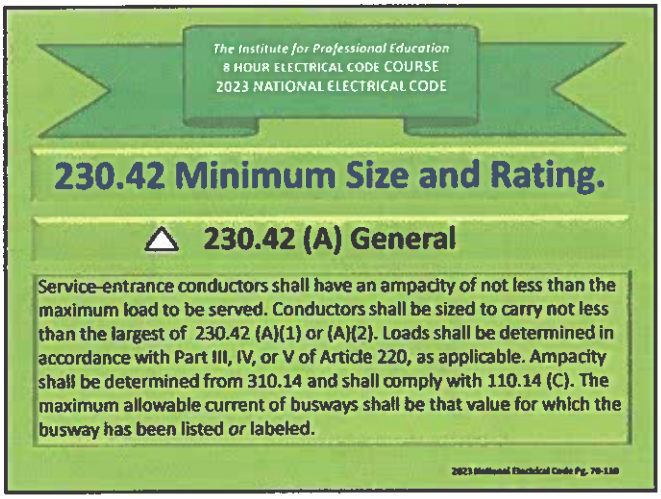
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230.42 Minimum Size and Rating.
△ 230.42 (A) General
Service-entrance conductors shall have an ampacity of not less than the maximum load to be served. Conductors shall be sized to carry not less than the largest of 230.42 (A)(1) or (A)(2). Loads shall be determined in accordance with Part III, IV, or V of Article 220, as applicable. Ampacity shall be determined from 310.14 and shall comply with 110.14 (C). The maximum allowable current of busways shall be that value for which the busway has been listed or labeled.

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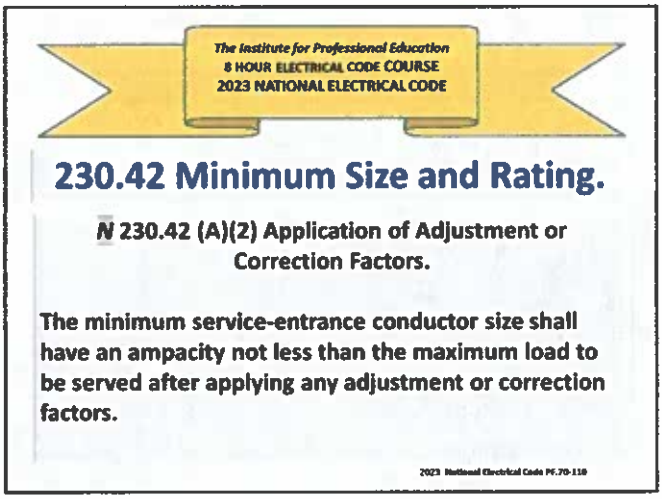
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230.42 Minimum Size and Rating.
N 230.42 (A)(2) Application of Adjustment or Correction Factors.
The minimum service-entrance conductor size shall have an ampacity not less than the maximum load to be served after applying any adjustment or correction factors.

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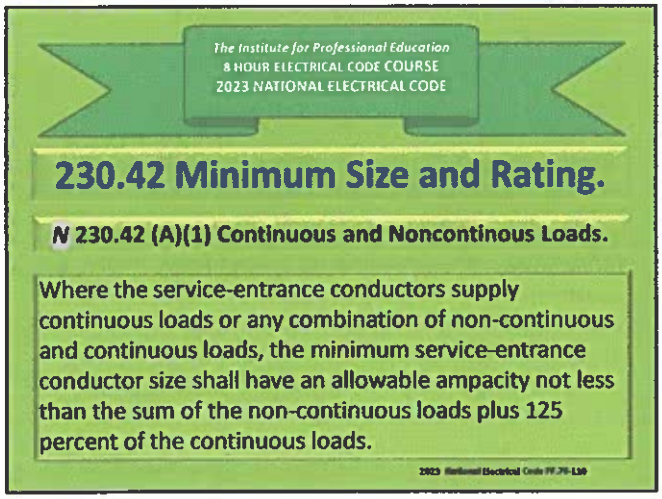
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230.42 Minimum Size and Rating.
N 230.42 (A)(1) Continuous and Noncontinous Loads.
Where the service-entrance conductors supply continuous loads or any combination of non-continuous and continuous loads, the minimum service-entrance conductor size shall have an allowable ampacity not less than the sum of the non-continuous loads plus 125 percent of the continuous loads.

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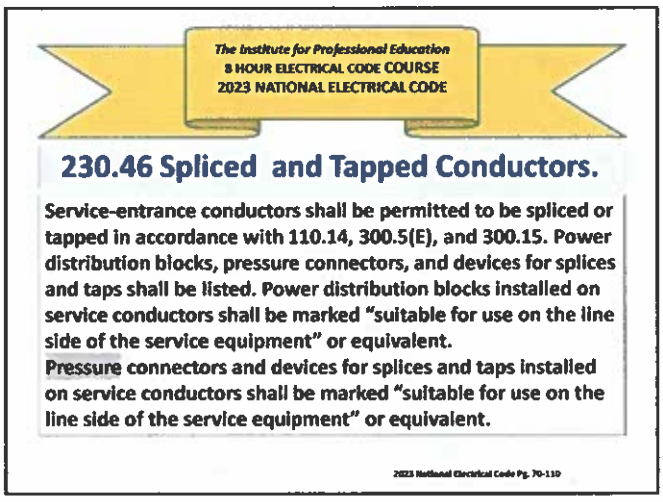
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230.46 Spliced and Tapped Conductors.
Service-entrance conductors shall be permitted to be spliced or tapped in accordance with 110.14, 300.5(E), and 300.15. Power distribution blocks, pressure connectors, and devices for splices and taps shall be listed. Power distribution blocks installed on service conductors shall be marked "suitable for use on the line side of the service equipment" or equivalent.
Pressure connectors and devices for splices and taps installed on service conductors shall be marked "suitable for use on the line side of the service equipment" or equivalent.

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230.62 Service Equipment – Enclosed or Guarded

230.62 (C) Barriers.

Barriers shall be placed in service equipment such that no uninsulated, ungrounded service busbar or service terminal is exposed to inadvertent contact by persons or maintenance equipment while servicing load terminals with the service disconnect in the open position.

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230.66 Marking.

230.66 (B) Meter Sockets.

Meter sockets shall not be considered service equipment but shall be listed and rated for the voltage and current rating of the service.

Exception: Meter sockets supplied by and under the exclusive control of the electric utility shall not be required to be listed.

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230.66 Marking.

230.66 (A) General

Service equipment rated at 1000 volts or less shall be marked to identify it as being suitable for use as service equipment. All service equipment shall be listed, or field evaluated.

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230.67 Surge Protection.

230.67 (A) Surge-Protective Device.

All services supplying the following occupancies shall be provided with a surge-protective device (SPD)

(1) Dwelling units
(2) Dormitory units
(3) Guest rooms and guest suites of hotels and motels
(4) Areas of nursing homes and limited-care facilities used exclusively as patient sleeping rooms

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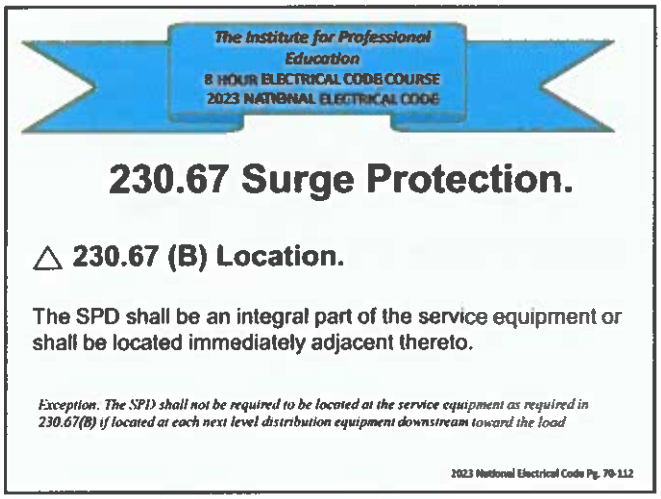
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230.67 Surge Protection.
△ 230.67 (B) Location.
The SPD shall be an integral part of the service equipment or shall be located immediately adjacent thereto.
Exception. The SPD shall not be required to be located at the service equipment as required in 230.67(B) if located at each next level distribution equipment downstream toward the load
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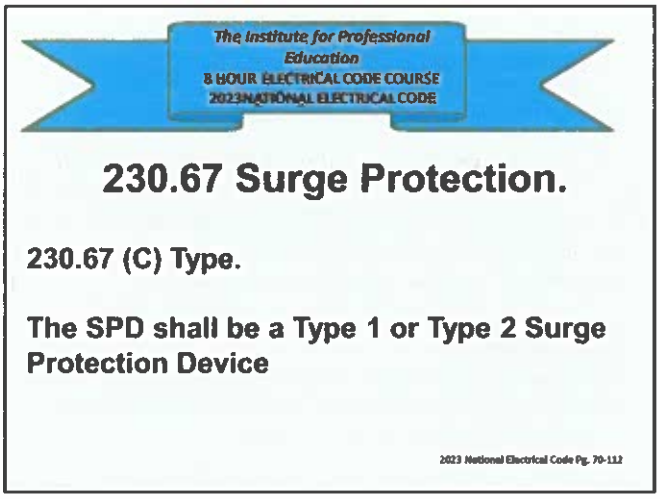
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230.67 Surge Protection.
230.67 (C) Type.
The SPD shall be a Type 1 or Type 2 Surge Protection Device
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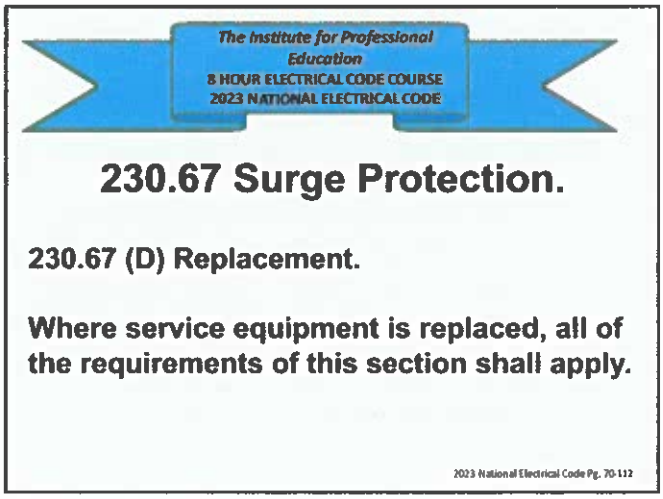
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230.67 Surge Protection.
230.67 (D) Replacement.
Where service equipment is replaced, all of the requirements of this section shall apply.
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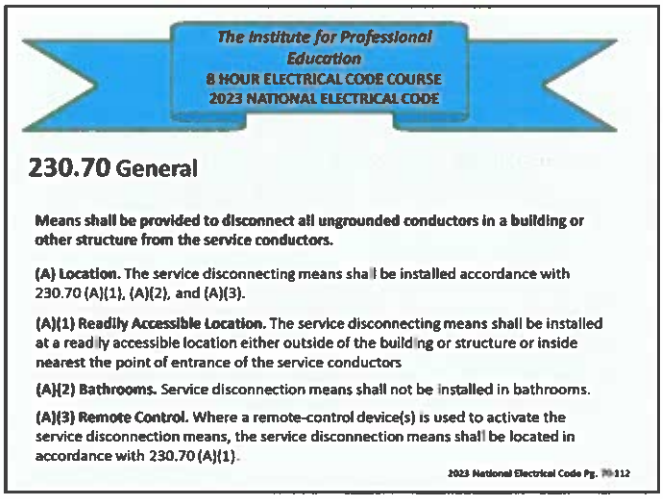
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230.70 General
Means shall be provided to disconnect all ungrounded conductors in a building or other structure from the service conductors.
(A) Location. The service disconnecting means shall be installed accordance with 230.70 (A)(1), (A)(2), and (A)(3).
(A)(1) Readily Accessible Location. The service disconnecting means shall be installed at a readily accessible location either outside of the building or structure or inside nearest the point of entrance of the service conductors
(A)(2) Bathrooms. Service disconnection means shall not be installed in bathrooms.
(A)(3) Remote Control. Where a remote-control device(s) is used to activate the service disconnection means, the service disconnection means shall be located in accordance with 230.70 (A)(1).
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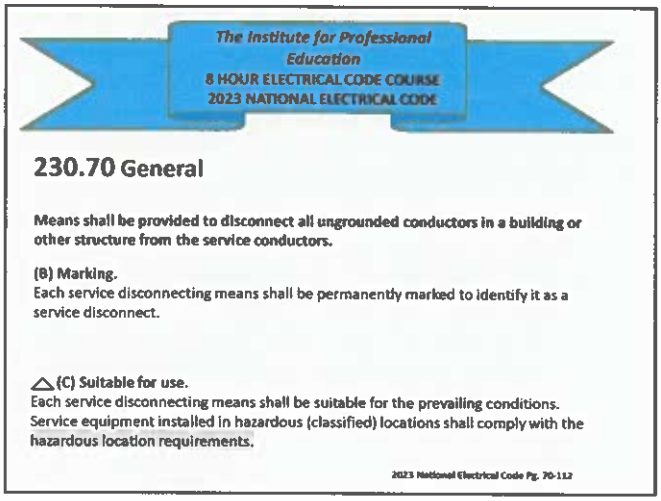
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230.70 General
Means shall be provided to disconnect all ungrounded conductors in a building or other structure from the service conductors.
(B) Marking.
Each service disconnecting means shall be permanently marked to identify it as a service disconnect.
△(C) Suitable for use.
Each service disconnecting means shall be suitable for the prevailing conditions. Service equipment installed in hazardous (classified) locations shall comply with the hazardous location requirements.
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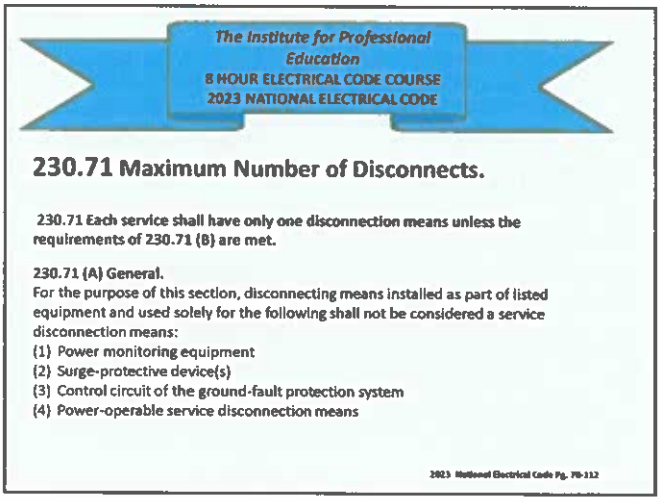
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2023 NATIONAL ELECTRICAL CODE
230.71 Maximum Number of Disconnects.
230.71 Each service shall have only one disconnection means unless the requirements of 230.71 (B) are met.
230.71 (A) General.
For the purpose of this section, disconnecting means installed as part of listed equipment and used solely for the following shall not be considered a service disconnection means:
(1) Power monitoring equipment
(2) Surge-protective device(s)
(3) Control circuit of the ground-fault protection system
(4) Power-operable service disconnection means
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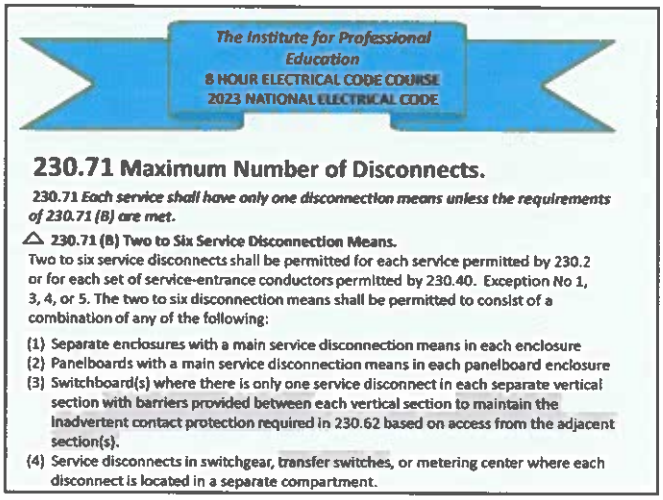
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230.71 Maximum Number of Disconnects.
230.71 Each service shall have only one disconnection means unless the requirements of 230.71 (B) are met.
△ 230.71 (B) Two to Six Service Disconnection Means.
Two to six service disconnects shall be permitted for each service permitted by 230.2 or for each set of service-entrance conductors permitted by 230.40. Exception No 1, 3, 4, or 5. The two to six disconnection means shall be permitted to consist of a combination of any of the following:
(1) Separate enclosures with a main service disconnection means in each enclosure
(2) Panelboards with a main service disconnection means in each panelboard enclosure
(3) Switchboard(s) where there is only one service disconnect in each separate vertical section with barriers provided between each vertical section to maintain the inadvertent contact protection required in 230.62 based on access from the adjacent section(s).
(4) Service disconnects in switchgear, transfer switches, or metering center where each disconnect is located in a separate compartment.

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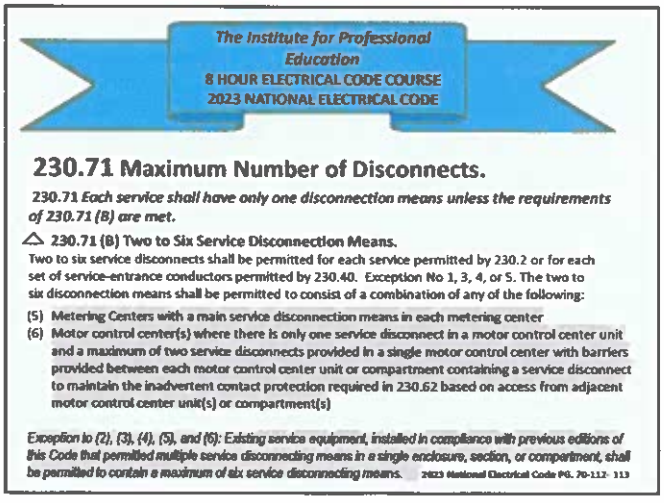
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230.71 Maximum Number of Disconnects.
230.71 Each service shall have only one disconnection means unless the requirements of 230.71 (B) are met.
△ 230.71 (B) Two to Six Service Disconnection Means.
Two to six service disconnects shall be permitted for each service permitted by 230.2 or for each set of service-entrance conductors permitted by 230.40. Exception No 1, 3, 4, or 5. The two to six disconnection means shall be permitted to consist of a combination of any of the following:
(5) Metering Centers with a main service disconnection means in each metering center
(6) Motor control center(s) where there is only one service disconnect in a motor control center unit and a maximum of two service disconnects provided in a single motor control center with barriers provided between each motor control center unit or compartment containing a service disconnect to maintain the inadvertent contact protection required in 230.62 based on access from adjacent motor control center unit(s) or compartment(s)
Exception to (2), (3), (4), (5), and (6): Existing service equipment, installed in compliance with previous editions of this Code that permitted multiple service disconnecting means in a single enclosure, section, or compartment, shall be permitted to contain a maximum of six service disconnecting means. 2023 National Electrical Code PG. 70-112- 113

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230.72 Grouping of Disconnects.

230. 72 (A) General

The two to six disconnects, if permitted in 230.71 shall be grouped. Each disconnect shall be marked to indicate the load served.

Exception: One of the two to six service disconnecting means permitted in 230.71, where used for a water pump also intended to provide fire protection, shall be permitted to be located remote from the other disconnecting means. If remotely installed in accordance with this exception, a plaque shall be posted at the location of the remaining grouped disconnects denoting its location.

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230.72 Grouping of Disconnects.

230. 72 (B) Additional Service Disconnecting Means

The one or more additional service disconnecting means for fire pumps, emergency systems, legally required standby, or optional standby services permitted in 230.2 shall be installed remote from the one to six service disconnection means for normal service to minimize the possibility of simultaneous interruption of supply.

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230.72 Grouping of Disconnects.

230. 72 (C) Access to Occupants.

In a multi-occupancy building, each occupant shall have access to the occupant's service disconnecting means.

Exception: In a multiple-occupancy building where electric service and electrical maintenance are provided by the building management and where these are under continuous building management supervision the service disconnecting means supplying more than one occupancy shall be permitted to be accessible to authorized management personnel only

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230.75 Disconnection of Grounded Conductor.

Where the service disconnection means does not disconnect the grounded conductor from the premises wiring, other means shall be provided for this purpose in the service equipment. A terminal or bus to which all grounded conductors can be attached by means of a pressure connector shall be permitted for this purpose. In a multi-section switchboard or switchgear, disconnects for the grounded conductor shall be permitted to be in any section of the switchboard or switchgear. , if the switchboard or switchgear section is marked to indicate a ground conductor disconnect is located within.

Informational Note:
In switchgear or multisection switchboards, the disconnection means provided for the grounded conductor is typically identified as a neutral disconnect link and is typically located in the bus to which the service grounded conductor is connected.

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230.79 Rating of Service Disconnecting Means.

The service disconnecting means shall have a rating not less than the calculated load to be carried, determined in accordance with Part III, IIV, or V of Article 220, as applicable. In no case shall the rating be lower than specified in 230.79 (A),(B),(C), or (D)

230.79(A) One-Circuit Installations.
For installation of supply only limited loads of a single branch circuit, the service disconnecting means shall have a rating of not less than 15 amperes

230.79(B) Two-Circuit Installations.
For installations consisting of not more than two 2-wire branch circuits, the service disconnecting means shall have a rating of not less than 30 amperes

230.79(C) One-Family Dwellings.
For a one-family dwelling, the service disconnecting means shall have a rating of not less than 100 amperes.

230.79(D) All others.
For all other installations, the service disconnecting means shall have a rating of not less the 60 amperes

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△230.82 Equipment Connected to the Supply Side of the Service Disconnect.

Only the following equipment shall be permitted to be connected to the supply side of the service disconnecting means:

(1) Cable limiters.
(2) Meters and meter sockets nominally rated not in excess of 1000 volts, in all metal housings and service enclosures are grounded in accordance with Part VII and bonded in accordance with Part V of Article 250.
(3) Meter disconnect switched normally rater not in excess of 1000 volts that have a short-circuit current rating equal to or greater than the available fault current if all metal housing and service enclosures are grounded in accordance with Part VII and bonded in accordance with Part V of Article 250. A meter disconnect switch shall be capable of interrupting the load served. A meter disconnect shall be legibly field marked on its exterior in a manner suitable for the environment as follows:
METER DISCONNECT NOT SERVICE EQUIPMENT

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△230.82 Equipment Connected to the Supply Side of the Service Disconnect.

Only the following equipment shall be permitted to be connected to the supply side of the service disconnecting means:

(4) Instrument transformers (current and voltage), impedance shunts, load management devices, surge arresters, and Type 1 serge-protective devices.
(5) Conductors used to supply energy management systems, circuits for standby power systems, fire pump equipment, and fire and sprinkler alarms, if provide with service equipment and installed in accordance with requirements for service-entrance conductors.
(6) Solar photovoltaic systems, fuel cell systems, wind electric systems, energy storage systems, or interconnected electric power production sources, if provided with a disconnecting means listed as suitable for use as specified in Par VII of Article 230.

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△230.82 Equipment Connected to the Supply Side of the Service Disconnect.

Only the following equipment shall be permitted to be connected to the supply side of the service disconnecting means:

(7) Control circuits for power-operable service disconnecting means, if suitable overcurrent protection and disconnecting means are provided.
(8) Ground-fault protection systems or Type 2 surge protective devices, where installed as part of listed equipment, if suitable overcurrent protection and disconnecting means are provided.
(9) Connections used only to supply listed communications equipment under the exclusive control of the serving electric utility, if suitable overcurrent protection and disconnecting means are provided. For installations of equipment by the serving electric utility, a disconnecting means is not required if the supply is installed as part of a meter socket, such that access can only be gained with the meter removed.

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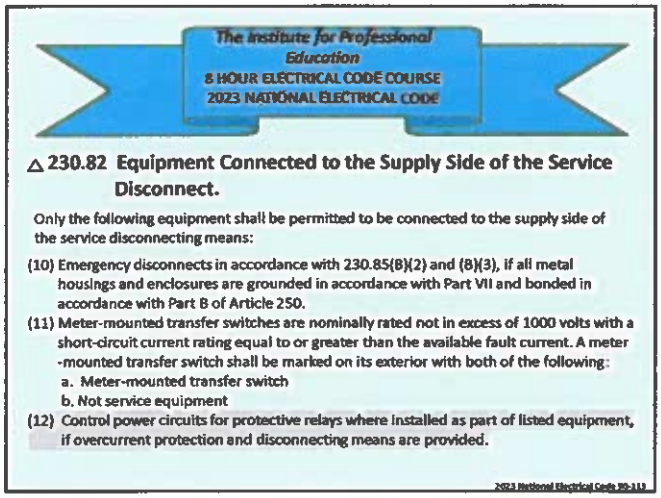
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△230.82 Equipment Connected to the Supply Side of the Service Disconnect.
Only the following equipment shall be permitted to be connected to the supply side of the service disconnecting means:
(10) Emergency disconnects in accordance with 230.85(B)(2) and (B)(3), if all metal housings and enclosures are grounded in accordance with Part VII and bonded in accordance with Part B of Article 250.
(11) Meter-mounted transfer switches are nominally rated not in excess of 1000 volts with a short-circuit current rating equal to or greater than the available fault current. A meter -mounted transfer switch shall be marked on its exterior with both of the following:
a. Meter-mounted transfer switch
b. Not service equipment
(12) Control power circuits for protective relays where installed as part of listed equipment, if overcurrent protection and disconnecting means are provided.

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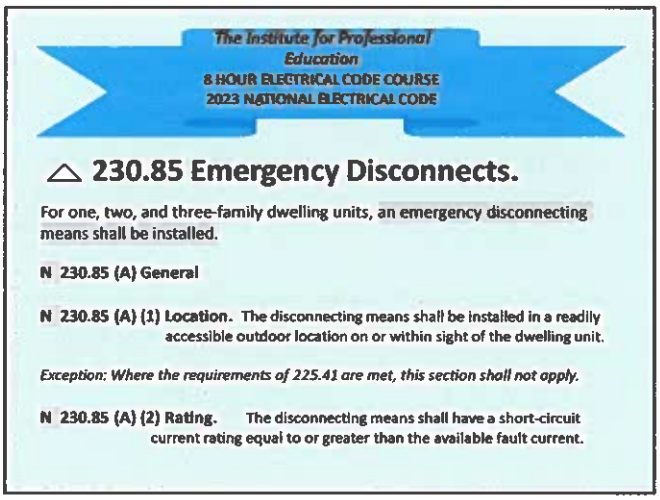
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△ 230.85 Emergency Disconnects.
For one, two, and three-family dwelling units, an emergency disconnecting means shall be installed.
N 230.85 (A) General
N 230.85 (A) (1) Location. The disconnecting means shall be installed in a readily accessible outdoor location on or within sight of the dwelling unit.
Exception: Where the requirements of 225.41 are met, this section shall not apply.
N 230.85 (A) (2) Rating. The disconnecting means shall have a short-circuit current rating equal to or greater than the available fault current.

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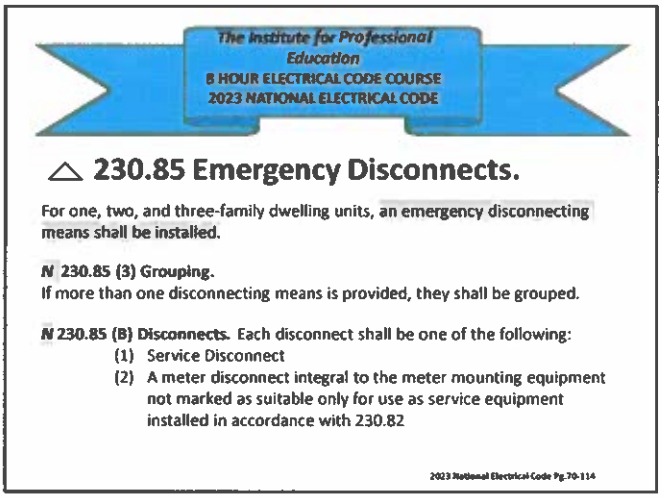
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△ 230.85 Emergency Disconnects.
For one, two, and three-family dwelling units, an emergency disconnecting means shall be installed.
N 230.85 (3) Grouping.
If more than one disconnecting means is provided, they shall be grouped.
N 230.85 (B) Disconnects. Each disconnect shall be one of the following:
(1) Service Disconnect
(2) A meter disconnect integral to the meter mounting equipment not marked as suitable only for use as service equipment installed in accordance with 230.82
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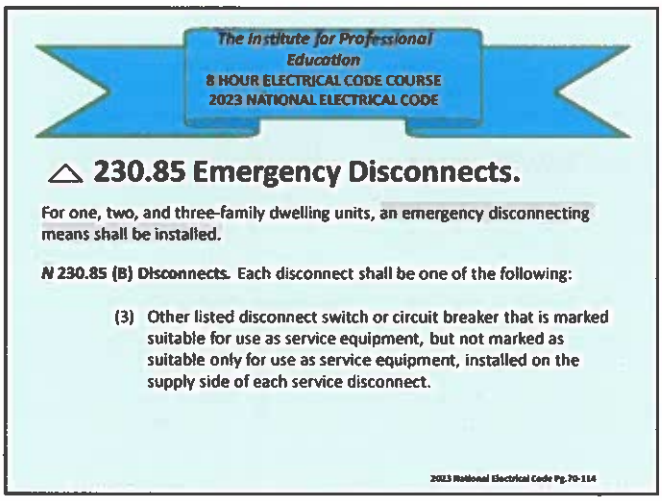
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△ 230.85 Emergency Disconnects.
For one, two, and three-family dwelling units, an emergency disconnecting means shall be installed.
N 230.85 (B) Disconnects. Each disconnect shall be one of the following:
(3) Other listed disconnect switch or circuit breaker that is marked suitable for use as service equipment, but not marked as suitable only for use as service equipment, installed on the supply side of each service disconnect.
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△ 230.85 Emergency Disconnects.

For one, two, and three-family dwelling units, an emergency disconnecting means shall be installed.

***N* 230.85 (C) Replacement.**

Where service equipment is replaced, all of the requirements of this section shall apply.

Exception: Where only meter sockets, service entrance conductors, or related raceways and fittings are replaced, the requirements of this section shall not apply

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△ 230.85 Emergency Disconnects.

For one, two, and three-family dwelling units, an emergency disconnecting means shall be installed.

***N* 230.85 (D) Identification of Other Isolation Disconnects.**

Where equipment for isolation of other energy source systems is not located adjacent to the emergency disconnect required by this section, a plaque or directory identifying the location of all equipment for isolation of other energy sources shall be located adjacent to the disconnecting means required by this section.

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△ 230.85 Emergency Disconnects.

For one, two, and three-family dwelling units, an emergency disconnecting means shall be installed.

***N* 230.85 (E) Marking.**

***N* 230.85 (E)(1) Marking Test.** The disconnecting means shall be marked as follows:

(1) Service Disconnect (EMERGENCY DISCONNECT, SERVICE DISCONNECT)
(2) Meter disconnects installed in accordance with 230.82(3) and marked as follows:
(EMERGENCY DISCONNECT, METER DISCONNECT, NOT SERVICE EQUIPMENT)

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△ 230.85 Emergency Disconnects.

For one, two, and three-family dwelling units, an emergency disconnecting means shall be installed.

***N* 230.85 (E) Marking.**

***N* 230.85 (E)(2) Marking Location and Size.**

Markings shall comply with 110.21(B) and both of the following:

(1) The marking or labels shall be located on the outside front of the disconnect enclosure with red background and white text.
(2) The letters shall be at least 13mm (1/2 in.) high.

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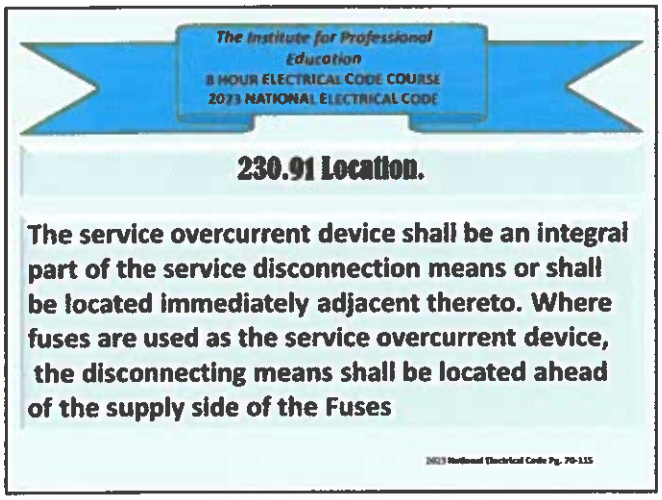
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230.91 Location.
The service overcurrent device shall be an integral part of the service disconnection means or shall be located immediately adjacent thereto. Where fuses are used as the service overcurrent device, the disconnecting means shall be located ahead of the supply side of the Fuses

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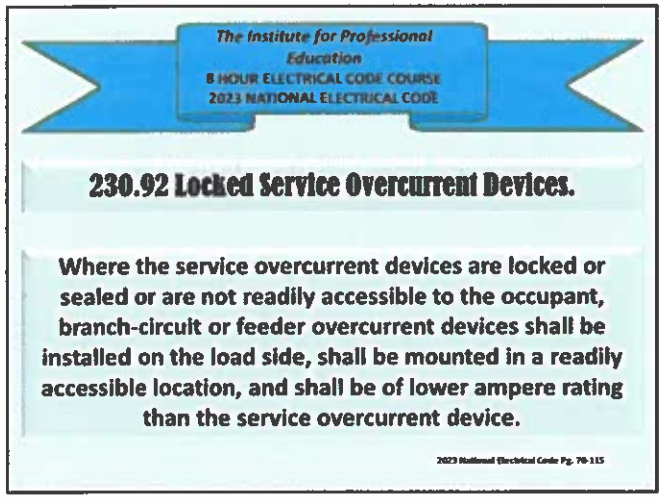
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230.92 Locked Service Overcurrent Devices.
Where the service overcurrent devices are locked or sealed or are not readily accessible to the occupant, branch-circuit or feeder overcurrent devices shall be installed on the load side, shall be mounted in a readily accessible location, and shall be of lower ampere rating than the service overcurrent device.

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230.95 Ground-Fault Protection of Equipment.
230.95 (C) Performance Testing.
The ground-fault protection system shall be performance tested when first installed onsite. This testing shall be conducted by a qualified person(s) using a test process of primary current injection, in accordance with instructions that shall be provided with the equipment. A written record of this testing shall be made and shall be available to the authority having jurisdiction.

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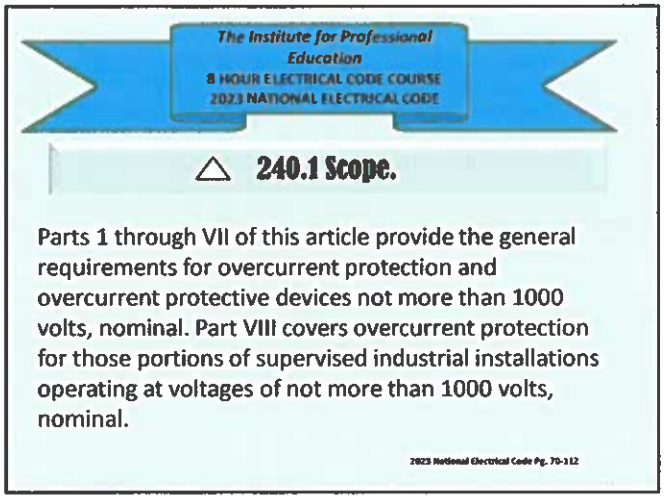
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△ 240.1 Scope.
Parts 1 through VII of this article provide the general requirements for overcurrent protection and overcurrent protective devices not more than 1000 volts, nominal. Part VIII covers overcurrent protection for those portions of supervised industrial installations operating at voltages of not more than 1000 volts, nominal.

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N 240.2 Reconditioned Equipment.

N 240.2(A) Reconditioning Not Permitted. The following equipment shall not be reconditioned:

(1) Equipment providing ground-fault protection of equipment
(2) Ground-fault circuit interrupters
(3) Low-voltage fuse holders and low-voltage nonrenewable fuses
(4) Molded-case circuit breakers
(5) Low-voltage power circuit breaker electronic trip units.

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240.4 Protection of Conductors.

240.4 (G) Overcurrent Protection for Specific Conductor Applications.

Overcurrent protection for the specific conductors shall be permitted to be provided as referenced in Table 240.4(G).

N 240.4 (H) Dwelling Unit Service and Feeder Conductors.

Dwelling unit service and feeder conductors shall be permitted to be protected against overcurrent at the ampacity values in 310.12.

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240.4 Protection of Conductors.

N 240.4 (D)(3)14 AWG Copper-Clad Aluminum.
10 amperes, provided all the following conditions are met:

(1) Continuous loads do not exceed 8 amperes.
(2) Overcurrent protection is provided by one of the following:
   a. Branch-circuit-rated circuit breakers listed and marked for use with 18AWG copper conductor
   b. Branch-circuit-rated fused listed and marked for use with 16AWG copper conductor
   c. Class CC, Class CF, Class J, or Class T fuses

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240.40 Disconnecting Means for Fuses.

Cartridge fuses in circuits of any voltage, and all fuses in circuits over 150 volts to ground, shall be provided with a disconnecting means on their supply side so that each circuit containing fuses can be independently disconnected from the source of power. A cable limiter without a disconnecting means shall be permitted on the supply side of more than one set of fuses as permitted on the supply side of the serviced disconnecting means as permitted by 230.82. A single disconnecting means shall be permitted on the supply side of more than one set of fuses as permitted by 430.112, exception, for group operation of motors, 424.22(C) for fixed resistance and electrode industrial process heating equipment, and 425.22(C) for fixed resistance and electrode industrial process heating equipment or where specifically permitted elsewhere in this code.

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240.60 General

240.60 (D) Renewable Fuses.
Class H cartridge fuses of the renewable type shall be permitted to be used only for replacement in existing installations where there is no evidence of overfusing or tampering.

N **240.60(E) Fuse Reducers.**
Fuse reducers shall be listed.

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△ 240.67 Arc Energy Reduction.

Where fuses rated 1200 amperes or higher are installed, 240.67(A), (B), and (C) shall apply.

240.67 (A) Documentation.
Documentation shall be available to those authorized to design, install, operate, or inspect the installation as to the location of the fuses(s).

Documentation shall also be provided to demonstrate that the method chosen to reduce clearing time is set to operate at a value below the available arching current.

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240.67 Arc Energy Reduction.

△ **240.67 (B) Method to Reduce Clearing Time.**
A fuse shall have a clearing time of 0.07 seconds or less at the available arching current, or one of the following means shall be provided and shall be set to operate at less than the available arching current:

240.67 (B)(1) Differential relaying
240.67 (B)(2) Energy-reducing maintenance switching with local status indicator
240.67 (B)(3) Energy-reducing active arc-flash mitigation system
240.67 (B)(4) Current-limiting, electronically activated fuses
240.67 (B)(5) An approved equivalent means

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240.67 Arc Energy Reduction.

240.67 (C) Performance Testing.
The arc energy reduction protection system shall be performance tested by primary current injection testing or another approved method when first installed on site. This testing shall be conducted by a qualified person(s) in accordance with the manufacturer's instructions.

A written record of this testing shall be made and shall be available to the authority having jurisdiction.

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240.91 Protection of Conductors.
Conductors shall be protected in accordance with 240.91(A) or 240.91(B).

(A) General. Conductors shall be protected in accordance with 240.4.

(B) Devices Rated Over 800 Amperes.
Where the overcurrent device is rated over 800 amperes, the ampacity of the conductors it protects shall be equal to or greater than 95 percent of the rating of the overcurrent device specified in accordance with the following:
(1) The conductors are protected within recognized time vs. current limits for short-circuit currents
Informational note: Table 240.92(B) provided a time vs. short-circuit current formulas to determine limits for copper and aluminum conductors.
(2) All equipment in which the conductors terminate is listed and marked for the application.

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Article 242 Overvoltage Protection

△ 242.1 Scope.

This article provides the general requirements, installation requirements, and connection requirements for overvoltage protection and overvoltage protective devices. Part II covers surge-protective devices (SPDs) permanently installed on premises wiring systems of not more than 1000 volts, nominal, while Part III covers surge arresters permanently installed on premises wiring systems over 1000 volts, nominal.

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Article 242 Overvoltage Protection

***N* 242.2 Reconditioned Equipment.**

SPDs and surge arresters shall not be reconditioned.

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△ Table 242.3 Other Articles

Equipment	Article
Class I Locations	501
Class II Locations	502
Community Antenna Television and radio distribution systems.	820
Critical operations power systems	708
Elevators, dumbwaiters, escalators, moving walk, platform lifts, and stairway chairlifts	620
Emergency systems	700
Equipment over 1000 volts, nominal	495
Fire pumps	695
Industrial machinery	670
Informational technology equipment	645
Modular data centers	646
Outdoor overhead conductors over 1000 volts	395
Radio and Television Equipment	810
Receptacles, cord connectors, and attachment plugs (caps)	406
Wind electric systems	694

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Article 242 Overvoltage Protection

242.6 Listing.

An SPD device shall be a listed device.

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Article 242 Overvoltage Protection

***N* 242.9 Indicating.**

An SPD shall provide indication that it is functioning properly.

242.12 Uses Not Permitted. An SPD device shall not be installed in the following:

(1) Circuits over 1000 volts
(2) On ungrounded systems, impedance grounded systems, or corner grounded delta systems unless listed specifically for use on these systems
(3) Where the rating of the SPD is less than the maximum continuous phase-to-ground voltage at the power frequency available at the point of application

242.13 Type 1 SPDs, 242.13 (B) At the Service.

When installed at services, Type I SPDs shall be connected to one of the following:

(1) Grounded service conductor
(2) Grounding electrode conductor
(3) Grounding electrode for the service
(4) Equipment grounding terminal in the service equipment

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Article 242 Overvoltage Protection

242.8 Short Circuit-Rating.

The SPD shall be marked with a short-circuit Current Rating and shall not be installed at a point on the system where the available fault current is in excess of that rating. This marking requirement shall not apply to receptacles.

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Article 242 Overvoltage Protection

242.13 Type I SPDs. Type I SPDs shall be installed in accordance with 242.13 (A) and (B)

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Article 242 Overvoltage Protection

242.13 Type I SPDs. Type I SPDs shall be installed in accordance with 242.13 (A) and (B)

Meter Socket Type One Surge Protector

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Article 242 Overvoltage Protection

N **242.13 Type I SPDs.** Type I SPDs shall be installed in accordance with 242.13 (A) and (B)

Breaker Style Type One Device

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Article 242 Overvoltage Protection

242.14 Type 2 SPDs.
Type 2 SPDs shall be installed in accordance with 242.14 (A) through (C).

242.14 (A) Service-Supplied Building or Structure.
Type 2 SPDs shall be installed on connected anywhere on the load side of a service disconnect overcurrent device required in 230.91 unless installed in accordance with 230.82(8).

242.14 (B) Feeder-Supplied Building or Structure.
Type 2 SPDs shall be connected at the building or structure anywhere on the load side of the first overcurrent device at the building or structure.

242.14 (C) Separately Derived System.
The SPD shall be connected on the load side of the first overcurrent device in a separately derived system.

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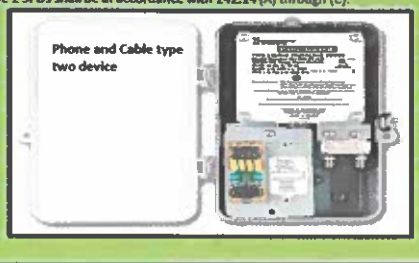
Article 242 Overvoltage Protection

242.14 Type 2 SPDs.
Type 2 SPDs shall be in accordance with 242.14 (A) through (C).



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Article 242 Overvoltage Protection

242.14 Type 2 SPDs.

Type 2 SPDs shall be installed in accordance with 242.14 (A) through (C).

Whole house Type two device

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Article 242 Overvoltage Protection

242.16 Type 3 SPDs.

Phase to Phase type three Surge Protective Device

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Article 242 Overvoltage Protection

242.16 Type 3 SPDs.

Type 3 SPDs shall be permitted to be installed on the load side of branch circuit overcurrent protection up to the equipment served. If included in the manufacture's instructions, the Type 3 SPD connection shall be a minimum 10m (30ft) of conductor distance from the service or separately derived system disconnect.

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Article 242 Overvoltage Protection

242.18 Type 4 and Other Component Type SPDs.

Type 4 component assemblies and other component-type SPSs shall only be installed by the equipment manufacturer.

242.20 Number Required

Where used at a point on a circuit, the SPD shall be connected to each ungrounded conductor.

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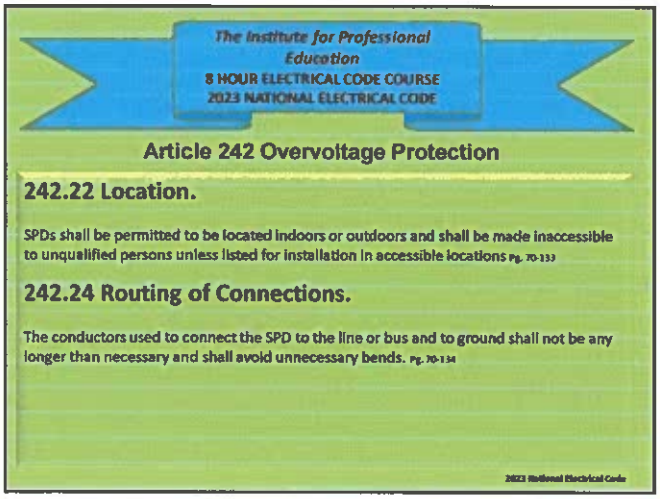
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Article 242 Overvoltage Protection
242.22 Location.
SPDs shall be permitted to be located indoors or outdoors and shall be made inaccessible to unqualified persons unless listed for installation in accessible locations Pg. 70-133
242.24 Routing of Connections.
The conductors used to connect the SPD to the line or bus and to ground shall not be any longer than necessary and shall avoid unnecessary bends. Pg. 70-134

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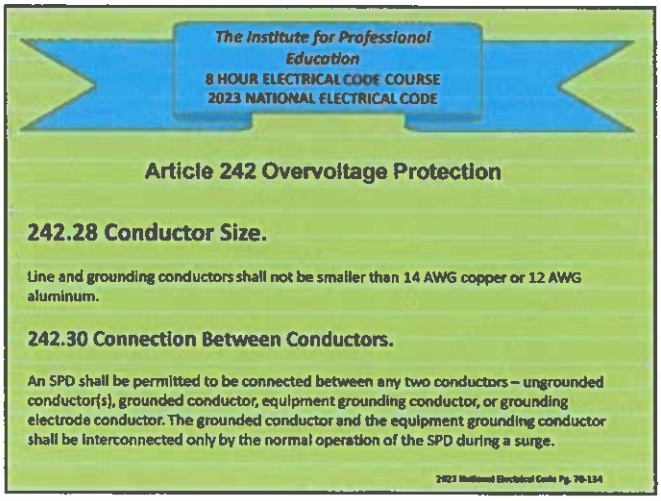
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Article 242 Overvoltage Protection
242.28 Conductor Size.
Line and grounding conductors shall not be smaller than 14 AWG copper or 12 AWG aluminum.
242.30 Connection Between Conductors.
An SPD shall be permitted to be connected between any two conductors – ungrounded conductor(s), grounded conductor, equipment grounding conductor, or grounding electrode conductor. The grounded conductor and the equipment grounding conductor shall be interconnected only by the normal operation of the SPD during a surge.

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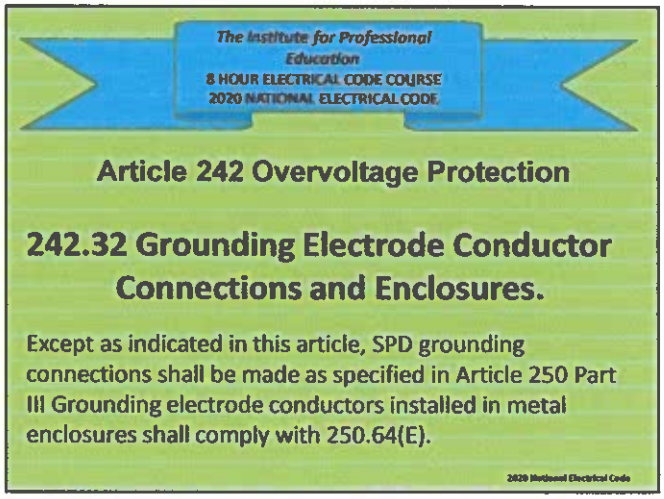
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Article 242 Overvoltage Protection
242.32 Grounding Electrode Conductor Connections and Enclosures.
Except as indicated in this article, SPD grounding connections shall be made as specified in Article 250 Part III Grounding electrode conductors installed in metal enclosures shall comply with 250.64(E).

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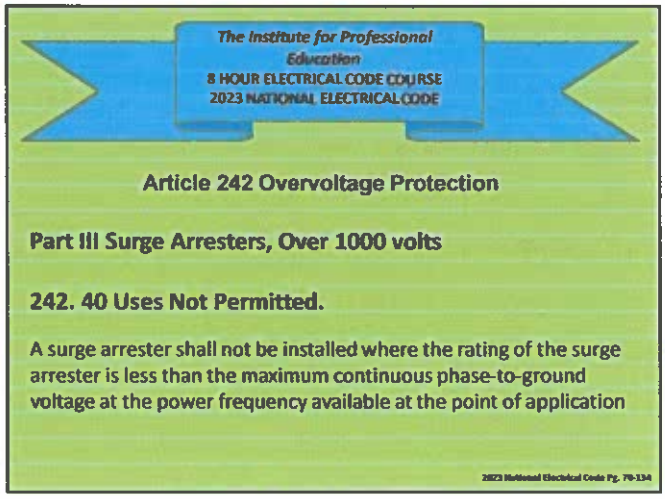
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Article 242 Overvoltage Protection
Part III Surge Arresters, Over 1000 volts
242. 40 Uses Not Permitted.
A surge arrester shall not be installed where the rating of the surge arrester is less than the maximum continuous phase-to-ground voltage at the power frequency available at the point of application

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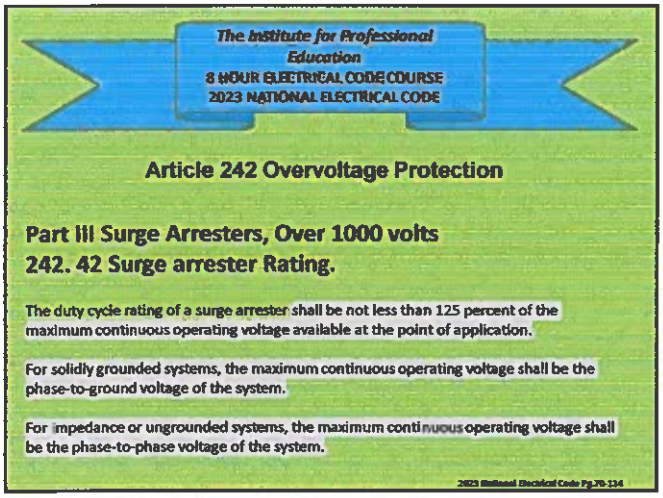
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242. 42 Surge arrester Rating.
The duty cycle rating of a surge arrester shall be not less than 125 percent of the maximum continuous operating voltage available at the point of application.
For solidly grounded systems, the maximum continuous operating voltage shall be the phase-to-ground voltage of the system.
For impedance or ungrounded systems, the maximum continuous operating voltage shall be the phase-to-phase voltage of the system.

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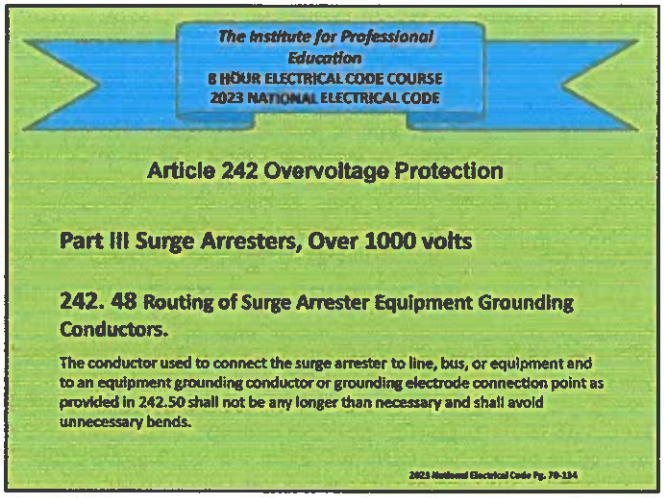
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242. 48 Routing of Surge Arrester Equipment Grounding Conductors.
The conductor used to connect the surge arrester to line, bus, or equipment and to an equipment grounding conductor or grounding electrode connection point as provided in 242.50 shall not be any longer than necessary and shall avoid unnecessary bends.

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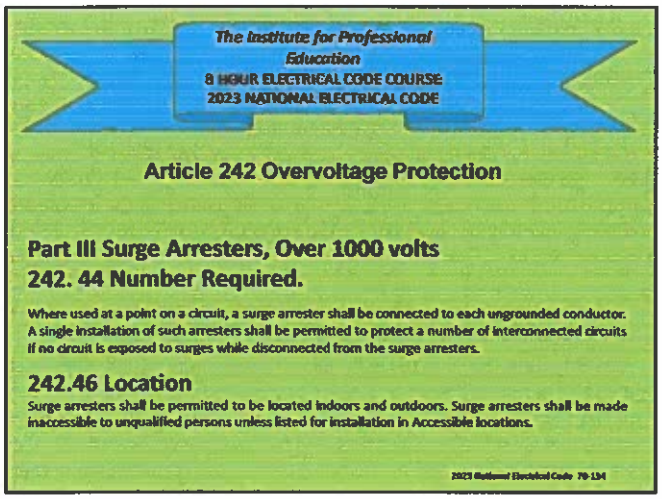
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Part III Surge Arresters, Over 1000 volts
242. 44 Number Required.
Where used at a point on a circuit, a surge arrester shall be connected to each ungrounded conductor. A single installation of such arresters shall be permitted to protect a number of interconnected circuits if no circuit is exposed to surges while disconnected from the surge arresters.
242.46 Location
Surge arresters shall be permitted to be located indoors and outdoors. Surge arresters shall be made inaccessible to unqualified persons unless listed for installation in Accessible locations.

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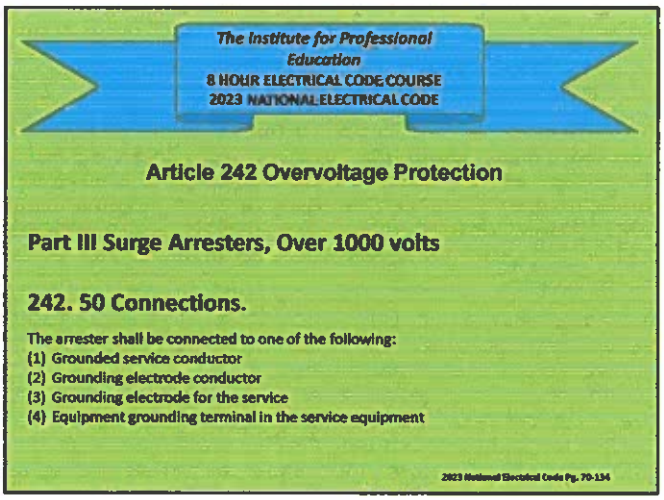
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Part III Surge Arresters, Over 1000 volts
242. 50 Connections.
The arrester shall be connected to one of the following:
(1) Grounded service conductor
(2) Grounding electrode conductor
(3) Grounding electrode for the service
(4) Equipment grounding terminal in the service equipment

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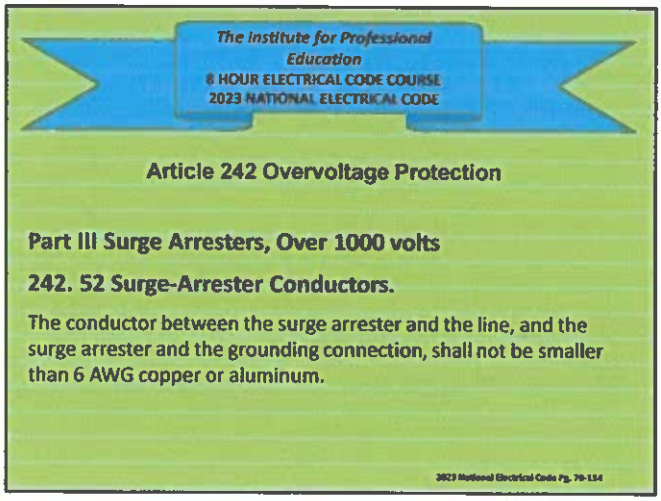
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242. 52 Surge-Arrester Conductors.
The conductor between the surge arrester and the line, and the surge arrester and the grounding connection, shall not be smaller than 6 AWG copper or aluminum.

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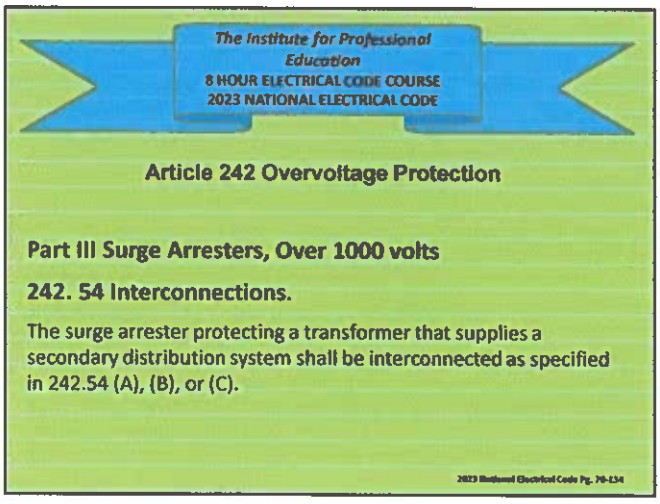
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Part III Surge Arresters, Over 1000 volts
242. 54 Interconnections.
The surge arrester protecting a transformer that supplies a secondary distribution system shall be interconnected as specified in 242.54 (A), (B), or (C).

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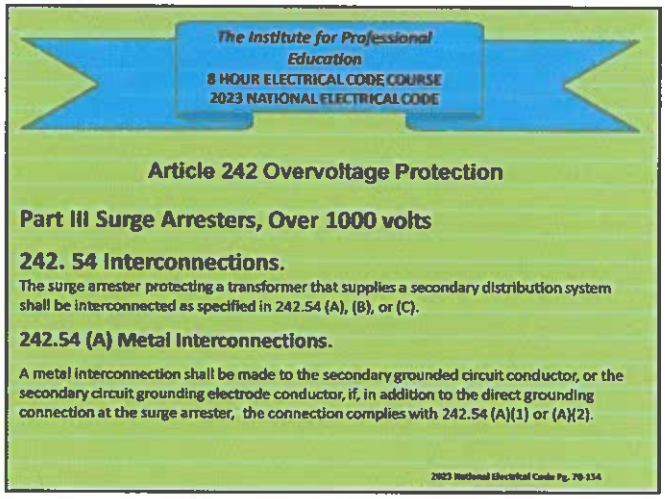
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Part III Surge Arresters, Over 1000 volts
242. 54 Interconnections.
242.54 (A) Metal Interconnections.
A metal interconnection shall be made to the secondary grounded circuit conductor, or the secondary circuit grounding electrode conductor, if, in addition to the direct grounding connection at the surge arrester, the connection complies with 242.54 (A)(1) or (A)(2).

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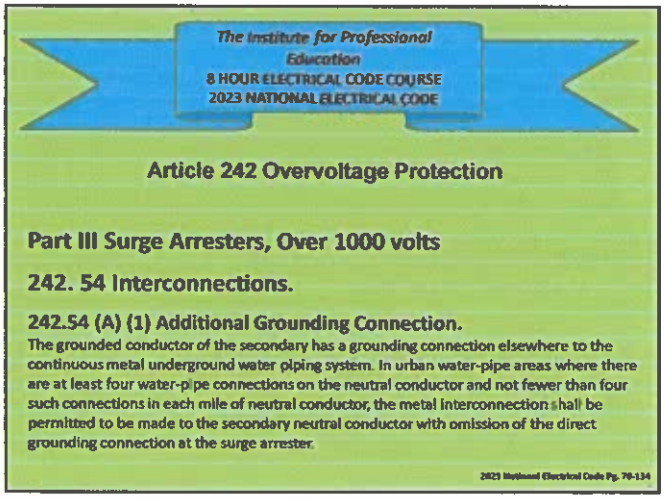
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2023 NATIONAL ELECTRICAL CODE
Article 242 Overvoltage Protection
Part III Surge Arresters, Over 1000 volts
242. 54 Interconnections.
242.54 (A) (1) Additional Grounding Connection.
The grounded conductor of the secondary has a grounding connection elsewhere to the continuous metal underground water piping system. In urban water-pipe areas where there are at least four water-pipe connections on the neutral conductor and not fewer than four such connections in each mile of neutral conductor, the metal interconnection shall be permitted to be made to the secondary neutral conductor with omission of the direct grounding connection at the surge arrester.

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Article 242 Overvoltage Protection

Part III Surge Arresters, Over 1000 volts

242. 54 Interconnections.

242.54 (A) (2) Multigrounded Neutral Systems Connection.

The grounded conductor of the secondary system is part of a multigrounded neutral system or static wire of which the primary neutral conductor or static wire has at least four grounding connections in each 1.6 km (1 Mile) of line in addition to a grounding connection at each service.

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Article 242 Overvoltage Protection

Part III Surge Arresters, Over 1000 volts

242. 54 Interconnections.

242.54 (B)(1) Ungrounded or Unigrounded Primary System.

For ungrounded or unigrounded primary systems. The spark gap for a listed device shall have a 60-Hz breakdown voltage of at least twice the primary circuit voltage but not necessarily more than 10 Kv, and there shall be at least one other ground on the grounded conductor of the secondary that is not less than 6.0 m (20ft) distant from the surge-arrestor grounding electrode.

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Article 242 Overvoltage Protection

Part III Surge Arresters, Over 1000 volts

242. 54 Interconnections.

242.54 (B) Through Spark Gap or Device.

Where the surge arrester grounding electrode conductor is not connected as in 242.54(A), or where the secondary is not grounded as in 242.54(A) but is otherwise grounded as in 250.52, an interconnection shall be made through a spark gap or listed device as required by 242.54 (B)(1) or (B)(2).

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Article 242 Overvoltage Protection

Part III Surge Arresters, Over 1000 volts

242. 54 Interconnections.

242.54 (B)(2) Multigrounded Neutral Primary System.

For multigrounded neutral primary systems, the spark gap or listed device shall have a 60-Hz breakdown of not more than 3Kv, and there shall be at least one other ground on the grounded conductor of the secondary that is not less than 6.0 m (20 ft) distant from the surge-arrester grounding electrode.

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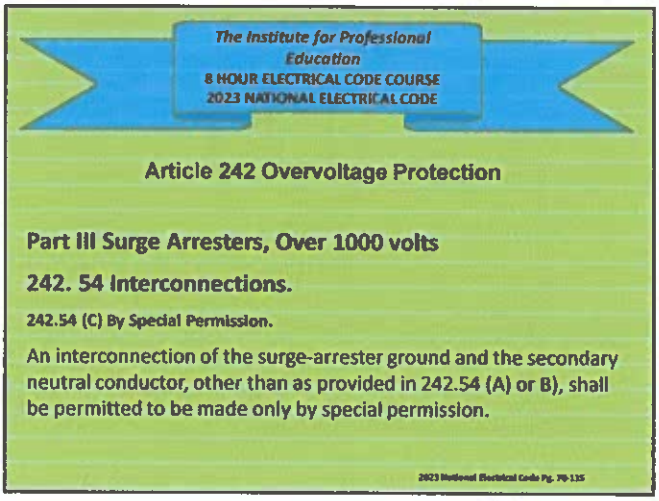
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Article 242 Overvoltage Protection
Part III Surge Arresters, Over 1000 volts
242. 54 Interconnections.
242.54 (C) By Special Permission.
An interconnection of the surge-arrester ground and the secondary neutral conductor, other than as provided in 242.54 (A) or B), shall be permitted to be made only by special permission.

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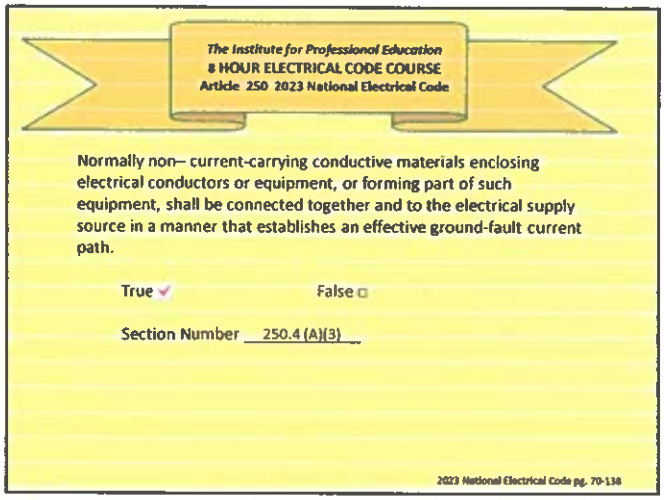
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Article 250 2023 National Electrical Code
Normally non– current-carrying conductive materials enclosing electrical conductors or equipment, or forming part of such equipment, shall be connected together and to the electrical supply source in a manner that establishes an effective ground-fault current path.
True
False
Section Number 250.4 (A)(3)

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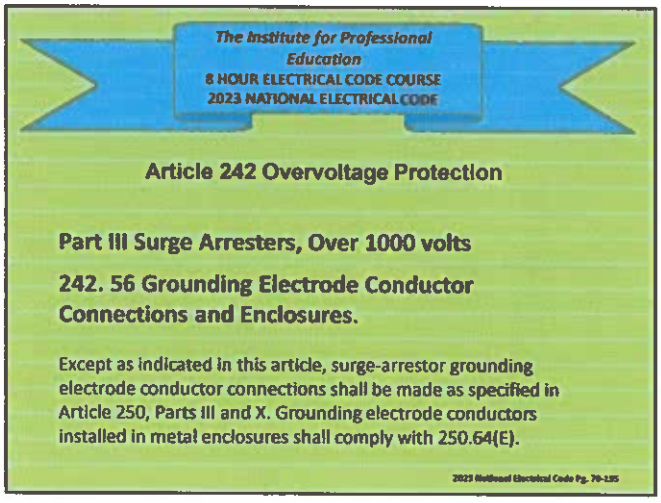
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Article 242 Overvoltage Protection
Part III Surge Arresters, Over 1000 volts
242. 56 Grounding Electrode Conductor Connections and Enclosures.
Except as indicated in this article, surge-arrestor grounding electrode conductor connections shall be made as specified in Article 250, Parts III and X. Grounding electrode conductors installed in metal enclosures shall comply with 250.64(E).

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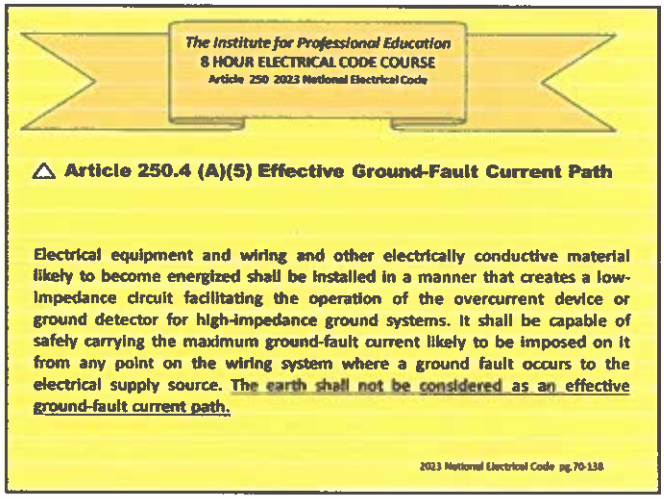
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Article 250 2023 National Electrical Code
△ Article 250.4 (A)(5) Effective Ground-Fault Current Path
Electrical equipment and wiring and other electrically conductive material likely to become energized shall be installed in a manner that creates a low-impedance circuit facilitating the operation of the overcurrent device or ground detector for high-impedance ground systems. It shall be capable of safely carrying the maximum ground-fault current likely to be imposed on it from any point on the wiring system where a ground fault occurs to the electrical supply source. The earth shall not be considered as an effective ground-fault current path.

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250.6 Objectional Current

250.6 (D) Limitations to Permissible Alterations

This section shall not be considered as permitting electronic equipment to be operated on ac systems or branch circuits that are not connected to an equipment grounding conductor as required by this article. Currents that introduce electromagnetic interference or data errors in electronic equipment shall not be considered the objectionable currents addressed in this section

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Article 250 2023 National Electrical Code

(4) Connection devices or fittings that depend solely on solder shall not be used for grounding.

True ✓ False ☐

Section Number 250.8 (B)

Why aren't we permitted to depend solely on solder for connecting grounding terminations?

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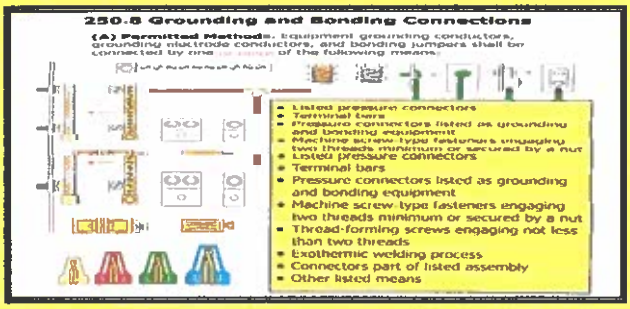
250.8 Connection of Grounding and Bonding Equipment.



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250.10 Protection of Ground Clamps and Fittings.

Ground clamps or other fittings exposed to physical damage shall be enclosed in metal, wood, or equivalent protective covering.

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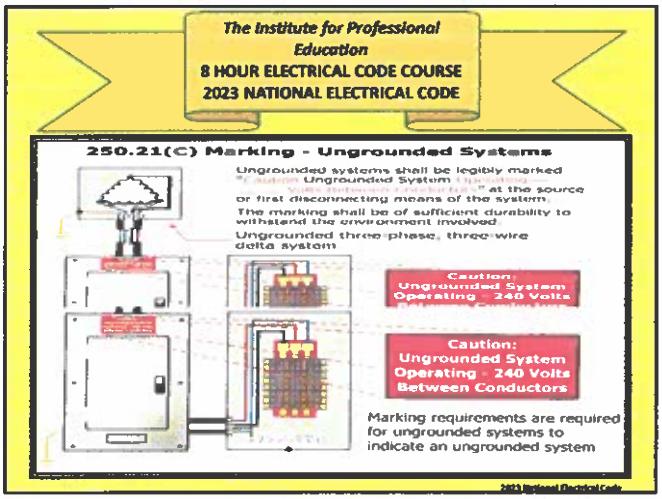
Slide 87

PF5 Why are we not allowed to solder a grounding connection?
Paul Fussner, 4/9/2017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250.21(C) Marking - Ungrounded Systems
Ungrounded systems shall be legibly marked "Caution Ungrounded System Operating Volts Between Conductors" at the source or first disconnecting means of the system.
The marking shall be of sufficient durability to withstand the environment involved.
Ungrounded three-phase, three-wire delta system
Caution Ungrounded System Operating 240 Volts
Caution: Ungrounded System Operating 240 Volts Between Conductors
Marking requirements are required for ungrounded systems to indicate an ungrounded system

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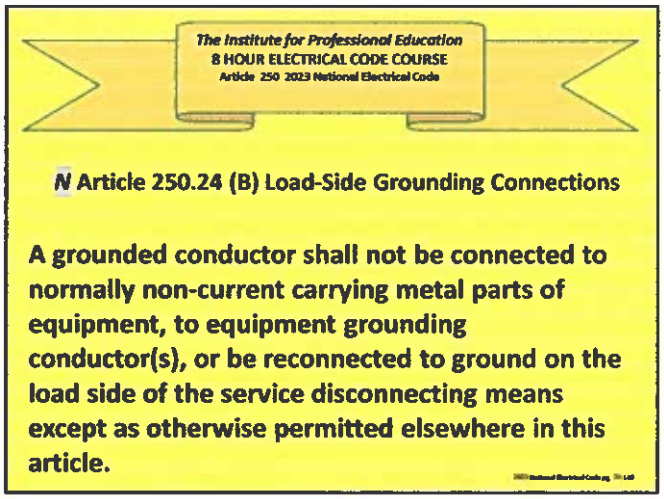
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Article 250 2023 National Electrical Code
N Article 250.24 (B) Load-Side Grounding Connections
A grounded conductor shall not be connected to normally non-current carrying metal parts of equipment, to equipment grounding conductor(s), or be reconnected to ground on the load side of the service disconnecting means except as otherwise permitted elsewhere in this article.

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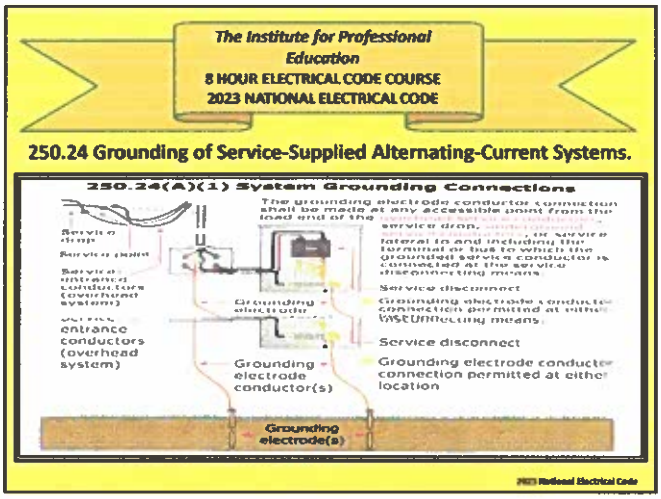
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2023 NATIONAL ELECTRICAL CODE
250.24 Grounding of Service-Supplied Alternating-Current Systems.
250.24(A)(1) System Grounding Connections
Service drop
Service point
Service-entrance conductors (overhead system)
Grounding electrode conductor(s)
Grounding electrode(s)
The grounding electrode conductor connection shall be made at any accessible point from the load end of the service drop to and including the terminal or bus to which the grounded service conductor is connected at the service disconnecting means.
Service disconnect
Grounding electrode conductor connection permitted at either location

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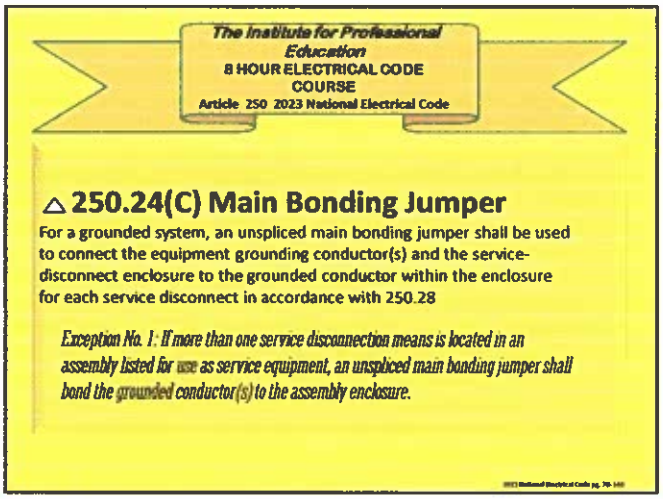
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Article 250 2023 National Electrical Code
△250.24(C) Main Bonding Jumper
For a grounded system, an unspliced main bonding jumper shall be used to connect the equipment grounding conductor(s) and the service-disconnect enclosure to the grounded conductor within the enclosure for each service disconnect in accordance with 250.28
Exception No. 1: If more than one service disconnection means is located in an assembly listed for use as service equipment, an unspliced main bonding jumper shall bond the grounded conductor(s) to the assembly enclosure.

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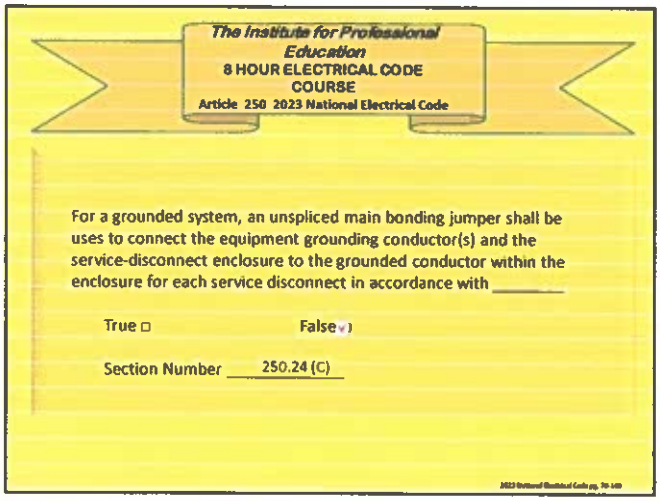
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Article 250 2023 National Electrical Code
For a grounded system, an unspliced main bonding jumper shall be uses to connect the equipment grounding conductor(s) and the service-disconnect enclosure to the grounded conductor within the enclosure for each service disconnect in accordance with _____
True □
False
Section Number 250.24 (C)

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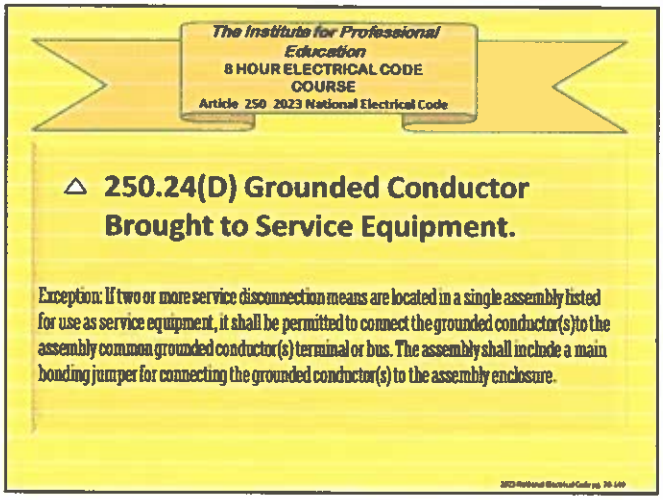
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Article 250 2023 National Electrical Code
△ 250.24(D) Grounded Conductor Brought to Service Equipment.
Exception: If two or more service disconnection means are located in a single assembly listed for use as service equipment, it shall be permitted to connect the grounded conductor(s) to the assembly common grounded conductor(s) terminal or bus. The assembly shall include a main bonding jumper for connecting the grounded conductor(s) to the assembly enclosure.

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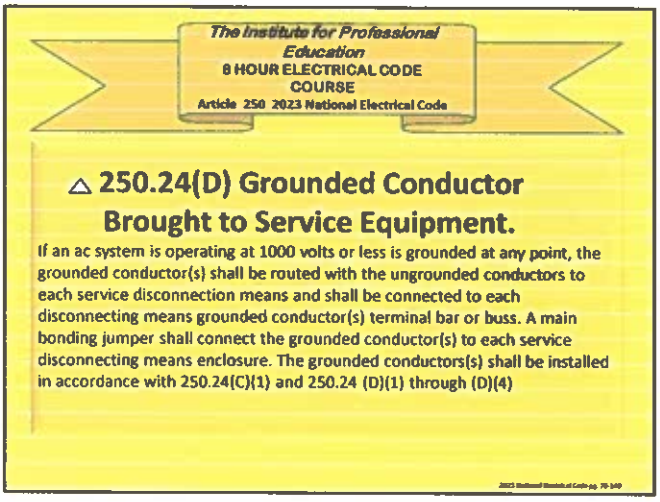
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Article 250 2023 National Electrical Code
△ 250.24(D) Grounded Conductor Brought to Service Equipment.
If an ac system is operating at 1000 volts or less is grounded at any point, the grounded conductor(s) shall be routed with the ungrounded conductors to each service disconnection means and shall be connected to each disconnecting means grounded conductor(s) terminal bar or buss. A main bonding jumper shall connect the grounded conductor(s) to each service disconnecting means enclosure. The grounded conductors(s) shall be installed in accordance with 250.24(C)(1) and 250.24 (D)(1) through (D)(4)

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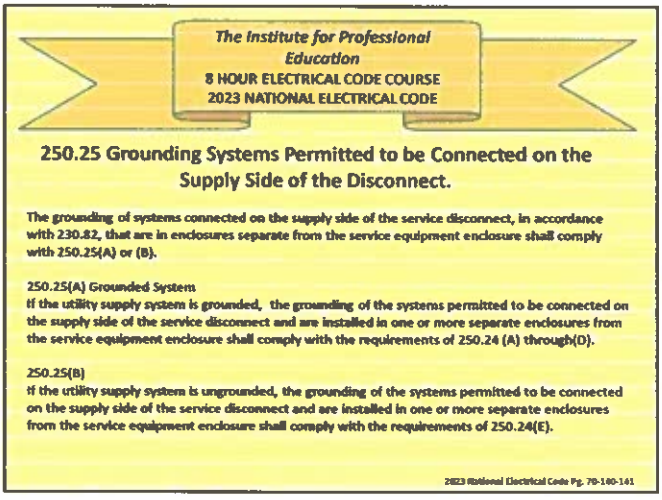
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250.25 Grounding Systems Permitted to be Connected on the Supply Side of the Disconnect.
The grounding of systems connected on the supply side of the service disconnect, in accordance with 230.82, that are in enclosures separate from the service equipment enclosure shall comply with 250.25(A) or (B).
250.25(A) Grounded System
If the utility supply system is grounded, the grounding of the systems permitted to be connected on the supply side of the service disconnect and are installed in one or more separate enclosures from the service equipment enclosure shall comply with the requirements of 250.24 (A) through(D).
250.25(B)
If the utility supply system is ungrounded, the grounding of the systems permitted to be connected on the supply side of the service disconnect and are installed in one or more separate enclosures from the service equipment enclosure shall comply with the requirements of 250.24(E).
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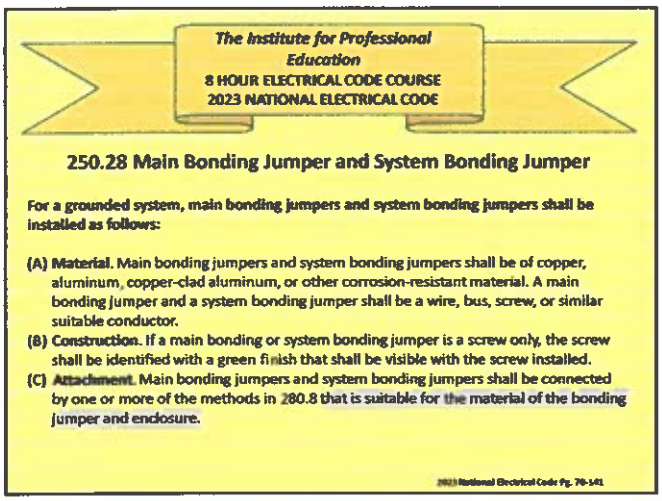
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250.28 Main Bonding Jumper and System Bonding Jumper
For a grounded system, main bonding jumpers and system bonding jumpers shall be installed as follows:
(A) Material. Main bonding jumpers and system bonding jumpers shall be of copper, aluminum, copper-clad aluminum, or other corrosion-resistant material. A main bonding jumper and a system bonding jumper shall be a wire, bus, screw, or similar suitable conductor.
(B) Construction. If a main bonding or system bonding jumper is a screw only, the screw shall be identified with a green finish that shall be visible with the screw installed.
(C) Attachment. Main bonding jumpers and system bonding jumpers shall be connected by one or more of the methods in 280.8 that is suitable for the material of the bonding jumper and enclosure.

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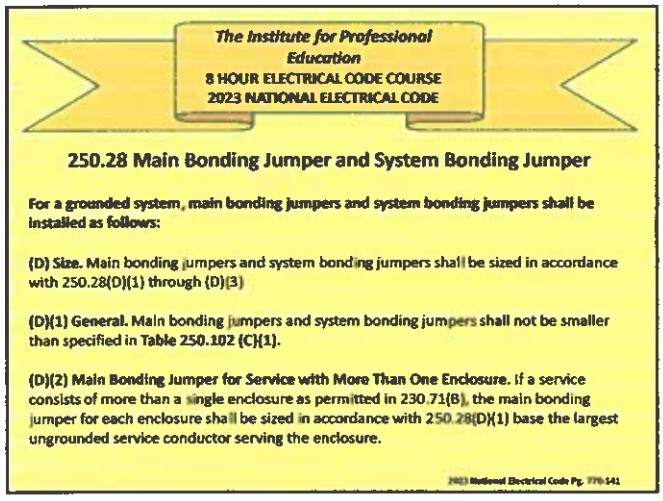
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250.28 Main Bonding Jumper and System Bonding Jumper
For a grounded system, main bonding jumpers and system bonding jumpers shall be installed as follows:
(D) Size. Main bonding jumpers and system bonding jumpers shall be sized in accordance with 250.28(D)(1) through (D)(3)
(D)(1) General. Main bonding jumpers and system bonding jumpers shall not be smaller than specified in Table 250.102 (C)(1).
(D)(2) Main Bonding Jumper for Service with More Than One Enclosure. If a service consists of more than a single enclosure as permitted in 230.71(B), the main bonding jumper for each enclosure shall be sized in accordance with 250.28(D)(1) base the largest ungrounded service conductor serving the enclosure.

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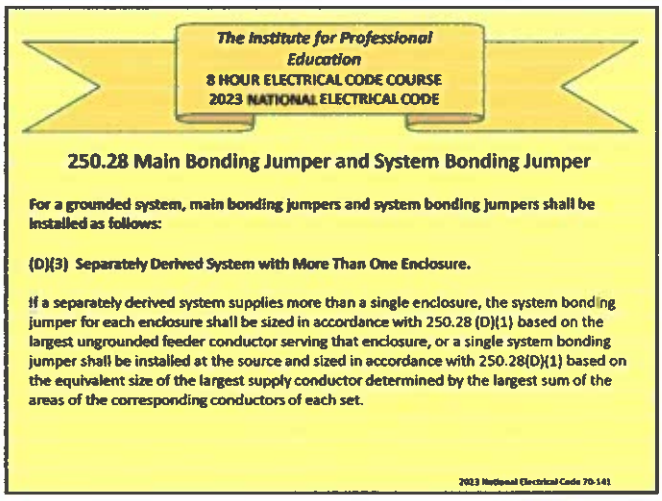
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250.28 Main Bonding Jumper and System Bonding Jumper
For a grounded system, main bonding jumpers and system bonding jumpers shall be installed as follows:
(D)(3) Separately Derived System with More Than One Enclosure.
If a separately derived system supplies more than a single enclosure, the system bonding jumper for each enclosure shall be sized in accordance with 250.28 (D)(1) based on the largest ungrounded feeder conductor serving that enclosure, or a single system bonding jumper shall be installed at the source and sized in accordance with 250.28(D)(1) based on the equivalent size of the largest supply conductor determined by the largest sum of the areas of the corresponding conductors of each set.

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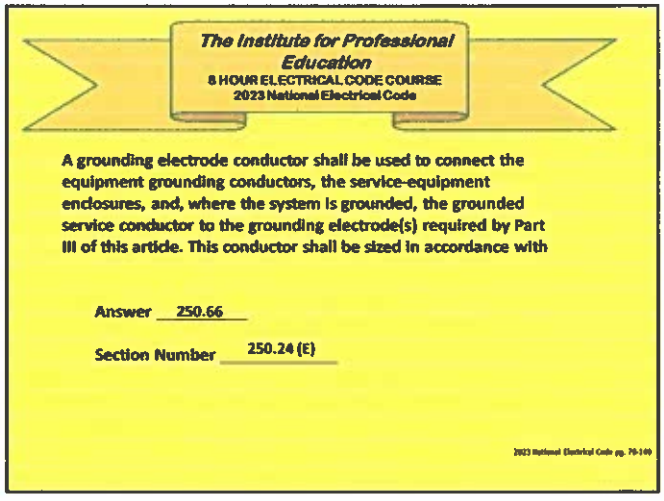
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A grounding electrode conductor shall be used to connect the equipment grounding conductors, the service-equipment enclosures, and, where the system is grounded, the grounded service conductor to the grounding electrode(s) required by Part III of this article. This conductor shall be sized in accordance with
Answer 250.66
Section Number 250.24 (E)

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If a service consists of more than a single enclosure as permitted in _____(B),the main bonding jumper for each enclosure shall be sized in accordance with _____(D)(1) based on the largest ungrounded service conductor serving that enclosure.

Answers. 250.71 , 250.28

Section Number. 250.28 (D)(2)

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△ 250.30 Grounding Separately Derived Alternation-Current Systems

In addition to complying with 250.30(A) for grounded systems, or as provided in 250.30(B) for ungrounded systems, separately derived systems shall comply with 250.20, 250.21, or 250.26, as applicable. Multiple power sources of the same type that are connected in parallel to form one system that supplies premises wiring shall be treated as a single separately derived system and shall be installed in accordance with 250.30

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△ 250.30 (A) Grounded Systems

A separately derived ac system that is grounded shall comply with 250.20(A)(1) Through (A)(8). Except as otherwise permitted in this article, a grounded conductor shall not be connected to normally non-current carrying metal part of equipment, be connected to equipment grounding conductors, or be reconnected to ground on the load side of the system bonding jumper.

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250.30 Grounding Separately Derived Alternation-Current Systems

250.30 (A)(3) Grounded Conductor

If a grounded conductor is installed and the system bonding jumper connection is not located at the source, 250.30(A)(3)(a) through 250.30(A)(3)(d) shall apply. The grounded conductor shall not be required to be larger than the derived ungrounded conductors.

250.30(A)(3)(a) *Sizing for a single raceway.* The grounded conductor shall not be smaller the specified in Table 250.102(C)(1)

250.30(A)(3)(b) *Conductors connected in parallel in two or more raceways or cables.* If the ungrounded conductor are connected in parallel in two or more raceways or cables, the grounded conductors shall also be installed in each raceway or cable and shall be connected in parallel. The size of the grounded conductor(s) in each raceway or cable shall be based on the largest derived ungrounded conductor in the raceway or cable, or the sum of the circular mil areas of the largest derived ungrounded conductors from each set connected in parallel in each raceway or cable in accordance with 250.30(A)(3)(a), but not smaller than 1/0 AGW.

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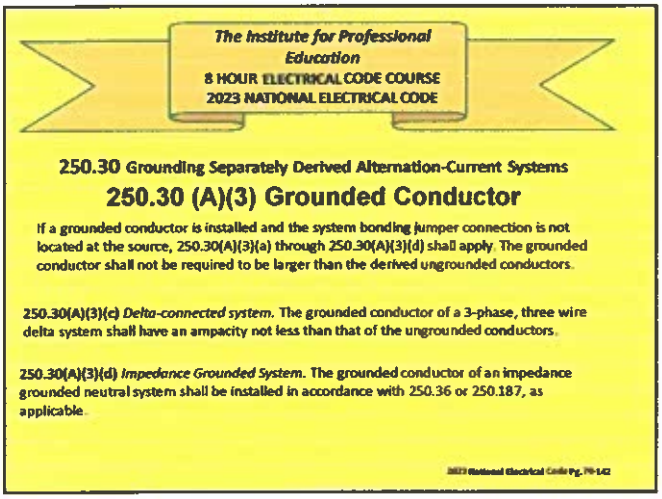

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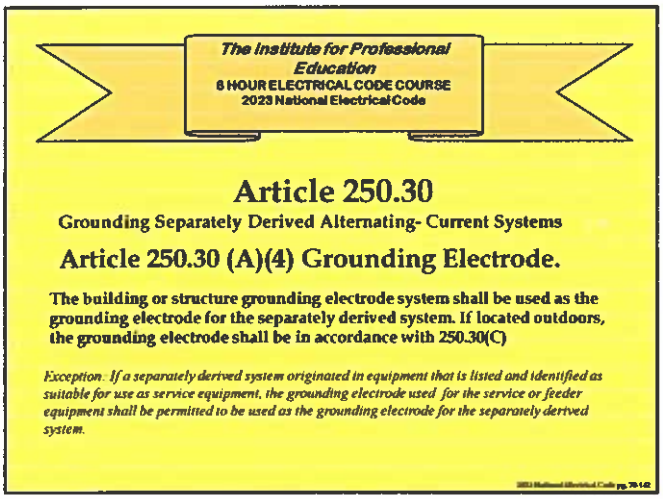

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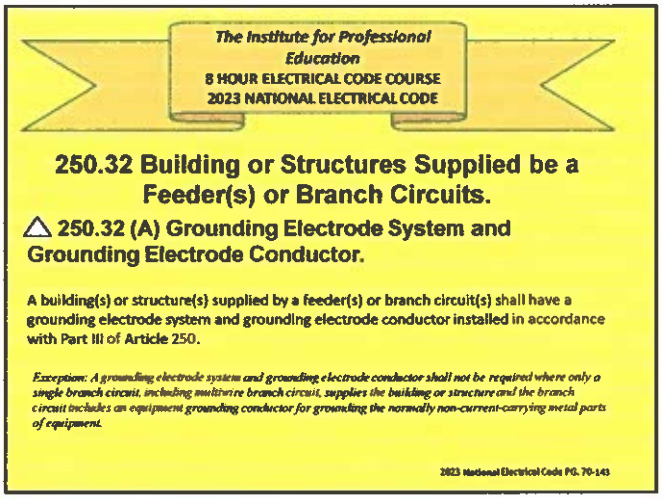

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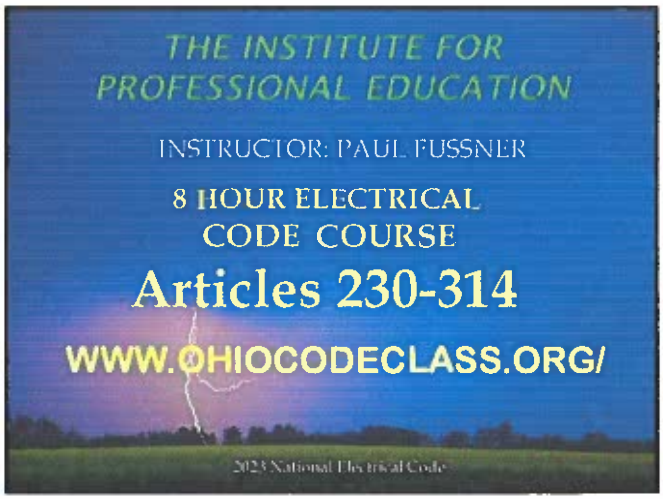

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250.34 Portable, Vehicle-Mounted and Trailer-Mounted Generators.

250.34(A) Portable Generators. The frame of a portable generator shall not be required to be connected to a grounding electrode as defined in 250.52 for a system supplied by the generator under both of the following conditions:

250.34(A)(1) The generator supplies only equipment mounted on the generator, cord-and-plug connected equipment through receptacles mounted on the generator, or both.

250.34(A)(2) The normally non-current-carrying metal parts of equipment and the equipment grounding conductor terminals of the receptacles are connected to the generator frame.

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250.34 Portable, Vehicle-Mounted, and Trailer-Mounted Generators.

250.34(B) Vehicle-Mounted and Trailer-Mounted Generators. The frame of a vehicle or trailer shall not be required to be connected to a grounding electrode as defined 250.52 for a system supplied by a generator located on this vehicle or trailer under all of the following conditions.

250.34(B)(1) The frame of the generator is bonded to the vehicle or trailer frame.

250.34(B)(2) The generator supplies only equipment located on the vehicle or trailer; cord-and-plug connected equipment through receptacles mounted on the vehicle; or both equipment located on the vehicle or trailer and cord-and-plug connected equipment through receptacles mounted on the vehicle, trailer, or on the generator.

250.34(B)(3) The normally non-current-carrying metal parts of equipment and the equipment grounding conductor terminals of the receptacles are connected to the generator frame.

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250.50 Grounding Electrode System.

All grounding electrodes as described in 250.52(A)(1) through (A)(7) that are present at each building or structure served shall be bonded together to form the grounding electrode system. If none of these grounding electrodes exist, one or more of the grounding electrodes specified in 250.52(A)(4) through (A)(8) shall be installed and used.

Exception: Concrete-encased electrodes of existing buildings or structures shall not be required to be part of the grounding electrode system if the steel reinforcing bars or rods are not accessible for use without disturbing the concrete.

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250.52 Grounding Electrodes.

(A) Electrodes Permitted for Grounding.

(1) Metal Underground Water Pipe.

A metal underground water pipe in direct contact with the earth for 3.0 m (10 ft) or more (including any metal well casing bonded to the pipe) and electrically continuous (or made electrically continuous by bonding around insulating joints or insulating pipe) to the points of connection of the grounding electrode conductor and the bonding conductor(s) or jumper(s), if installed.

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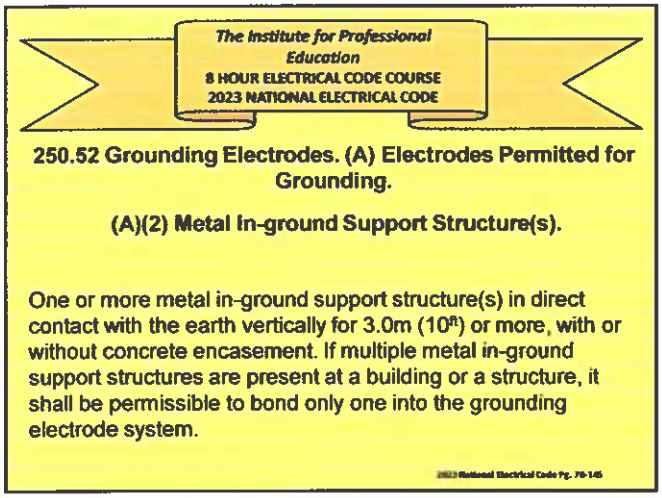

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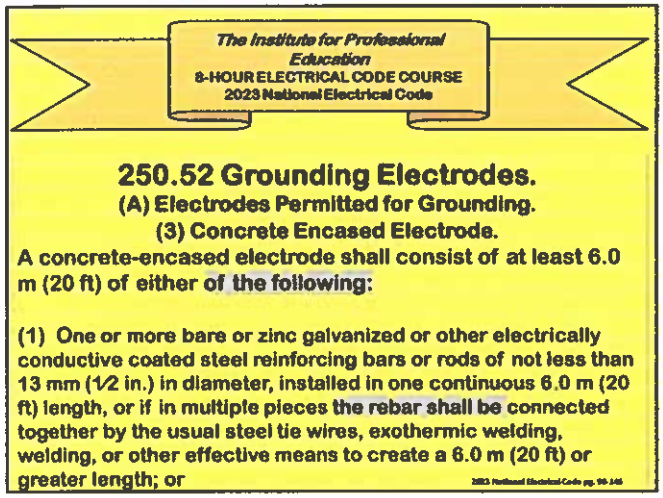

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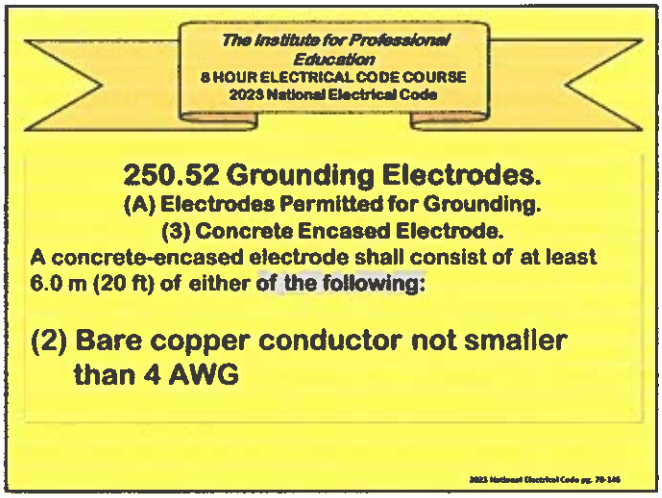

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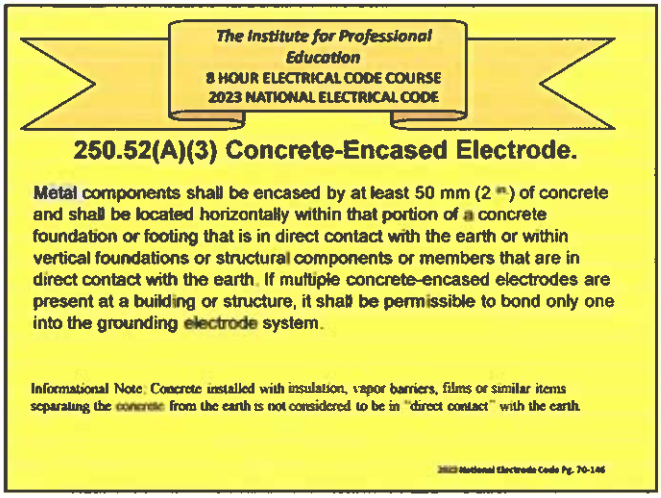

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250.52(A)(4) Ground Ring..

A ground ring encircling the building or structure, in direct contact with the earth, consisting of at least 6.0 m (20ft) of bare copper conductor not smaller than 2 AWG.

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250.52(A)(5)
Rod and Pipe Electrodes.

Rod and pipe electrodes shall not be less than 2.44 m (8 ft) in length and shall consist of the following materials.

(a) Grounding electrodes of pipe or conduit shall not be smaller than metric designator 21 (trade size 3/4) and, where of steel, shall have the outer surface galvanized or otherwise metal-coated for corrosion protection.

(b) Rod-type grounding electrodes of stainless steel and copper or zinc-coated steel shall be at least 15.87 mm (5/8 in.) in diameter unless listed.

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250.52(A)(6)
(6) Other Listed Electrodes.

Other listed grounding electrodes shall be permitted.

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250.52(A)(7) Plate Electrodes.

Each plate electrode shall expose not less than 0.186 m2 (2 ft²) of surface to exterior soil. Electrodes of bare or electrically conductive coated iron or steel plates shall be at least 6.4 mm (1/4 in.) in thickness. Solid, uncoated electrodes of nonferrous metal shall be at least 1.5 mm (0.06 in.) in thickness.

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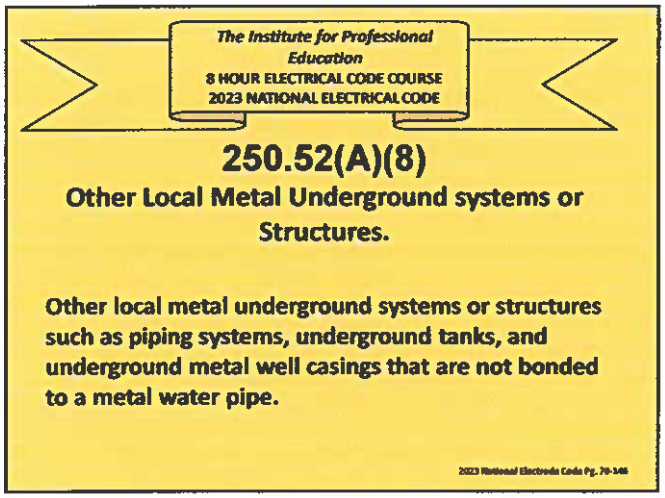

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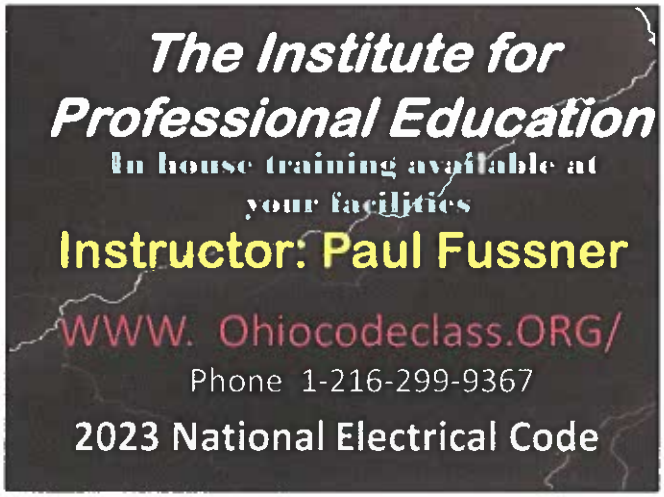

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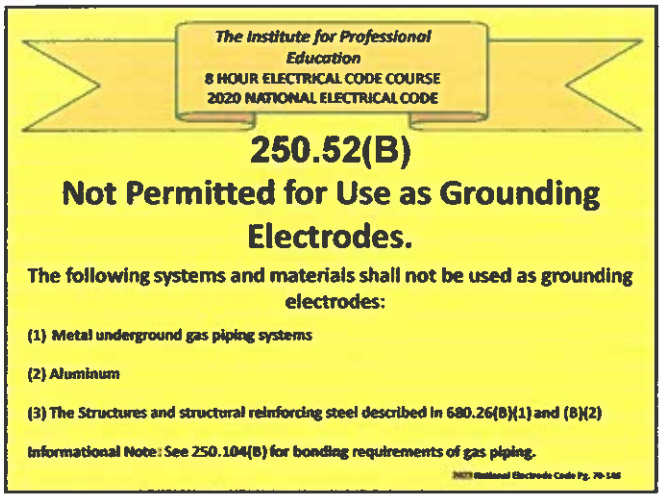

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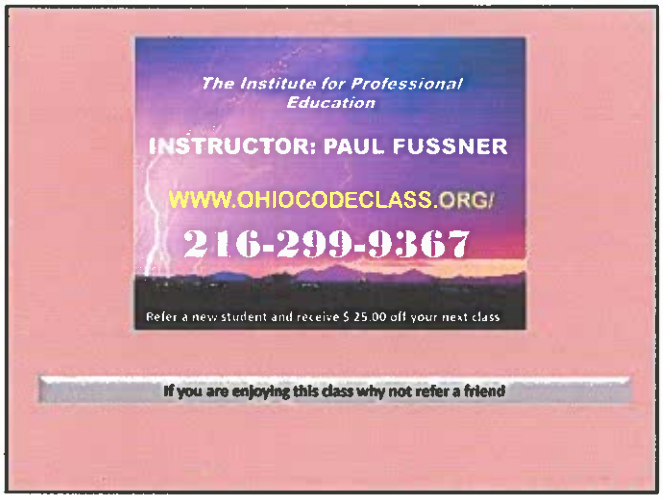

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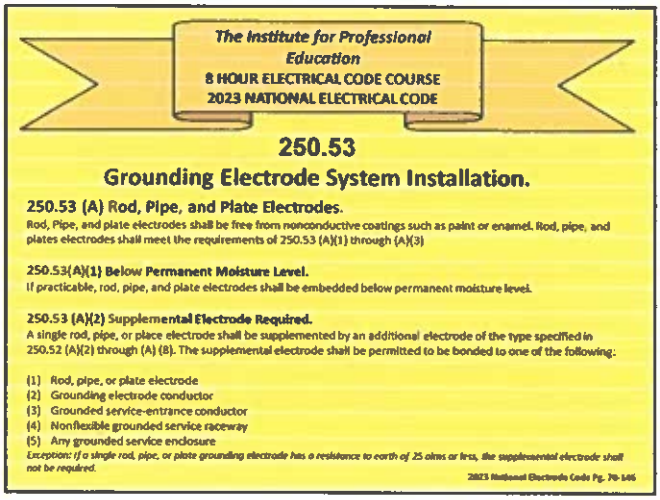

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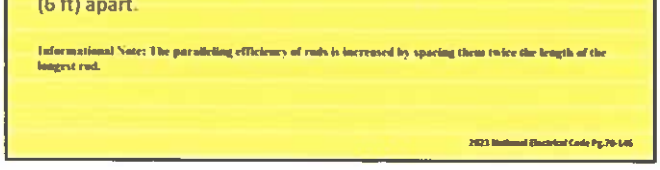

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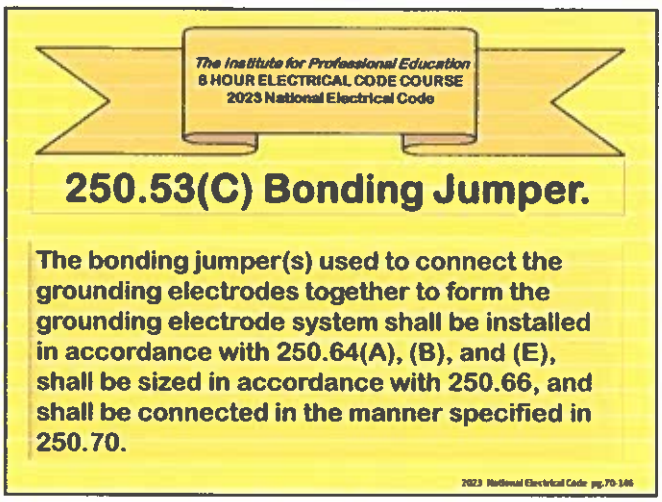

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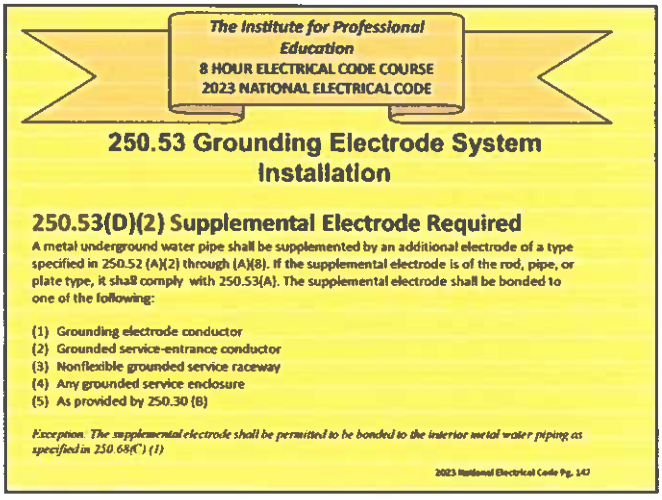

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250.64 Grounding Electrode Conductor Installation.

Grounding electrode conductors at the service, at each building or structure where supplied by a feeder(s) or branch circuit(s), or at a separately derived system shall be installed as specified in 250.64(A) through (F).

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250.64 Grounding Electrode Conductor Installation.

250.64(A) Aluminum or Copper-Clad Aluminum Conductors.

Grounding electrode conductors of bare, covered, or insulated aluminum or copper-clad aluminum shall comply with the following:

(1) Bare or covered conductors without an extruded polymeric covering shall not be installed where subject to corrosive conditions or be installed in direct contact with concrete.

(2) Terminations made within outdoor enclosures that are listed and identified for the environment shall be permitted within 450mm(18") of the bottom of the enclosure.

(3) Aluminum or copper-clad aluminum conductors external to buildings or equipment enclosures shall not be terminated within 450mm (18") of the earth.

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250.64 (B) Securing and Protection Against Physical Damage

If exposed, a grounding electrode conductor or its enclosure shall be securely fastened to the surface on which it is carried. Grounding electrode conductors shall be permitted to be installed on or through framing members.

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250.64 (C) Continuous

Except as provided in 250.30(A)(5) and (A)(6), 250.30(B)(1), and 250.68(C), grounding electrode conductor(s) shall be installed in one continuous length without a splice or joint. If necessary, splices or connections shall be made as permitted in the following:

(1) Splicing of the wire-type grounding electrode conductor shall be permitted only by irreversible compression-type connectors listed as grounding and bonding equipment or by the exothermic welding process.
(2) Sections of busbars shall be permitted to be connected together to form a grounding electrode conductor.
(3) Bolted, riveted, or welded connections of structural metal frames of buildings or structures.
(4) Threaded, welded, brazed, soldered or bolted-flange connections of metal water piping.

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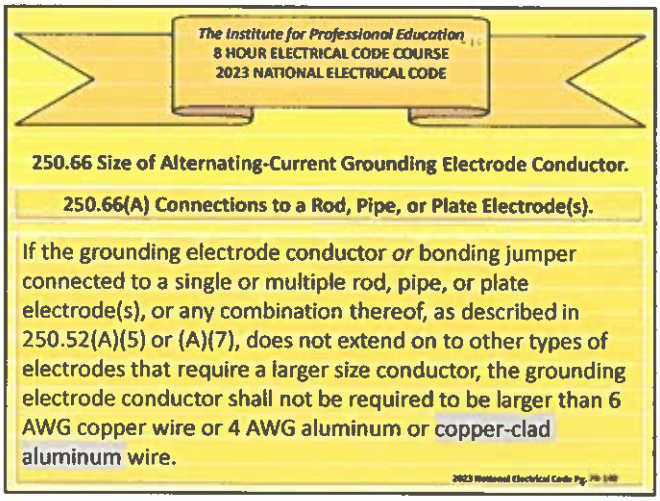

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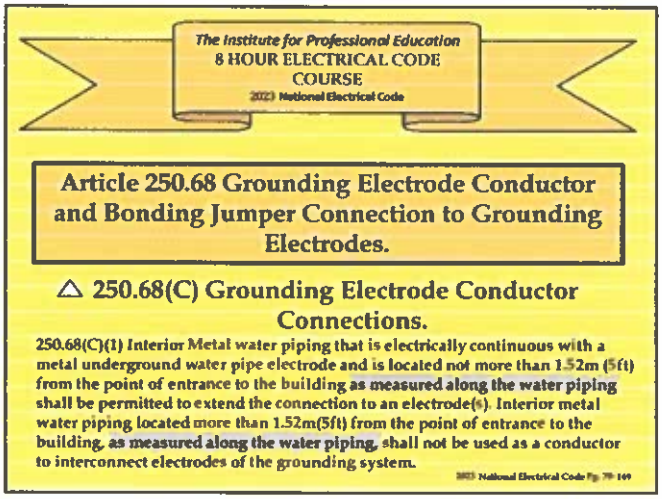

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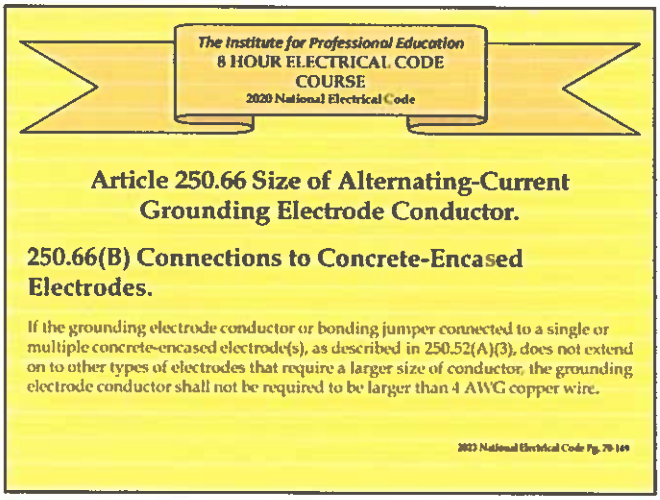

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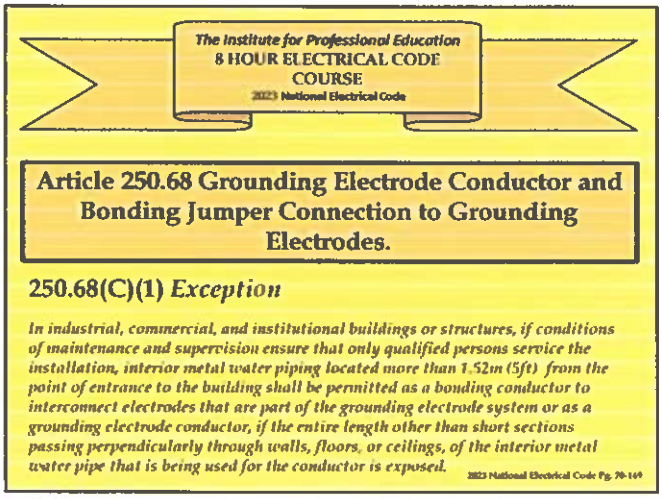

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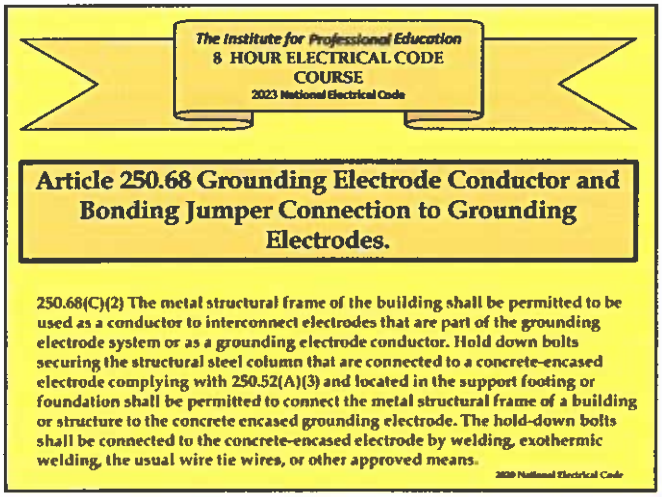

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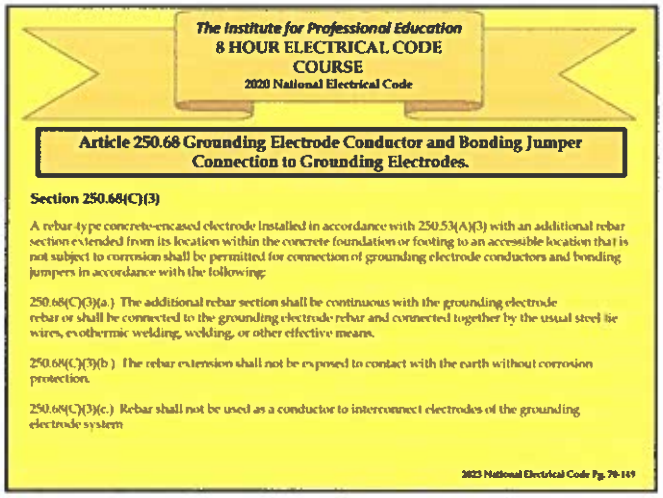

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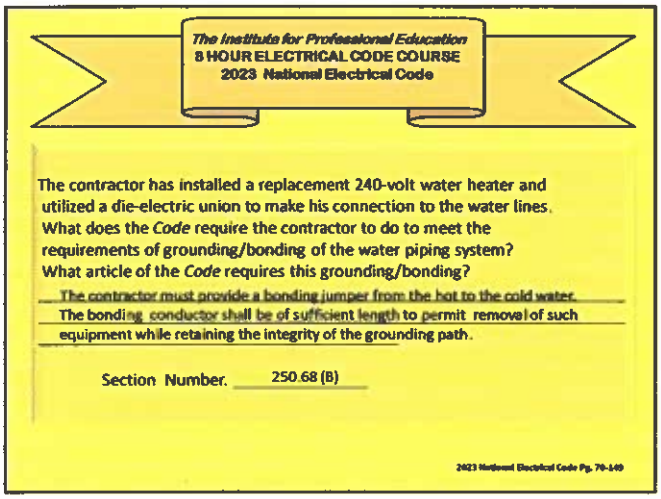

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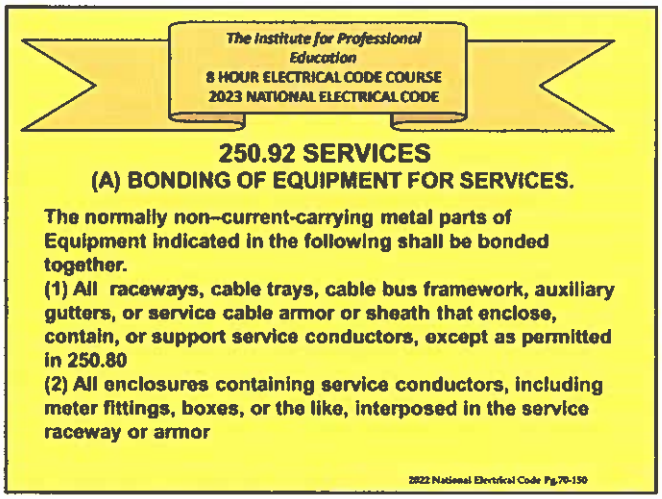

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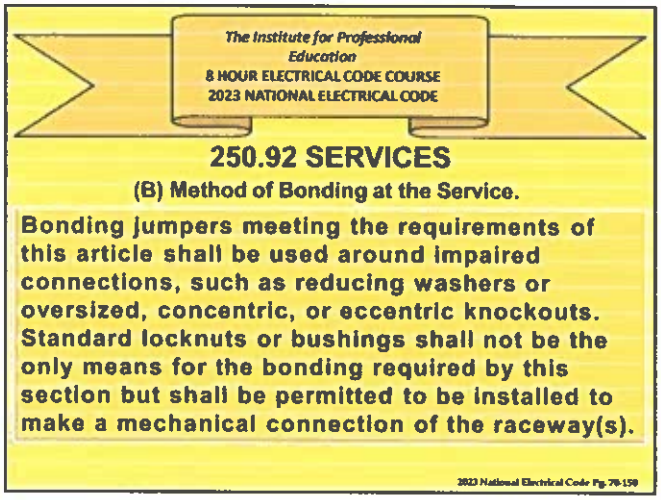

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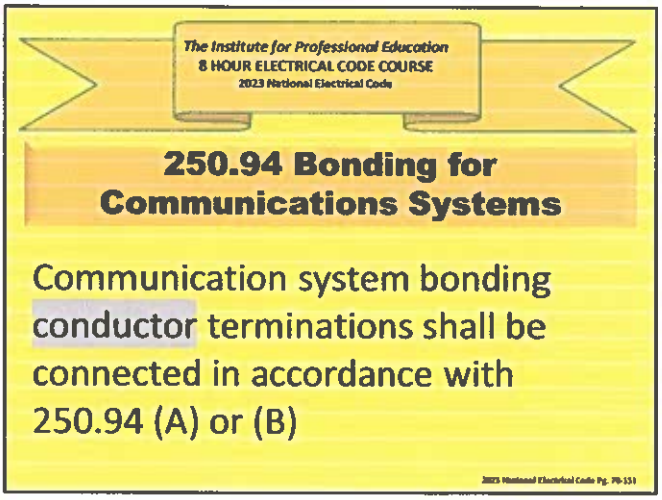

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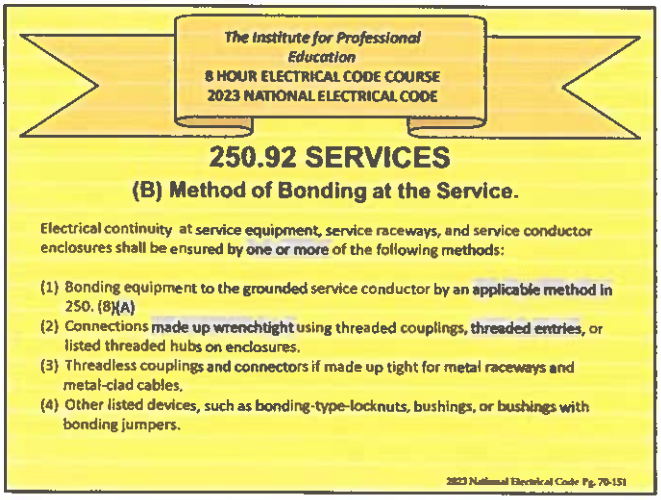

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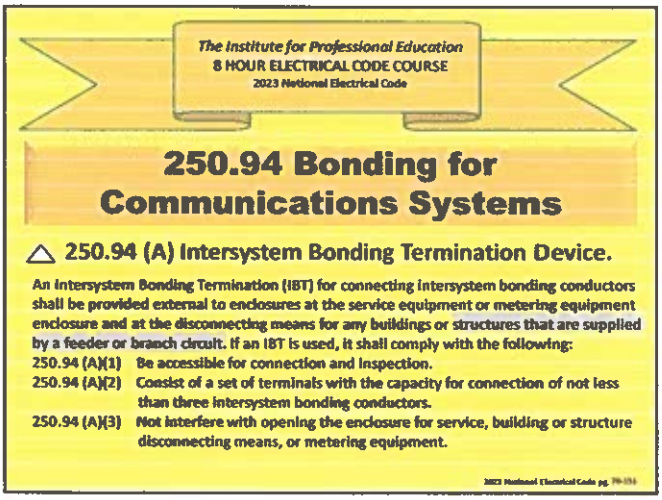

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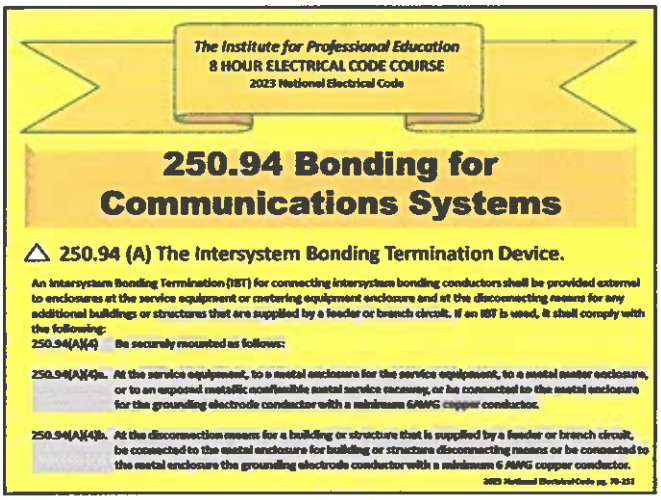

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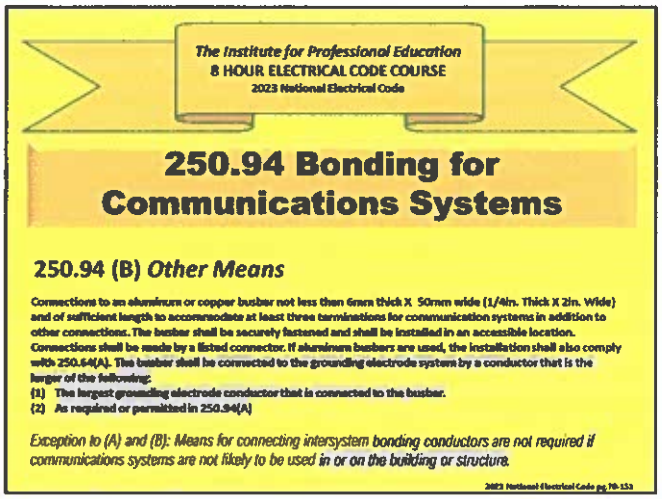

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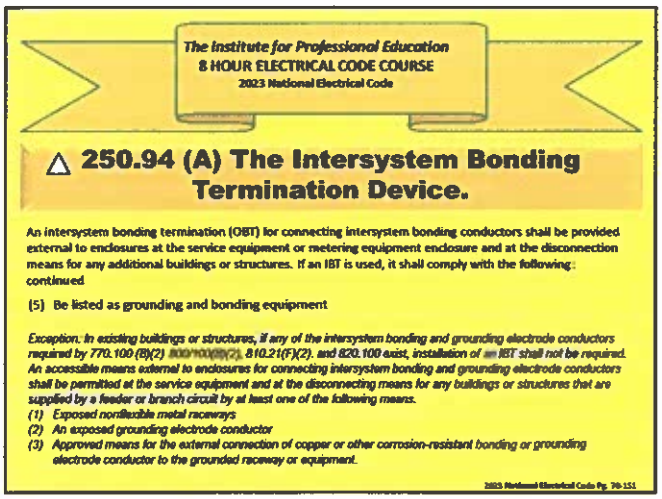

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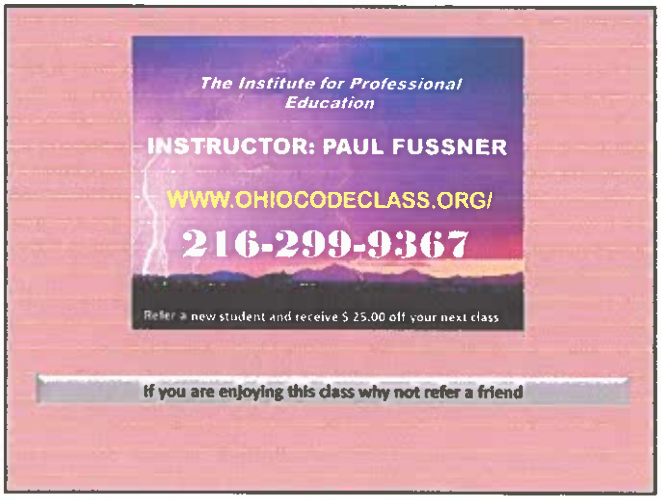

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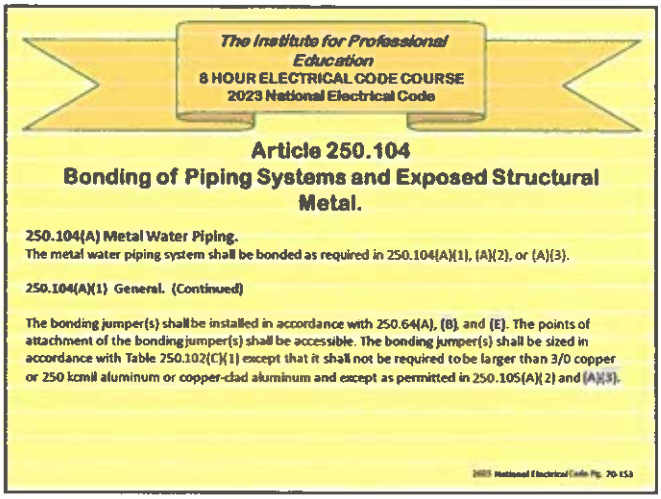

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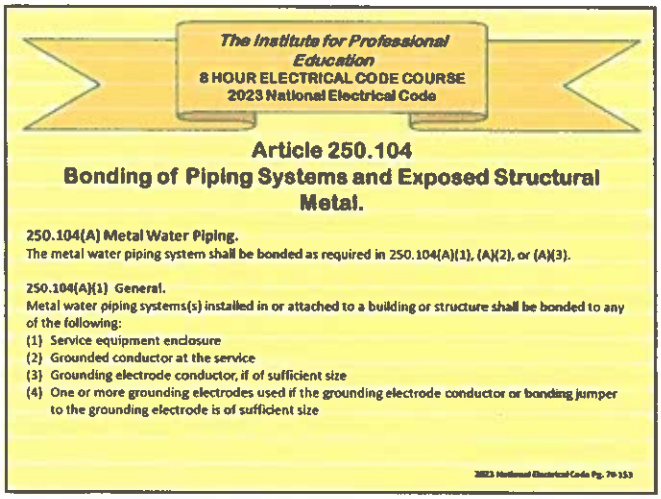

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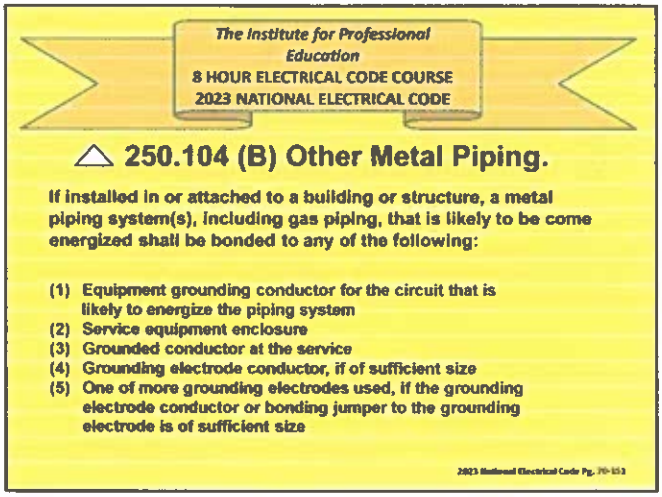

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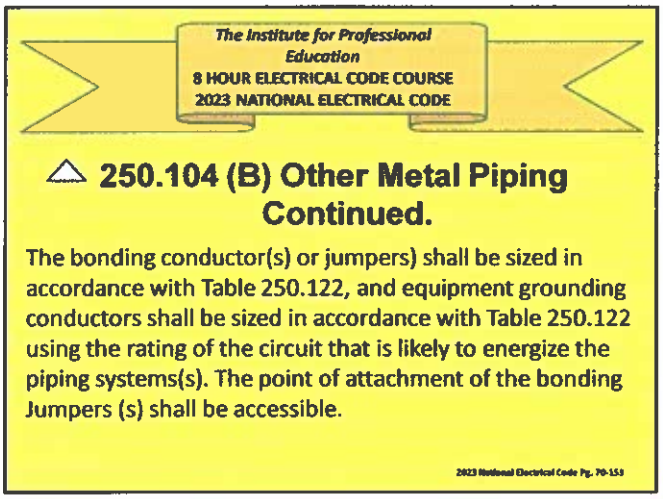

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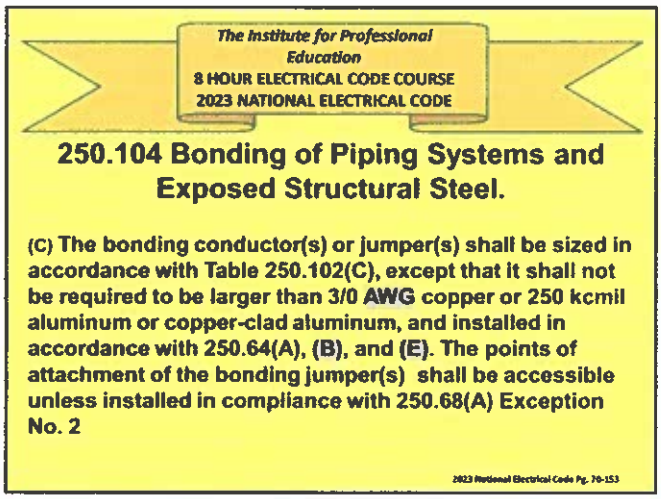

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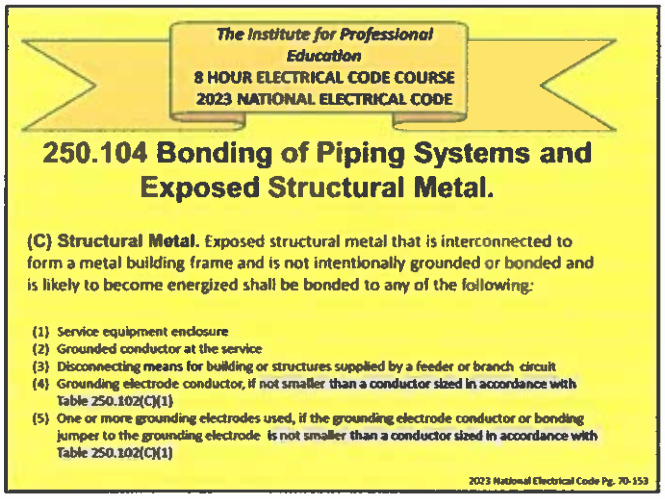

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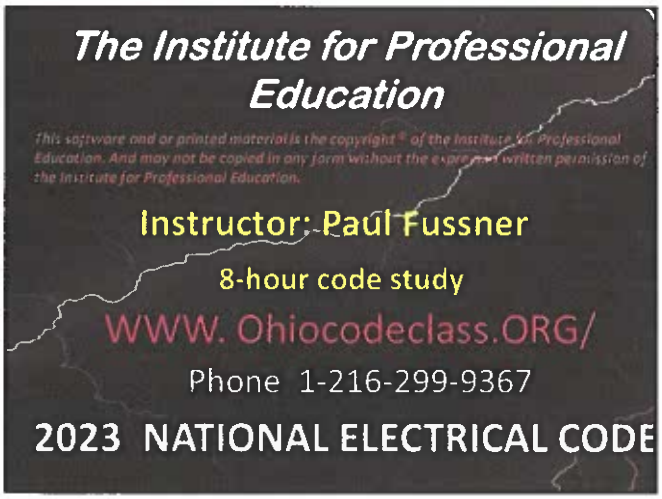

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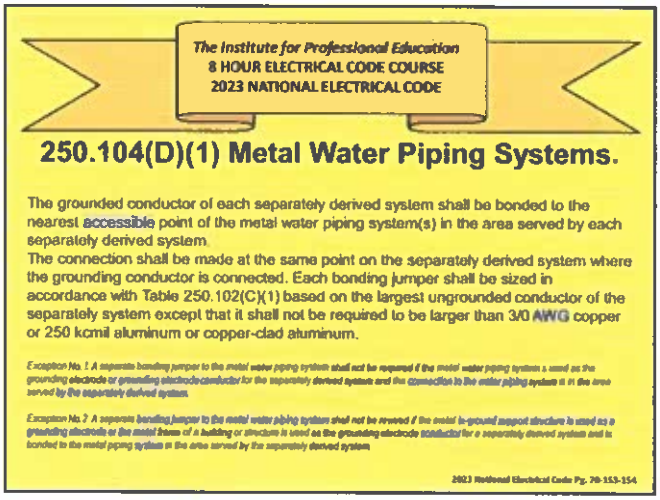

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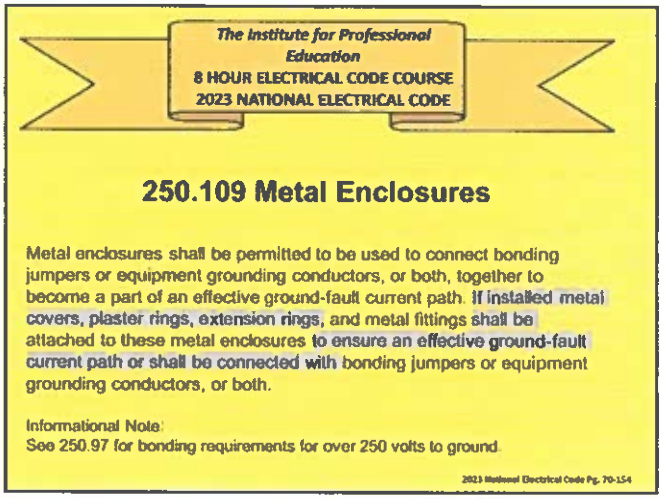

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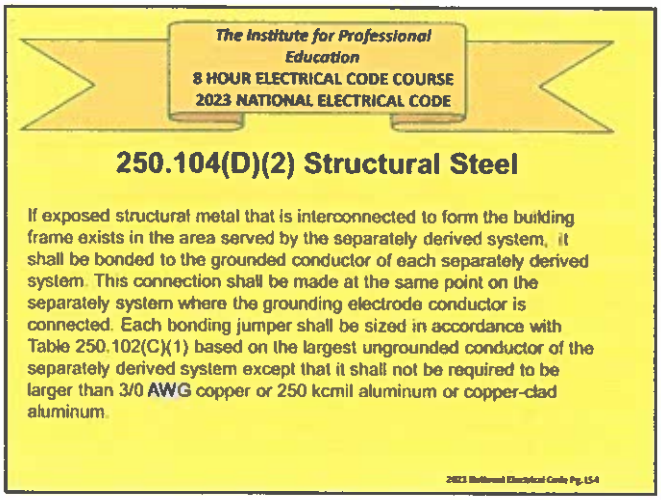

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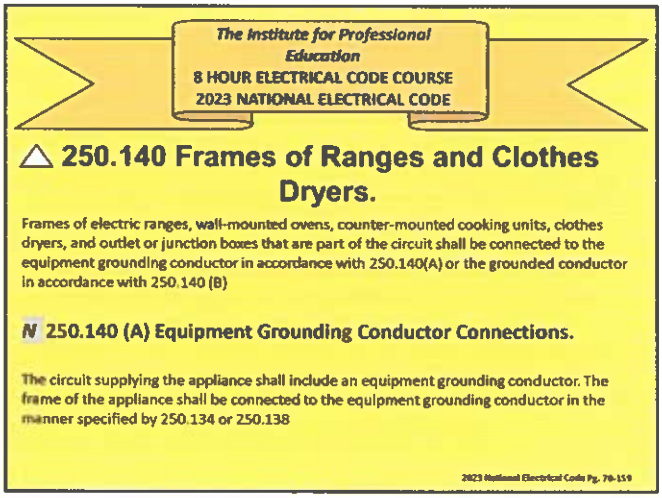

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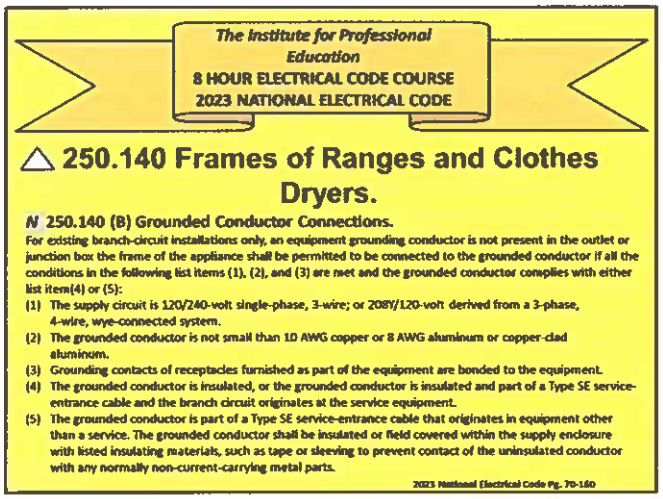

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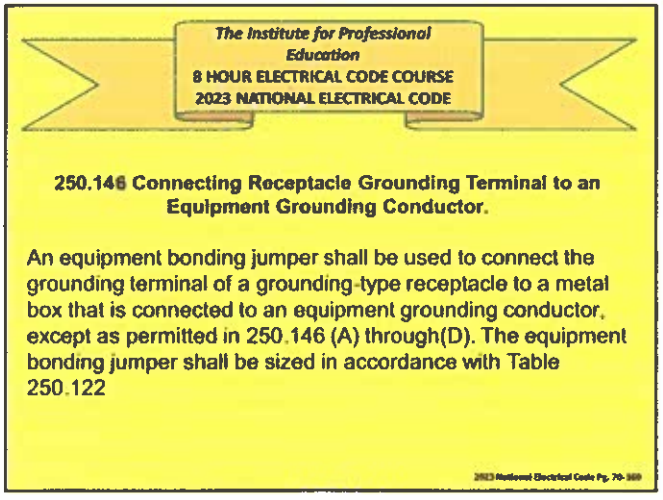

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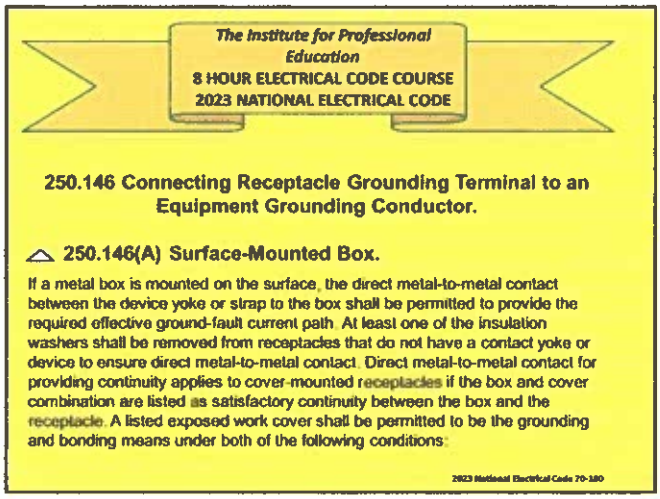

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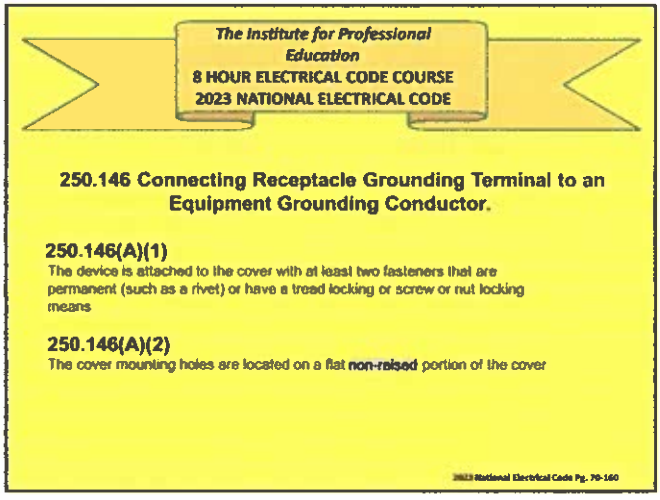

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300.5 Underground Installations.

(F) Backfill.

Backfill that contains large rocks, paving materials, cinders, large or sharply angular substances, or corrosive material shall not be placed in an excavation where materials might damage raceways, cables, conductors, or other substructures or prevent adequate compaction of fill or contribute to corrosion of raceways, cables, or other substructures.

Where necessary to prevent physical damage to the raceway, cable, or conductor, protection shall be provided in the form of granular or selected material, suitable running boards, suitable sleeves, or other approved means.

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300.22 Wiring in Ducts Not Used for Air Handling Fabricated Ducts for Environmental Air, and Other Spaces for Environmental Air (Plenums)

The requirements of this section shall apply to the installation and uses of electrical wiring and equipment in ducts used for dust, loose stock, or vapor removal; ducts specifically fabricated for environment air; and other spaces used for environmental air (plenums).

300.22(C) Other Spaces Used for Environmental Air (Plenums).

This section shall apply to spaces not specifically fabricated for environmental air-handling purposes but used for air-handling purposes as plenum. This section shall not apply to habitable rooms or areas of buildings, the prime purpose of which is not air handling.

Exception: This section shall not apply to the joist or stud spaces of dwelling units where the wiring passes through such spaces perpendicular to the long dimension of such spaces.

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300.5 Underground Installations.

(G) Raceway Seals.

Conduits and raceway through which moisture may contact live parts shall be sealed or plugged at either or both ends. Spare or used raceways shall also be sealed. Sealants shall be identified for use with the cable insulation, bare conductor, shield, or other components.

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300.22 (C)(1) Wiring Methods.

The wiring methods for other spaces used for environmental air shall be limited to totally enclosed, non-ventilated, insulated busway having no provisions for plug-in connections, Type MI cable without an overall nonmetallic covering, Type MC cable without an overall nonmetallic covering, Type AC cable, or other factory-assembled multi-conductor control or power cable that is specifically listed for use within an air-handling space, or listed prefabricated cable assemblies of metallic manufactured wiring systems without nonmetallic sheath. Other types of cables, conductors, and raceways shall be permitted to be installed in electrical metallic tubing, flexible metallic tubing, intermediate metal conduit, rigid metal conduit without an overall nonmetallic covering, flexible metal conduit, or, where accessible, surface metal raceway or metal wire way with metal covers.

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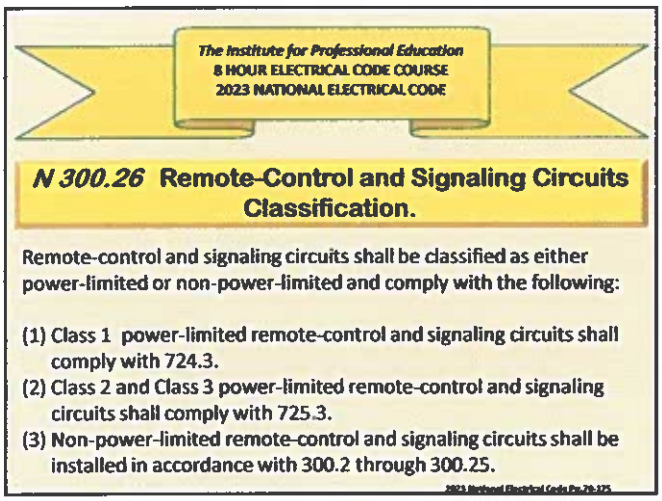

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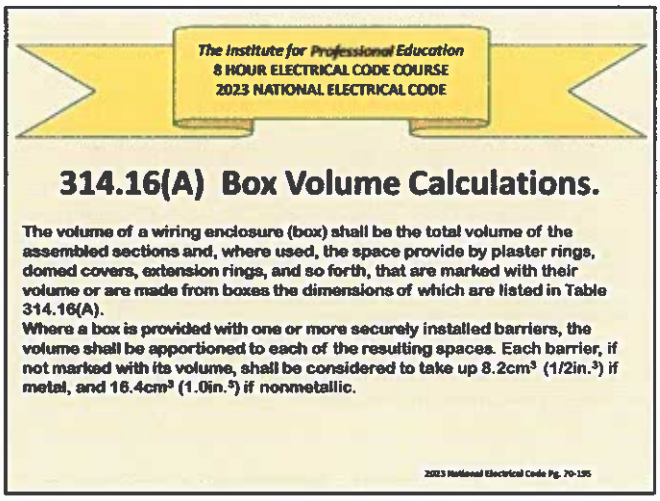

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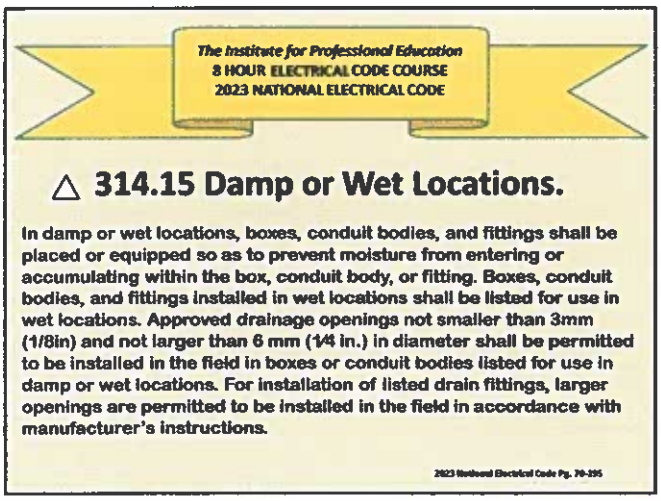

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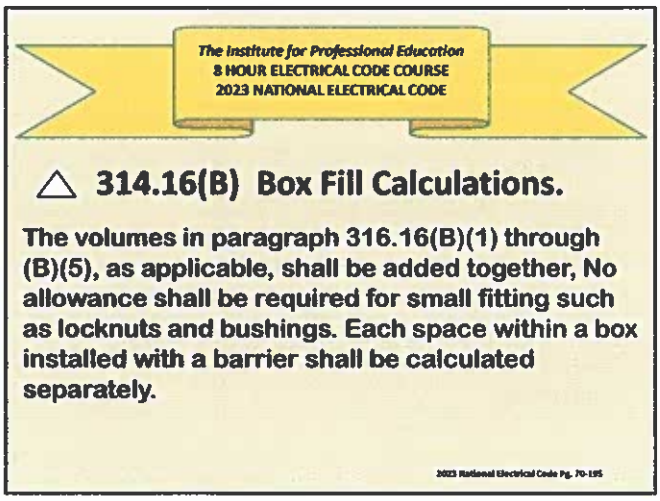

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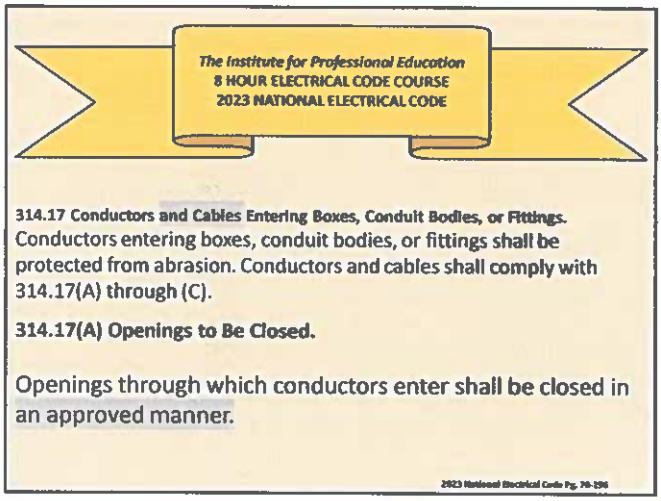

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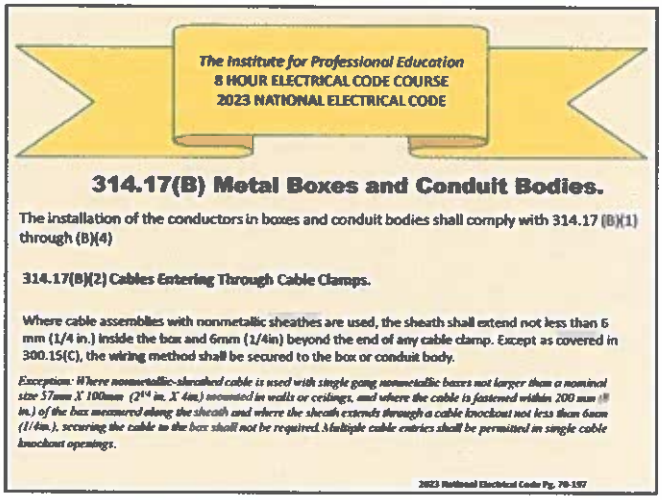

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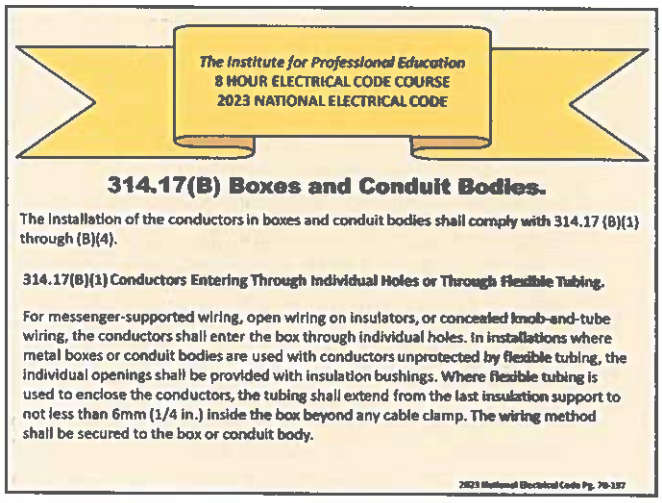

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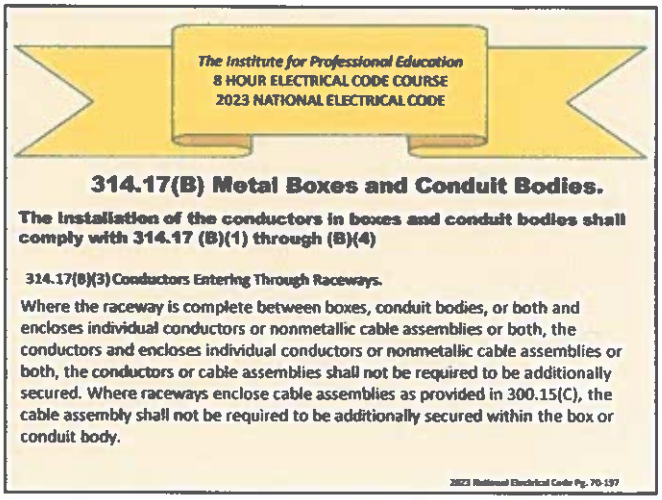

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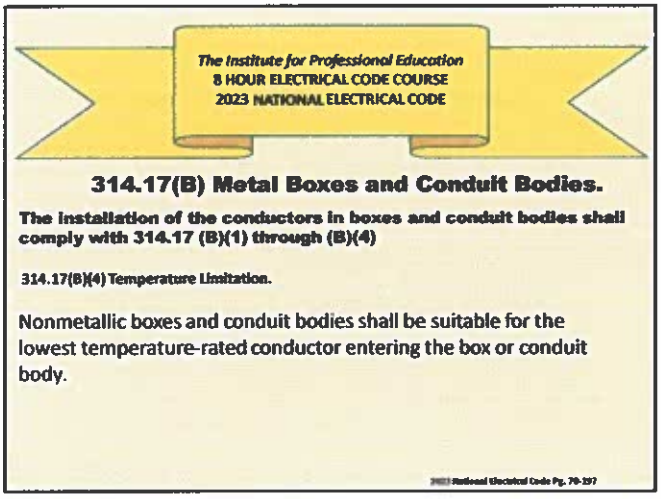

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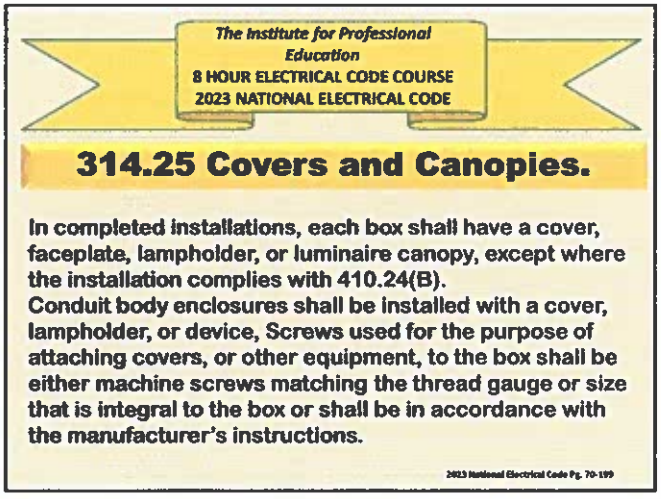

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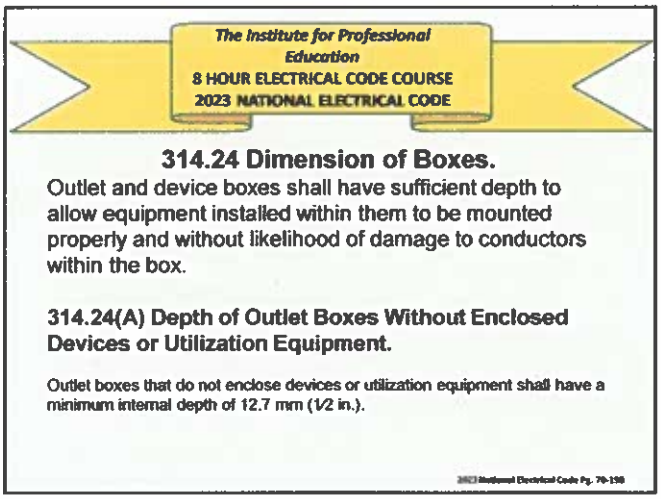

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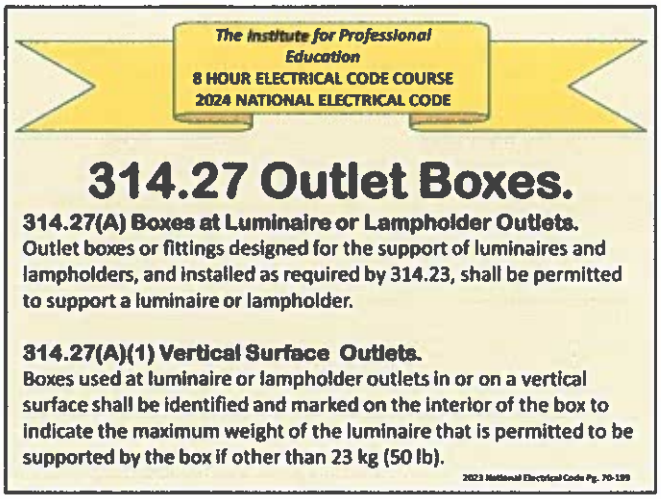

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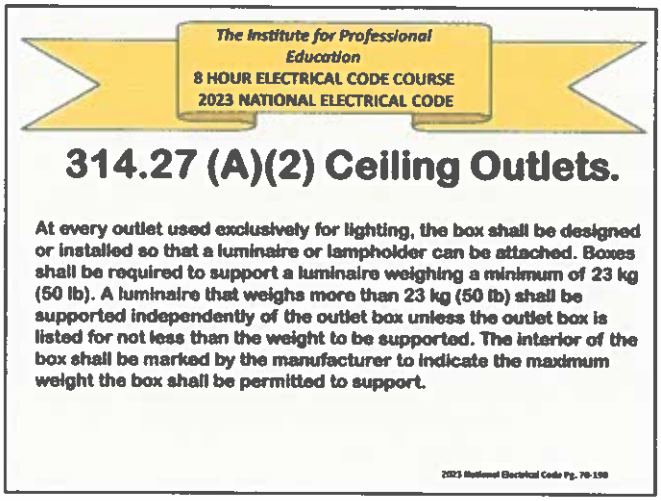

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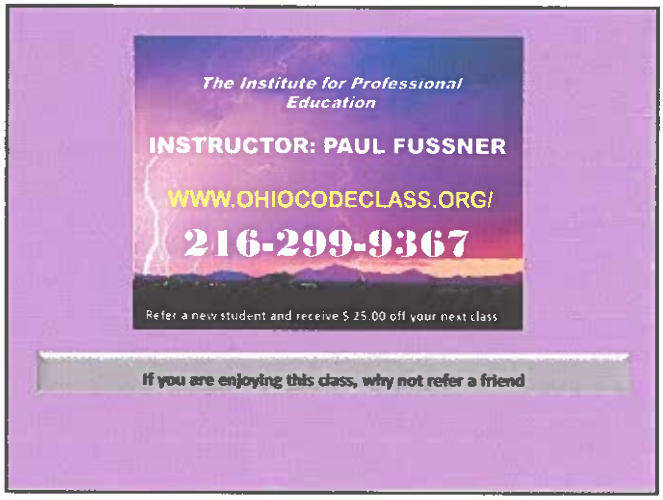

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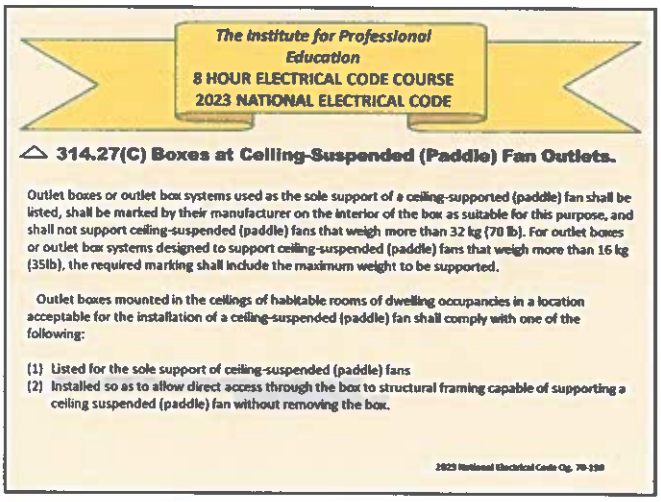

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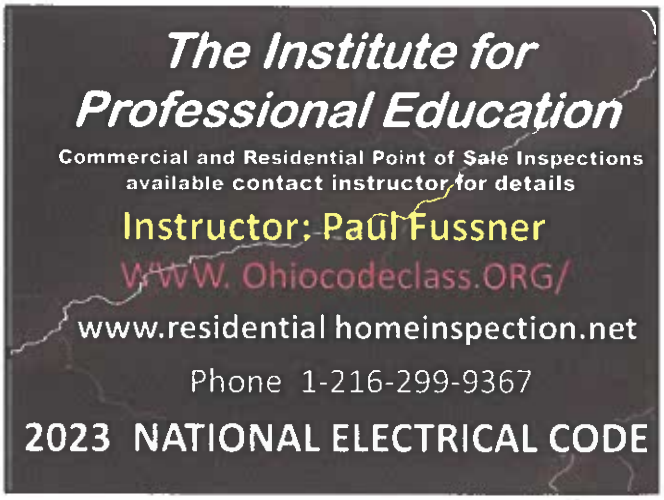

184

File Attachments for Item:

ER-5 2023 NEC Articles 90-200 (Institute for Professional Education)

All certifications (4 hours)

Staff Notes:

ESIAC Recommendation:

Committee Recommendation:

Board of Building Standards

Application for Continuing Education Course Approval

Provider Information:

Name: Paul R. Fussner BBS# 504
Organization: Institute for Professional Education
Address: 30508 Ronald Drive, Willowick, Ohio 44095
E-mail: pfussner@paulfussner.onmicrosoft.com Telephone: 216-299-9367
Website: www.ohiocodeclass.org/
Conference Sponsor (if applicable) Elaine's Educational Services, LLC Conference Email: vlussner1955@gmail.com / pfussner@paulfussner.onmicrosoft.com

Check here if Course Renewal: ____ Prior course number _____ *(i.e. BBS2018-429)*
Renewals will only be granted for identical content and certifications, within the current code cycle.
Attach a copy of prior course approval letter for confirmation. No further information is required.

New Course Information:

Course title: 2023 National Electrical Code Atricles 90-210
Course instructor: Paul Fussner BBS # 504
Course description: Eight Hour Power Point Presentation with questions and answers covering 2023 NEC Atricles 90-210 Sign in begins 30 minutes before start of session, 10 minute breaks at the top of the hour One hour lunch break is taken 12:00 to 1:00 pm. Session sign out and dismissal at 5:00pm

Instructional hours per session: Eight Hours Number of Sessions: _____
Course Date(s) and Location: See attached 2024 tentive live and on line Zoom Virtual Schedule

Special Content:

Code Administration: ____
Existing Buildings: ____
Electrical Instruction: X
Plumbing Instruction: ____

Conference Course: Live and on line courses thoughout Year
Conference Name: 8-hour review 2023 NEC Articles 90-210
Conference location: See attached proposed schedule

Course to be offered online? Yes **On Demand** ____ **Webinar** Virtual Zoom Session(s)
Course Website: www.ohiocodeclass.org/
Detail online course participation confirmation method *(i.e. test, quizlets, participant activity confirmation)*:
Each student logs in with course link provided to each student after verification of contractors license and photo ID, this information is reviewed again by instructor during log in, day of course

Course applicable for the following certifications

Residential Certifications Only: X Commercial Certifications: X
Administrative Course, All Certifications: X

Application materials included:

X Course Outline or Course Learning Objectives
X Presentation Materials/Slides (Power Point Presentation)
____ Assessment Materials (for online courses)
X Presenter Bio

Please submit application and materials in .pdf format to: michael.lane@com.ohio.gov or BBS@com.ohio.gov

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BOARD OF BUILDING STANDARDS

Paul Robert Fussner, dba

THE INSTITUTE FOR PROFESSIONAL EDUCATION

30508 Ronald Drive
Willowick, Ohio 44095-4341
pfussner@paulfussner.onmicrosoft.com

November 21, 2023

Ohio Board of Building Standards
6606 Tussing Rd
Reynoldsburg, Ohio 43068-9009

REGARDING: Course Syllabus Electrical Contractor. 8-Hour Study of 2023 National Electrical Code Changes Articles 90-210

In-person student classes utilize the normal sign-in method of showing a picture ID and state license before signing the BBS registration sheet, sign-in begins 30 minutes before the session start time.

Computer sign-in and registration(s) begin 30 minutes before the session, utilizing the Zoom login link assigned to each student who has pre-registered by mail or online. Students may log in with a computer, tablet, or smartphone.

Class Schedule

8:00	**am**	**Beginning of PowerPoint presentation and review of: Articles 90 through 210 of the 2023 National Electrical Code**
8:50	**am**	**Ten-minute break. 50 minutes per hour of study of the PowerPoint presentation.**
12:00	**pm**	**Students will be given a one-hour break for lunch**
1:50	**pm**	**Ten-minute break. 50 minutes per hour of study of the PowerPoint presentation**
5:00	**pm**	**Student dismissal**

Note: **All eight-hour sessions begin promptly at 8:00 am**

Paul Robert Fussner, dba
The Institute for Professional Education
30508 Ronald Drive
Willowick, Ohio 44095-4341
pfussner@paulfussner.onmicrosoft.com

INSTRUCTOR QUALIFICATIONS:

- State Certified Electrical Safety Inspector #504
- State Certified Building Inspector #504
- Building Official #504
- Residential Building Official #504
- Board of Building Standards Instructor, Electrical Safety Inspector Re-certification, established in 1999.
- OCILB Instructor, state-licensed, electrical, plumbing, HVAC, and Hydronics contractors continuing education courses, established in 1999.

50 years of experience in the building and electrical trades, as Founder and President of the Gibson Robert Company, Inc. I expedited all new work including researching and ordering the proper electrical equipment required for a safe, efficient installation, while meeting the requirements of The NFPA 70 Electrical Code, The B.O.C.A. Code, and The Ohio Building Code.

29 years of experience as a State Certified Electrical Safety Inspector, 24 years experience as a State Certified Building Inspector with 12 years of departmental management experience.

14 years as Building Official #504

Former Chairman, Western Reserve Chapter International Association of Electrical Inspectors. Two years as Education Chairman, Western Reserve Chapter of the IAEI.

Owner of The Institute for Professional Education, a State of Ohio Training Agency for the Mandatory Continuing Education Credits for Electrical Safety Inspectors and State Licensed Electrical Contractors. Accredited by the Ohio Board of Building Standards and the Ohio Construction industry licensing board. established 1999.

2024 IN-PERSON and ONLINE ZOOM SESSION(S) SCHEDULE for all OCILB. Contractors and BBS Certifications

TO REGISTER FOR A CLASS, VISIT OUR WEB PAGE:

WWW.OHIOCODECLASS.ORG / OR CALL 216-299-9367

January 13	**8-Hr Online Virtual Zoom Session** 2023 NEC Article 250 Understanding Grounding and Bonding	**Course # 3750064**
February 17	**4-hr Online Virtual Zoom Session** 7:45 am-12:00 pm 2023 NEC Articles 90-200	**Course # 3750066**
	4-Hr Online Virtual Zoom Session 1:00 pm - 5:00 pm 2023 NEC Articles 230-242	**Course # 3750060**
	2-Hr Online Virtual Zoom Session 5:00 pm - 7:00 pm 2019 RCO Chapter 113 Existing	**Course # 3750061**
March 23	**8-Hr Online Virtual Zoom Session** 2023 National Electrical Code Article's 230 – 314	**Course # 3750062**
April 27	**4-Hr Online Virtual Zoom Session** 7:45 am-12:00 pm 2023 NEC Articles 90-200	**Course # 3750066**
	4-Hr Online Virtual Zoom Session 1:00 pm - 5:00 pm 2023 NEC Articles 230-242	**Course # 3750060**
	2-Hr Online Virtual Zoom Session 5:00 pm - 7:00 pm 2019 RCO Chapter 3401.1(2)(1)	**Course # 3750065**
May 18	**8-Hr Online Virtual Zoom Session** 2023 National Electrical Code Article's 90 – 210	**Course # 3750063**
June 17	8-Hr Live in-person session 2023 NEC Article 250 Understanding Grounding and Bonding	**Course # 3750064**
	Location: Grace Church 36300 Ridge Rd, Willoughby, Ohio 44094 **Rear Lower Level Entrance**	
July 27	**8-Hr Online Virtual Zoom Session** 2023 National Electrical Code Article's 230 – 314	**Course # 3750062**
August 14	4-Hr Weekday **Virtual Zoom Session** 7:45 am-12:00 pm 2023 NEC Articles 90-200	Course # 3750066
August 21	4-Hr Weekday **Virtual Zoom Session** 7:45 am-12:00 pm 2023 NEC Articles 230-242	Course # 3750060
September 7	4-Hr Live in Person Session 7:45 am-12:00 pm 2023 NEC Articles 90-200	**Course # 3750066**
	4-Hr Live in Person Session 1:00 pm - 5:00 pm 2023 NEC Articles 230-242	**Course # 3750060**
	2-Hr Live in Person Session 5:00 pm - 7:00 pm 2019 RCO Chapter 113 Existing	**Course # 3750061**
	Location: Cretan Party Center 13853 W. 168th Street & Lorain Rd, Cleveland, Ohio 44111	
October 19	4-Hr Live in Person Session 7:45 am-12:00 pm 2023 NEC Articles 90-200	**Course # 3750066**
	4-Hr Live in Person Session 1:00 pm - 5:00 pm 2023 NEC Articles 230-242	**Course # 3750060**
	2-Hr Live in Person Session 5:00 pm - 7:00 pm 2019 RCO Chapter 3401.1(2)(1)	**Course # 3750065**
	Location: Huntsburg Civic Center 12396 Madison Rd. (Rt,528 & 322) Middlefield, Ohio 44062 Use the rear entrance	
November 16	**8-Hr Online Virtual Zoom Session** 2023 National Electrical Code Article 250 Grounding and Bonding	**Course # 3750064**
December 7	4-Hr Live in Person Session 7:45 am-12:00 pm 2023 NEC Articles 90-200	**Course # 3750066**
	4-Hr Live in Person Session 1:00 pm - 5:00 pm 2023 NEC Articles 230-242	**Course # 3750060**
	2-Hr Live in Person Session 5:00 pm - 7:00 pm 2019 RCO Chapter 113 Existing	**Course # 3750061**

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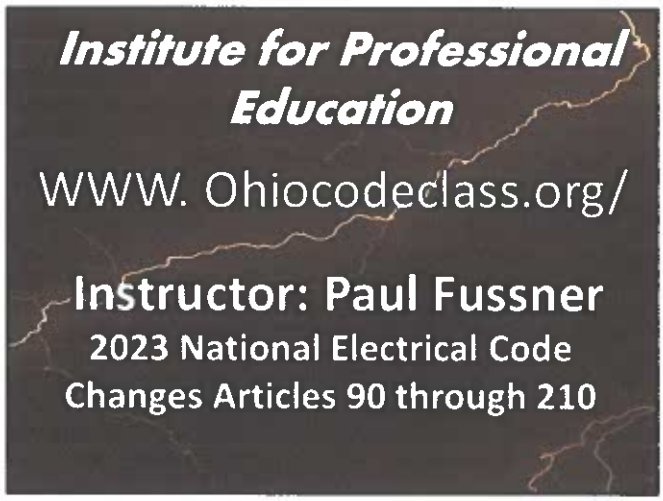
Ten Hours of Education	**$200.00**
Eight Hours of Education	**$180.00**
Four Hours of Education	**$ 90.00**
Two Hours of Education	**$ 50.00**


Institute for Professional Education
WWW. Ohiocodeclass.org/
Instructor: Paul Fussner
2023 National Electrical Code
Changes Articles 90 through 210

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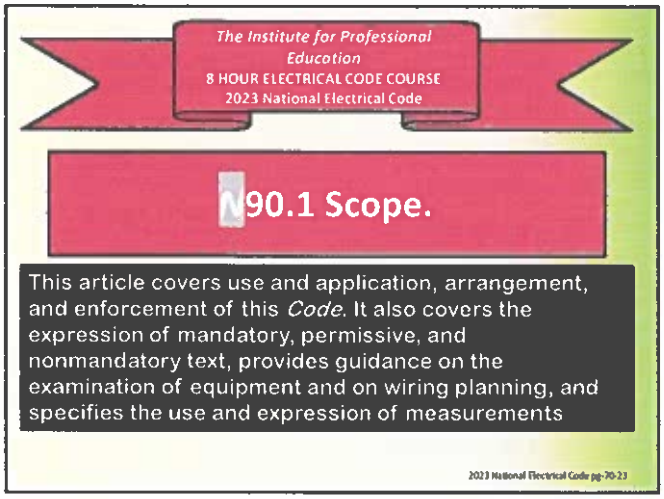
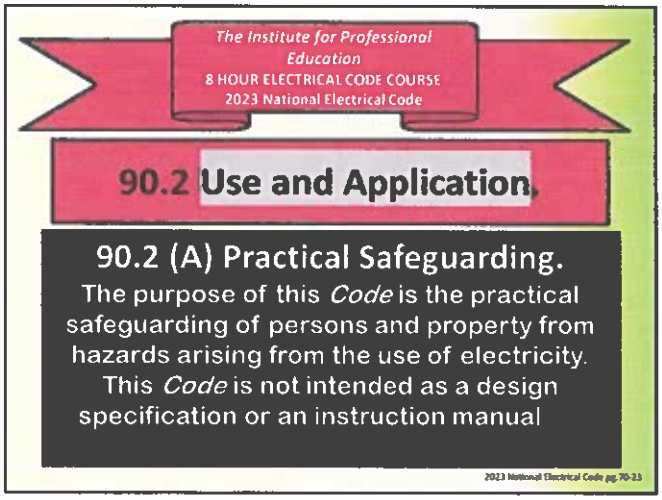

The Institute for Professional Education
8 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code
90.1 Scope.
This article covers use and application, arrangement, and enforcement of this Code. It also covers the expression of mandatory, permissive, and nonmandatory text, provides guidance on the examination of equipment and on wiring planning, and specifies the use and expression of measurements
2023 National Electrical Code pg-70-23

2


The Institute for Professional Education
8 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code
90.2 Use and Application.
90.2 (A) Practical Safeguarding.
The purpose of this Code is the practical safeguarding of persons and property from hazards arising from the use of electricity. This Code is not intended as a design specification or an instruction manual
2023 National Electrical Code pg 70-23

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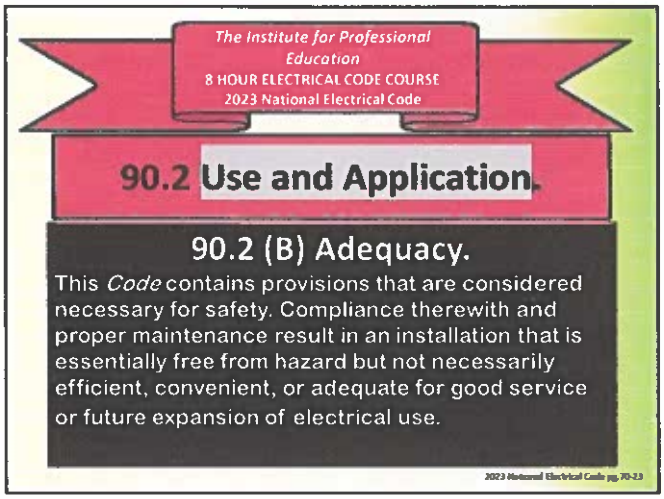
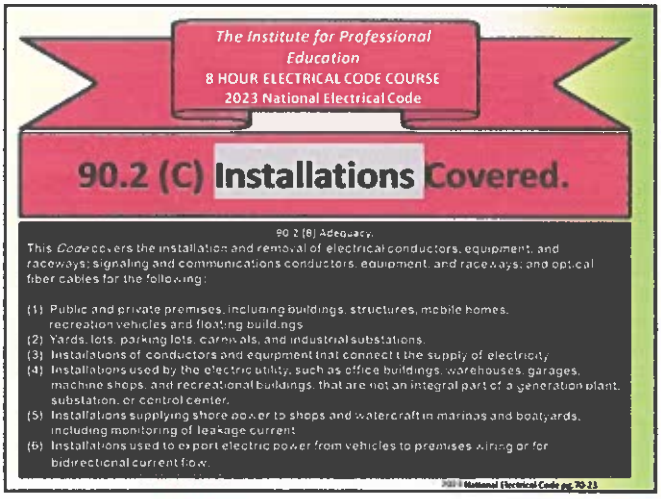

The Institute for Professional Education
8 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code
90.2 Use and Application.
90.2 (B) Adequacy.
This Code contains provisions that are considered necessary for safety. Compliance therewith and proper maintenance result in an installation that is essentially free from hazard but not necessarily efficient, convenient, or adequate for good service or future expansion of electrical use.

4


The Institute for Professional Education
8 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code
90.2 (C) Installations Covered.
90.2 (B) Adequacy.
This Code covers the installation and removal of electrical conductors, equipment, and raceways; signaling and communications conductors, equipment, and raceways; and optical fiber cables for the following:
(1) Public and private premises, including buildings, structures, mobile homes, recreation vehicles and floating buildings
(2) Yards, lots, parking lots, carnivals, and industrial substations
(3) Installations of conductors and equipment that connect the supply of electricity
(4) Installations used by the electric utility, such as office buildings, warehouses, garages, machine shops, and recreational buildings, that are not an integral part of a generation plant, substation, or control center
(5) Installations supplying shore power to ships and watercraft in marinas and boatyards, including monitoring of leakage current
(6) Installations used to export electric power from vehicles to premises wiring or for bidirectional current flow

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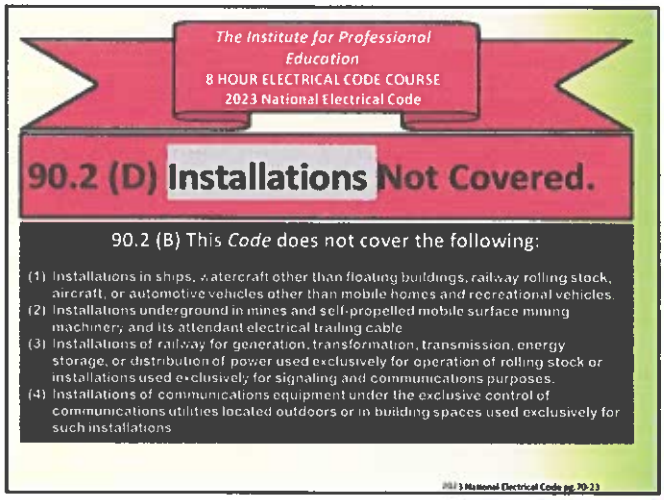
The Institute for Professional Education
8 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code
90.2 (D) Installations Not Covered.
90.2 (B) This Code does not cover the following:
(1) Installations in ships, watercraft other than floating buildings, railway rolling stock, aircraft, or automotive vehicles other than mobile homes and recreational vehicles.
(2) Installations underground in mines and self-propelled mobile surface mining machinery, and its attendant electrical trailing cable
(3) Installations of railway for generation, transformation, transmission, energy storage, or distribution of power used exclusively for operation of rolling stock or installations used exclusively for signaling and communications purposes.
(4) Installations of communications equipment under the exclusive control of communications utilities located outdoors or in building spaces used exclusively for such installations

6


The Institute for Professional Education
8 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code
90.2 (D) Installations Not Covered.
90.2 (B) This Code does not cover the following:
(5) Installations under the exclusive control of an electric utility where such installations
a. Consist of service drops or service laterals, and associated metering, or
b. Are on property owned or leased by the electric utility for the purpose of communications, metering, generation, control, transformation, transmission, energy storage, or distribution of electric energy, or
c. Are located in legally established easements or rights-of-way, or
d. Are located by other written agreements either designated by or recognized by public service commissions, utility commissions, or other regulatory agencies having jurisdiction for such installations. These written agreements shall be limited to installations for the purpose of communications, metering, generation, control, transformation, transmission, energy storage, or distribution of electric energy where legally established easements or rights-of-way cannot be obtained. These installations shall be limited to federal lands, Native American reservations through the U.S. Department of the Interior Bureau of Indian Affairs, Military based lands controlled by port authorities and state agencies and departments, and land owned by railroads

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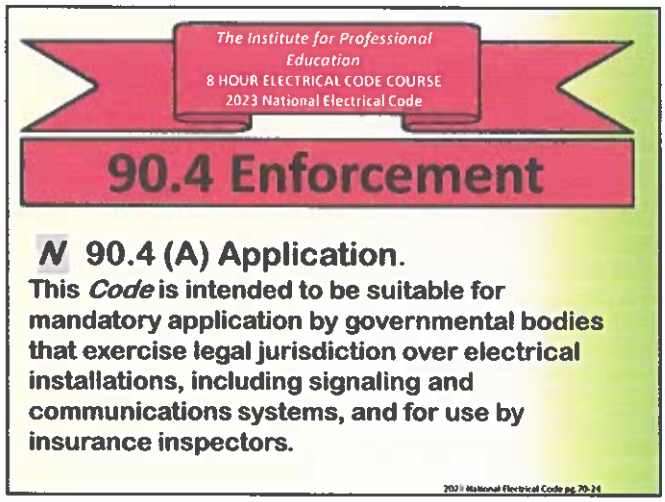
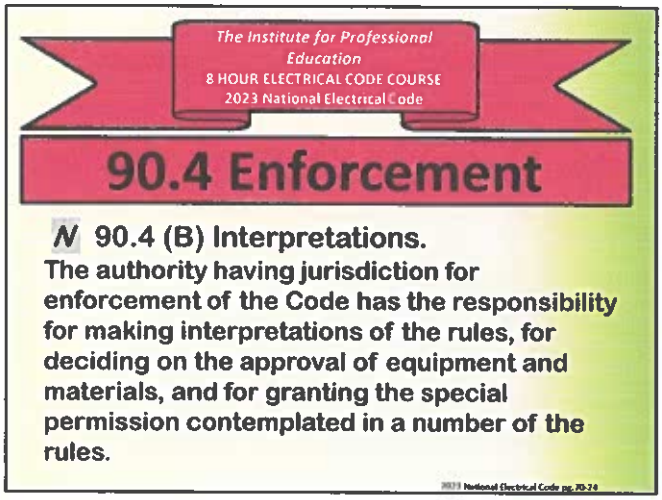

The Institute for Professional Education
8 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code
90.4 Enforcement
N 90.4 (A) Application.
This Code is intended to be suitable for mandatory application by governmental bodies that exercise legal jurisdiction over electrical installations, including signaling and communications systems, and for use by insurance inspectors.

8


The Institute for Professional Education
8 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code
90.4 Enforcement
N 90.4 (B) Interpretations.
The authority having jurisdiction for enforcement of the Code has the responsibility for making interpretations of the rules, for deciding on the approval of equipment and materials, and for granting the special permission contemplated in a number of the rules.

9


The Institute for Professional Education
8 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code
90.4 Enforcement
N 90.4 (C) Specific Requirements and Alternative Methods.
By special permission, the authority having jurisdiction may waive specific requirements in this Code or permit alternative methods where it is assured that equivalent objectives can be achieved by establishing and maintaining effective safety.

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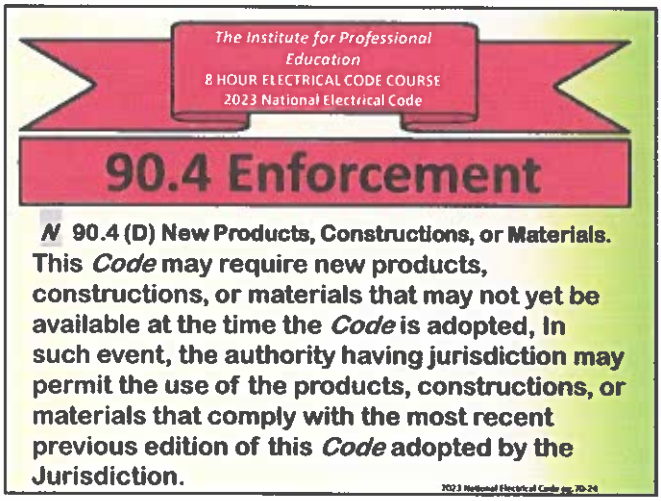
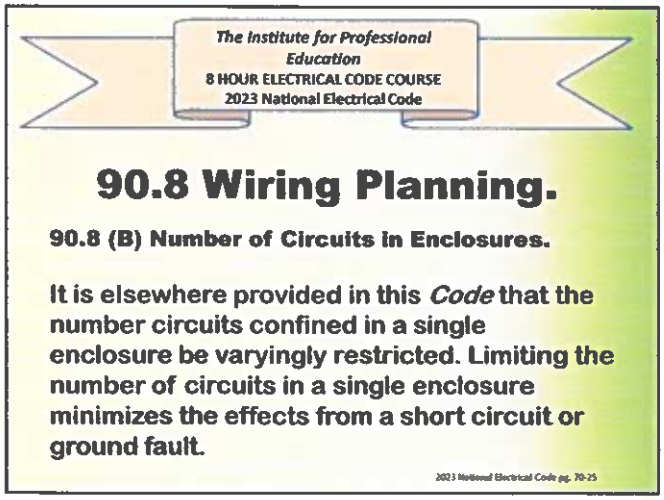
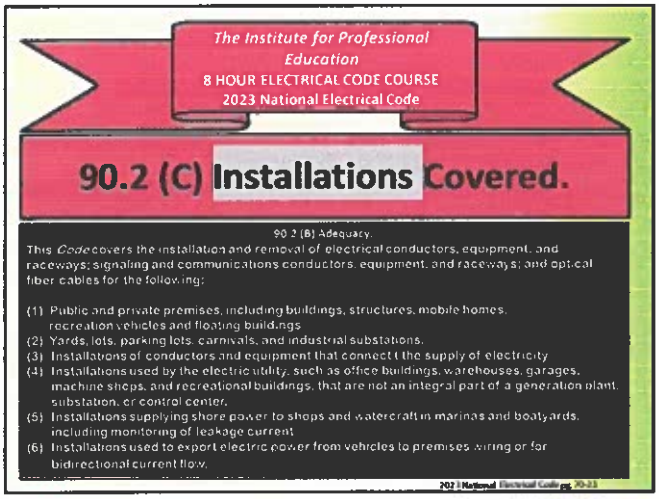

The Institute for Professional Education
8 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code
90.4 Enforcement
N 90.4 (D) New Products, Constructions, or Materials.
This Code may require new products, constructions, or materials that may not yet be available at the time the Code is adopted, In such event, the authority having jurisdiction may permit the use of the products, constructions, or materials that comply with the most recent previous edition of this Code adopted by the Jurisdiction.

11


The Institute for Professional Education
8 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code
90.8 Wiring Planning.
90.8 (B) Number of Circuits in Enclosures.
It is elsewhere provided in this Code that the number circuits confined in a single enclosure be varyingly restricted. Limiting the number of circuits in a single enclosure minimizes the effects from a short circuit or ground fault.

12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2023 National Electrical Code
90.2 (C) Installations Covered.
90.2 (B) Adequacy.
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(2) Yards, lots, parking lots, carnivals, and industrial substations.
(3) Installations of conductors and equipment that connect the supply of electricity
(4) Installations used by the electric utility, such as office buildings, warehouses, garages, machine shops, and recreational buildings, that are not an integral part of a generation plant, substation, or control center.
(5) Installations supplying shore power to ships and watercraft in marinas and boatyards, including monitoring of leakage current
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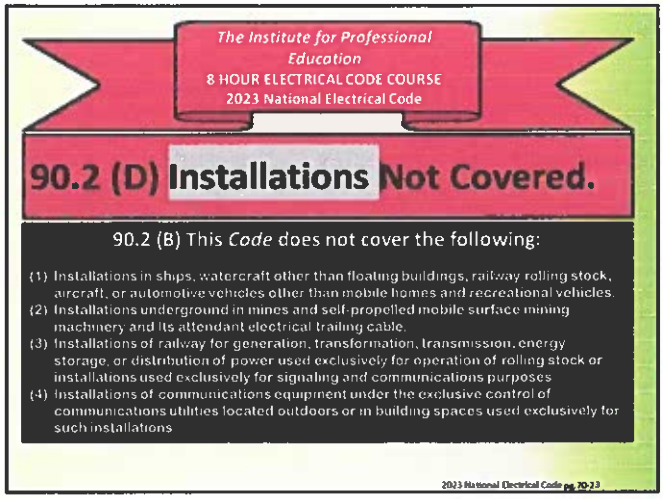
The Institute for Professional Education
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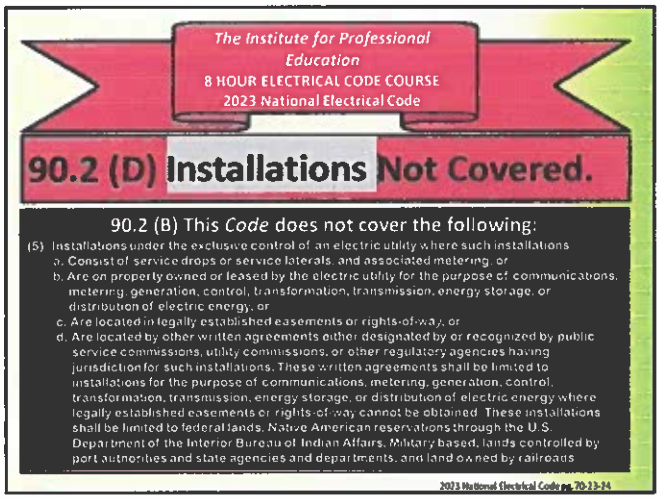
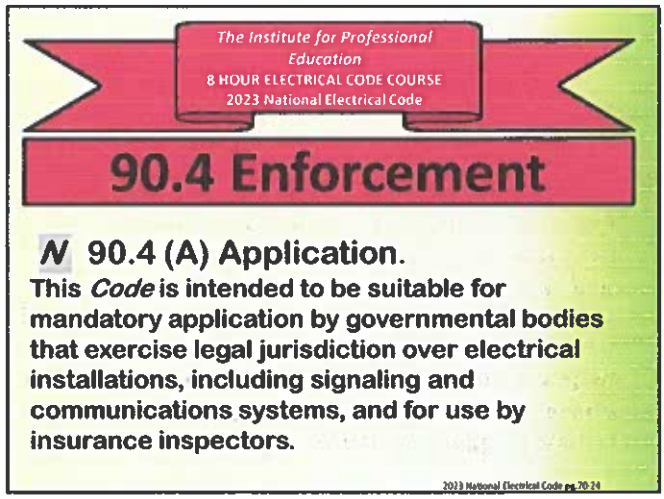
(2) Installations underground in mines and self-propelled mobile surface mining machinery and its attendant electrical trailing cable.
(3) Installations of railway for generation, transformation, transmission, energy storage, or distribution of power used exclusively for operation of rolling stock or installations used exclusively for signaling and communications purposes
(4) Installations of communications equipment under the exclusive control of communications utilities located outdoors or in building spaces used exclusively for such installations

6


The Institute for Professional Education
8 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code
90.2 (D) Installations Not Covered.
90.2 (B) This Code does not cover the following:
(5) Installations under the exclusive control of an electric utility where such installations
a. Consist of service drops or service laterals, and associated metering, or
b. Are on property owned or leased by the electric utility for the purpose of communications, metering, generation, control, transformation, transmission, energy storage, or distribution of electric energy, or
c. Are located in legally established easements or rights-of-way, or
d. Are located by other written agreements either designated by or recognized by public service commissions, utility commissions, or other regulatory agencies having jurisdiction for such installations. These written agreements shall be limited to installations for the purpose of communications, metering, generation, control, transformation, transmission, energy storage, or distribution of electric energy where legally established easements or rights-of-way cannot be obtained. These installations shall be limited to federal lands, Native American reservations through the U.S. Department of the Interior Bureau of Indian Affairs, Military based, lands controlled by port authorities and state agencies and departments, and land owned by railroads

7


The Institute for Professional Education
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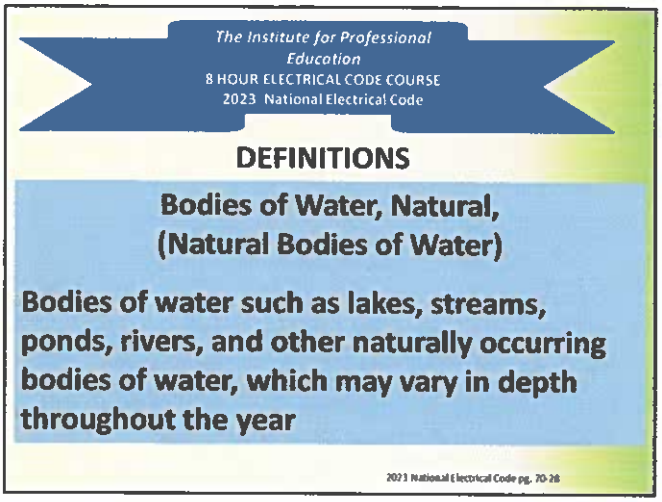
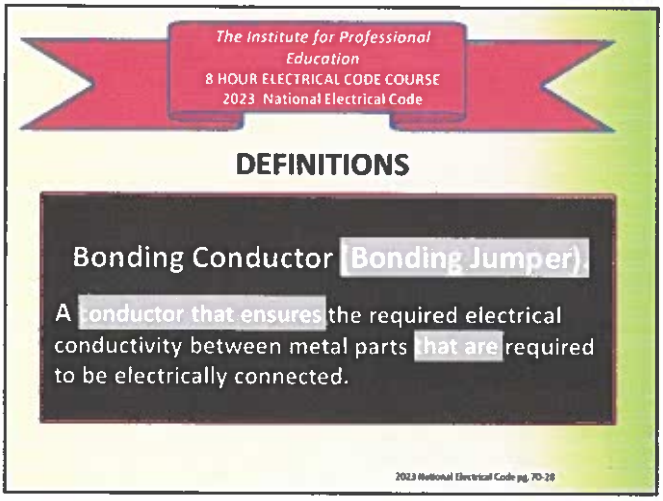
2023 National Electrical Code
90.4 Enforcement
N 90.4 (A) Application.
This Code is intended to be suitable for mandatory application by governmental bodies that exercise legal jurisdiction over electrical installations, including signaling and communications systems, and for use by insurance inspectors.

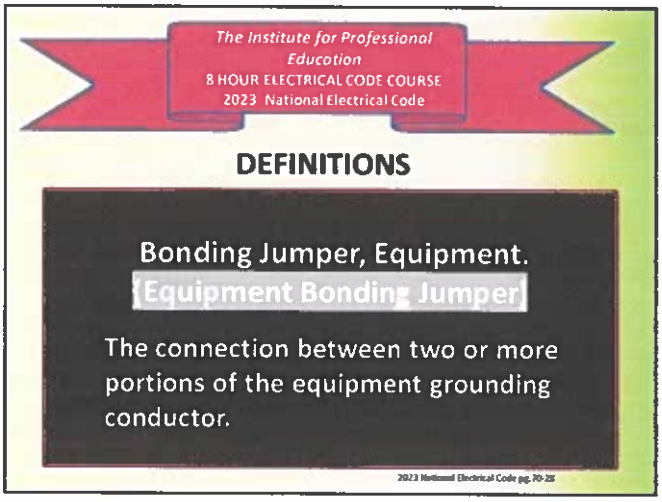
8


The Institute for Professional Education
8 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code
DEFINITIONS
Bodies of Water, Natural, (Natural Bodies of Water)
Bodies of water such as lakes, streams, ponds, rivers, and other naturally occurring bodies of water, which may vary in depth throughout the year
2023 National Electrical Code pg. 70-28

17


The Institute for Professional Education
8 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code
DEFINITIONS
Bonding Conductor (Bonding Jumper).
A conductor that ensures the required electrical conductivity between metal parts that are required to be electrically connected.
2023 National Electrical Code pg. 70-28

18


The Institute for Professional Education
8 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code
DEFINITIONS
Bonding Jumper, Equipment.
(Equipment Bonding Jumper)
The connection between two or more portions of the equipment grounding conductor.
2023 National Electrical Code pg. 70-28

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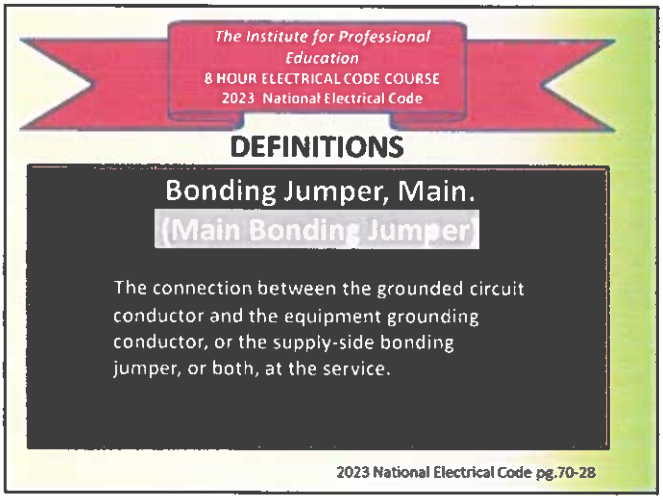
The Institute for Professional Education
8 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code
DEFINITIONS
Bonding Jumper, Main.
(Main Bonding Jumper)
The connection between the grounded circuit conductor and the equipment grounding conductor, or the supply-side bonding jumper, or both, at the service.
2023 National Electrical Code pg.70-28

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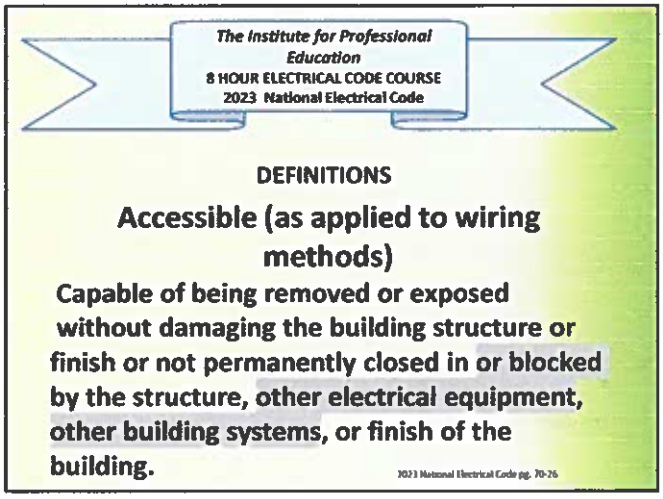
2023 National Electrical Code
DEFINITIONS
Accessible (as applied to equipment).
Capable of being reached for operation, renewal, and inspection
2023 National Electrical Code pg. 70-26

13


The Institute for Professional Education
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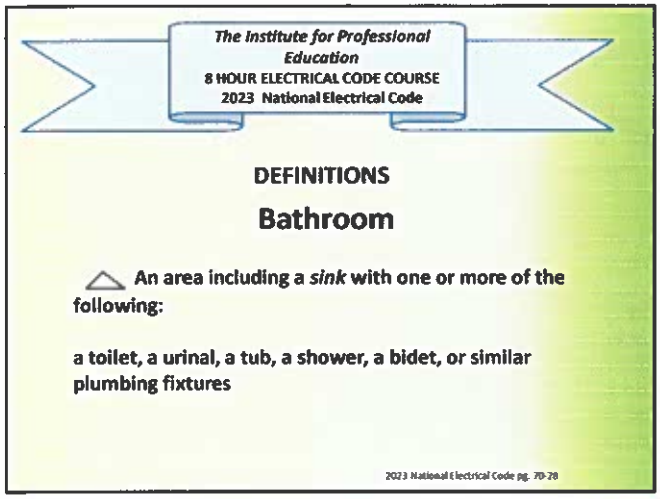
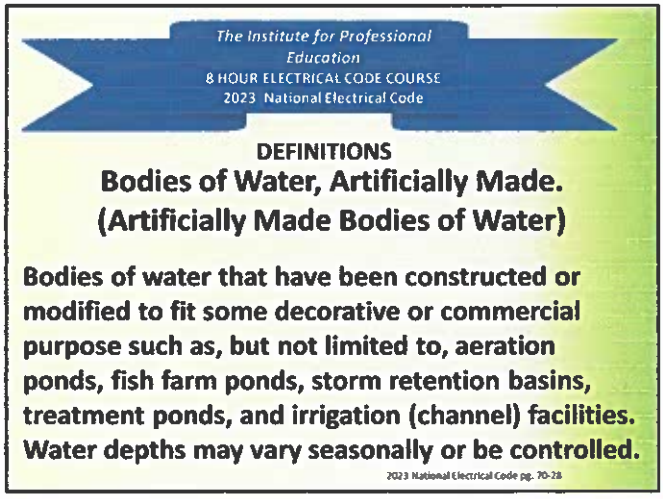
2023 National Electrical Code
DEFINITIONS
Accessible (as applied to wiring methods)
Capable of being removed or exposed without damaging the building structure or finish or not permanently closed in or blocked by the structure, other electrical equipment, other building systems, or finish of the building.
2023 National Electrical Code pg. 70-26

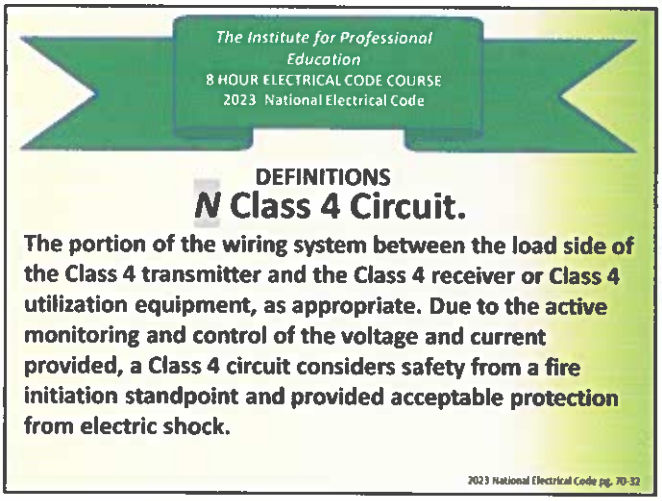
14


The Institute for Professional Education
8 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code
DEFINITIONS
Bathroom
An area including a sink with one or more of the following:
a toilet, a urinal, a tub, a shower, a bidet, or similar plumbing fixtures
2023 National Electrical Code pg. 70-28

15


The Institute for Professional Education
8 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code
DEFINITIONS
Bodies of Water, Artificially Made.
(Artificially Made Bodies of Water)
Bodies of water that have been constructed or modified to fit some decorative or commercial purpose such as, but not limited to, aeration ponds, fish farm ponds, storm retention basins, treatment ponds, and irrigation (channel) facilities. Water depths may vary seasonally or be controlled.
2023 National Electrical Code pg. 70-28

16


The Institute for Professional Education
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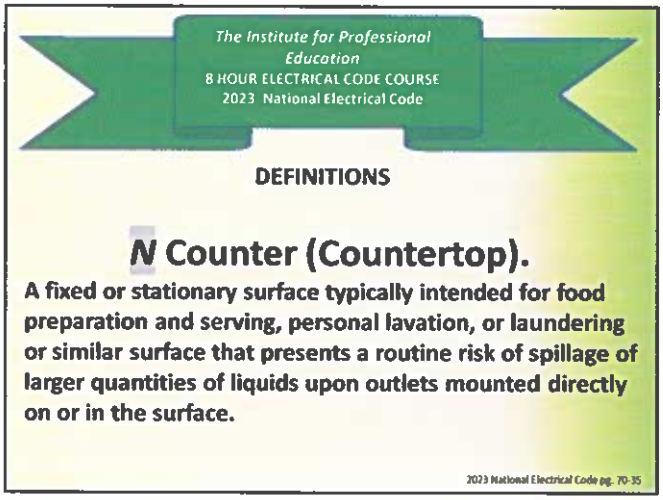
2023 National Electrical Code
DEFINITIONS
N Class 4 Circuit.
The portion of the wiring system between the load side of the Class 4 transmitter and the Class 4 receiver or Class 4 utilization equipment, as appropriate. Due to the active monitoring and control of the voltage and current provided, a Class 4 circuit considers safety from a fire initiation standpoint and provided acceptable protection from electric shock.
2023 National Electrical Code pg. 70-32

25


The Institute for Professional Education
8 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code
DEFINITIONS
N Counter (Countertop).
A fixed or stationary surface typically intended for food preparation and serving, personal lavation, or laundering or similar surface that presents a routine risk of spillage of larger quantities of liquids upon outlets mounted directly on or in the surface.
2023 National Electrical Code pg. 70-35

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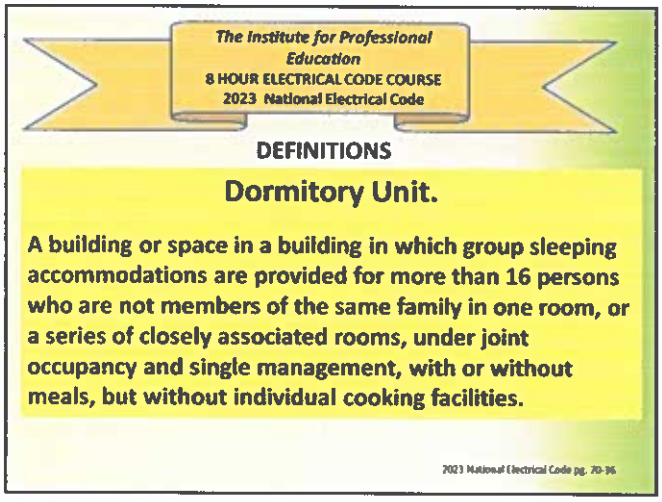
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2023 National Electrical Code
DEFINITIONS
Dormitory Unit.
A building or space in a building in which group sleeping accommodations are provided for more than 16 persons who are not members of the same family in one room, or a series of closely associated rooms, under joint occupancy and single management, with or without meals, but without individual cooking facilities.
2023 National Electrical Code pg. 70-36

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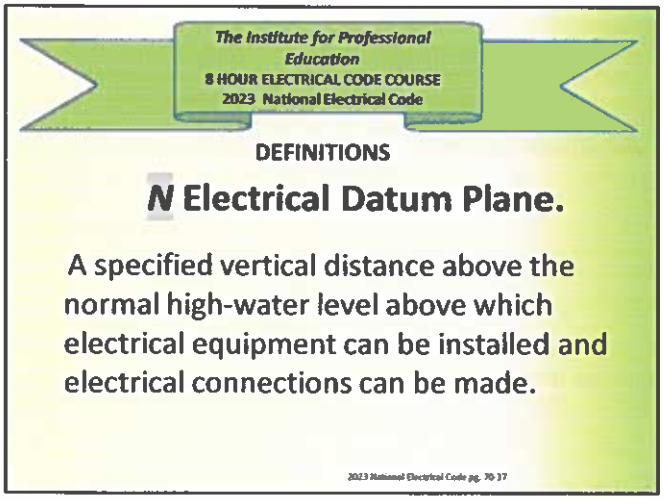
The Institute for Professional Education
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2023 National Electrical Code
DEFINITIONS
N Electrical Datum Plane.
A specified vertical distance above the normal high-water level above which electrical equipment can be installed and electrical connections can be made.
2023 National Electrical Code pg. 70-37

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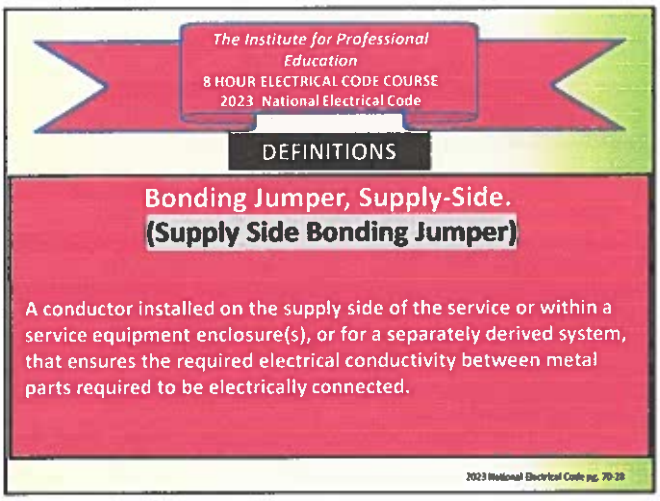
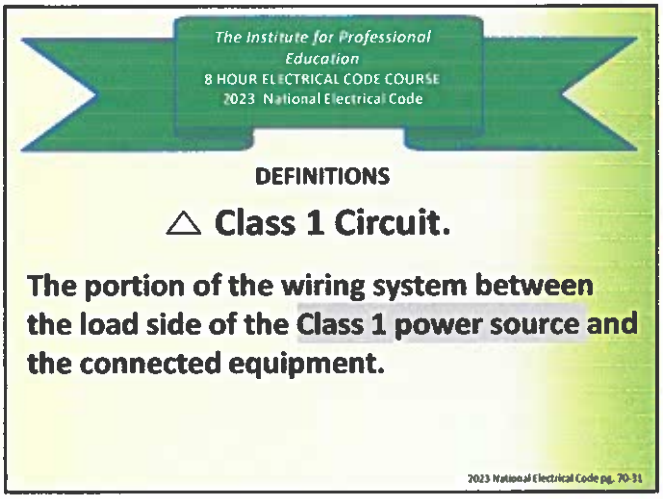

The Institute for Professional Education
8 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code
DEFINITIONS
Bonding Jumper, Supply-Side.
(Supply Side Bonding Jumper)
A conductor installed on the supply side of the service or within a service equipment enclosure(s), or for a separately derived system, that ensures the required electrical conductivity between metal parts required to be electrically connected.
2023 National Electrical Code pg. 70-28

21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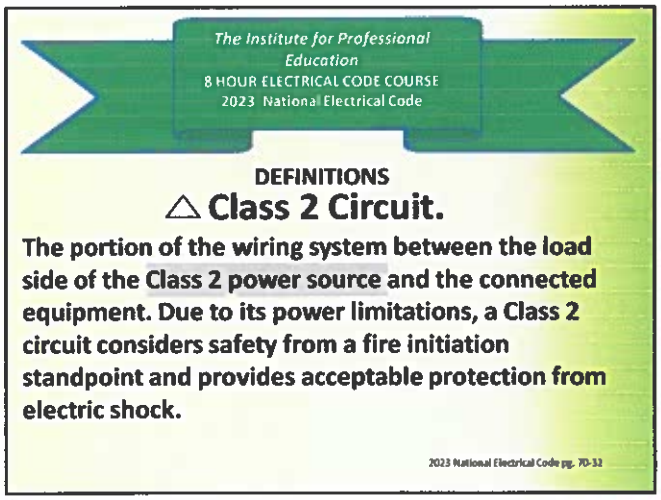
2023 National Electrical Code
DEFINITIONS
△ Class 1 Circuit.
The portion of the wiring system between the load side of the Class 1 power source and the connected equipment.
2023 National Electrical Code pg. 70-31

22


The Institute for Professional Education
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2023 National Electrical Code
DEFINITIONS
△ Class 2 Circuit.
The portion of the wiring system between the load side of the Class 2 power source and the connected equipment. Due to its power limitations, a Class 2 circuit considers safety from a fire initiation standpoint and provides acceptable protection from electric shock.
2023 National Electrical Code pg. 70-32

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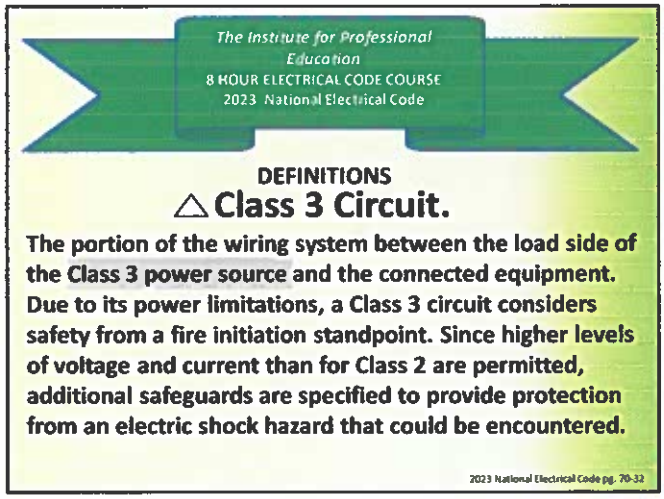
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2023 National Electrical Code
DEFINITIONS
△ Class 3 Circuit.
The portion of the wiring system between the load side of the Class 3 power source and the connected equipment. Due to its power limitations, a Class 3 circuit considers safety from a fire initiation standpoint. Since higher levels of voltage and current than for Class 2 are permitted, additional safeguards are specified to provide protection from an electric shock hazard that could be encountered.
2023 National Electrical Code pg. 70-32

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2023 National Electrical Code

DEFINITIONS

N Electrified Truck Parking Space

A truck parking space that has been provided with an electrical system that allows truck operators to connect their vehicles while stopped and to use off-board power sources in order to operate onboard systems such as air conditioning, heating, and appliances, without any engine idling.

2023 National Electrical Code pg. 70-37

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2023 National Electrical Code

DEFINITIONS

N Electrified Truck Parking Space Wiring Systems.

All of the electrical wiring, equipment, and appurtenances related to electrical installation within an electrified truck parking space, including the electrified parking space-supply equipment.

2023 National Electrical Code pg. 70-37

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2023 National Electrical Code

DEFINITIONS

△ **Fault Current, Available. (Available Fault Current)**

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

Information Note: A short-circuit can occur during abnormal conditions such as a fault between circuit conductors or a ground fault.

See Information Note Figure 100.1.

2023 National Electrical Code pg. 70-39

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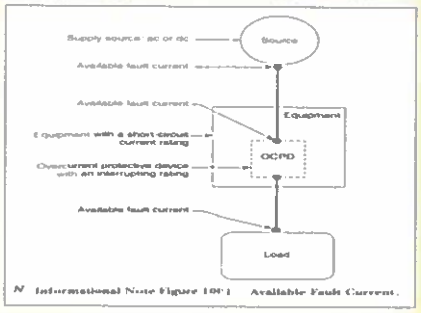
2023 National Electrical Code



N Informational Note Figure 100.1 Available Fault Current.

2023 National Electrical Code 70-39

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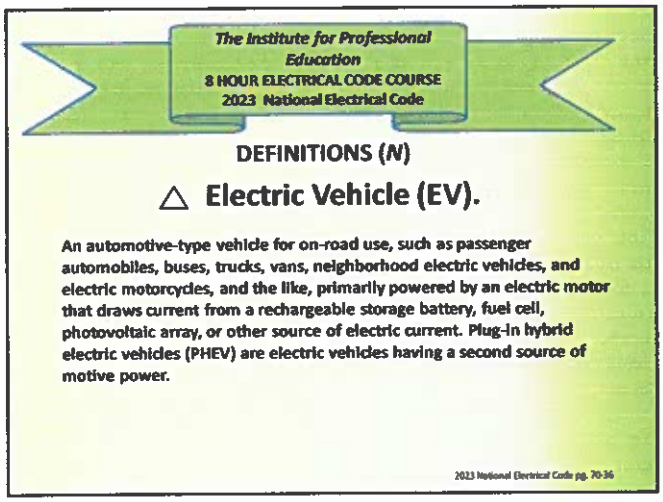
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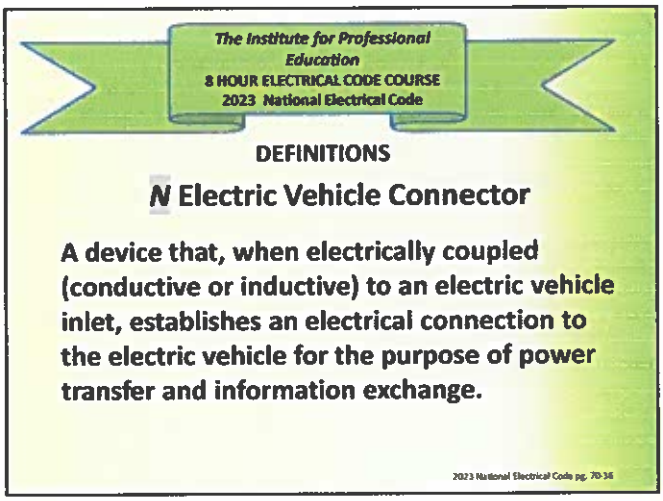
2023 National Electrical Code
DEFINITIONS (N)
△ Electric Vehicle (EV).
An automotive-type vehicle for on-road use, such as passenger automobiles, buses, trucks, vans, neighborhood electric vehicles, and electric motorcycles, and the like, primarily powered by an electric motor that draws current from a rechargeable storage battery, fuel cell, photovoltaic array, or other source of electric current. Plug-in hybrid electric vehicles (PHEV) are electric vehicles having a second source of motive power.
2023 National Electrical Code pg. 70-36

29


The Institute for Professional Education
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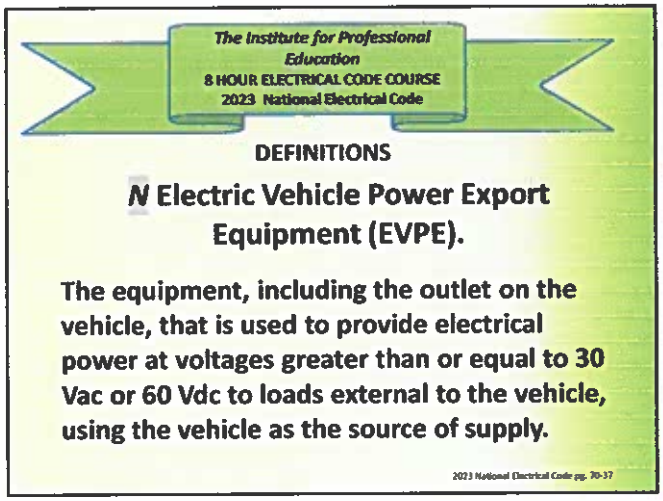
2023 National Electrical Code
DEFINITIONS
N Electric Vehicle Connector
A device that, when electrically coupled (conductive or inductive) to an electric vehicle inlet, establishes an electrical connection to the electric vehicle for the purpose of power transfer and information exchange.
2023 National Electrical Code pg. 70-36

30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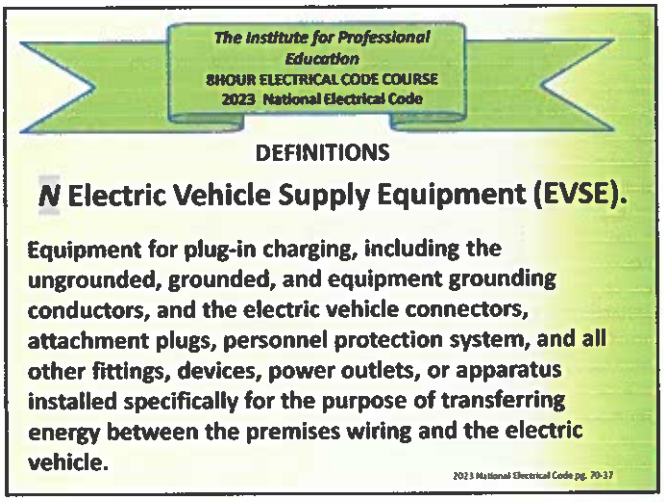
8 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code
DEFINITIONS
N Electric Vehicle Power Export Equipment (EVPE).
The equipment, including the outlet on the vehicle, that is used to provide electrical power at voltages greater than or equal to 30 Vac or 60 Vdc to loads external to the vehicle, using the vehicle as the source of supply.
2023 National Electrical Code pg. 70-37

31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8HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code
DEFINITIONS
N Electric Vehicle Supply Equipment (EVSE).
Equipment for plug-in charging, including the ungrounded, grounded, and equipment grounding conductors, and the electric vehicle connectors, attachment plugs, personnel protection system, and all other fittings, devices, power outlets, or apparatus installed specifically for the purpose of transferring energy between the premises wiring and the electric vehicle.
2023 National Electrical Code pg. 70-37

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2023 National Electrical Code

DIFINITIONS

Ground-Fault Current Path.

An electrically conductive path from the point of a ground fault on a wiring system through normally non-current-carrying conductors, grounded conductors, equipment, or the earth to the electrical supply source.

2023 National Electrical Code pg. 70-42

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2023 National Electrical Code

DIFINITIONS

Grounding Conductor, Equipment (EGC) Equipment Grounding Conductor

A conductive path(s) that is part of an effective ground-fault current path and connects normally non-current-carrying metal parts of equipment together and to the system grounded conductor or to the grounding electrode conductor, or both.

2023 National Electrical Code pg. 70-42

42

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2023 National Electrical Code

DEFINITIONS

Habitable Room.

A room in a building for living, sleeping, eating, or cooking, but excluding bathrooms, toilet rooms, closets, hallways, storage or utility spaces, and similar areas. Page 70-43

Information Technology Equipment Room.

A room within the information technology equipment area that contains the information technology equipment Page 70-44

2023 National Electrical Code

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2023 National Electrical Code

DIFINITIONS

Intersystem Bonding Termination. IBT

A device that provides a means for connecting intersystem bonding conductors for communications systems to the grounding electrode system.

2023 National Electrical Code pg. 70-44

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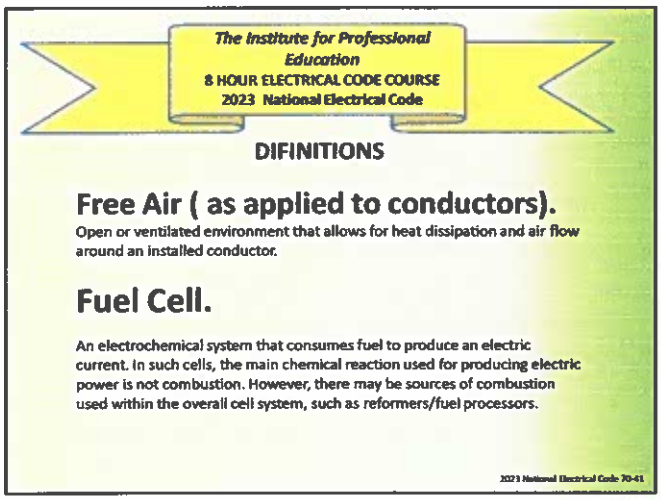
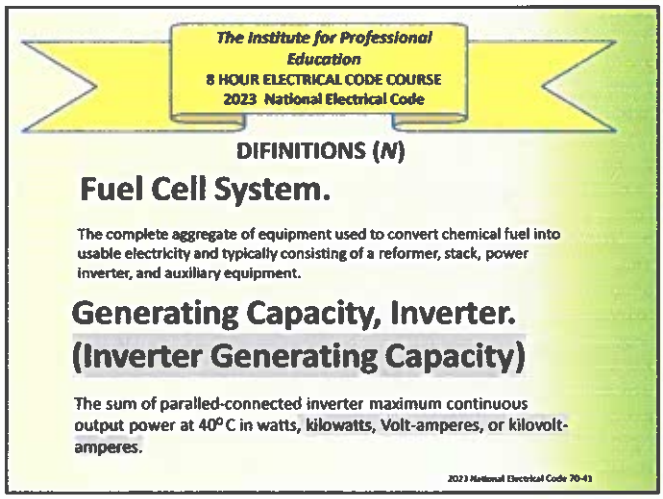

The Institute for Professional Education
8 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code
DIFINITIONS
Free Air (as applied to conductors).
Open or ventilated environment that allows for heat dissipation and air flow around an installed conductor.
Fuel Cell.
An electrochemical system that consumes fuel to produce an electric current. In such cells, the main chemical reaction used for producing electric power is not combustion. However, there may be sources of combustion used within the overall cell system, such as reformers/fuel processors.
2023 National Electrical Code 70-41

37


The Institute for Professional Education
8 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code
DIFINITIONS (N)
Fuel Cell System.
The complete aggregate of equipment used to convert chemical fuel into usable electricity and typically consisting of a reformer, stack, power inverter, and auxiliary equipment.
Generating Capacity, Inverter.
(Inverter Generating Capacity)
The sum of paralled-connected inverter maximum continuous output power at 40° C in watts, kilowatts, Volt-amperes, or kilovolt-amperes.
2023 National Electrical Code 70-41

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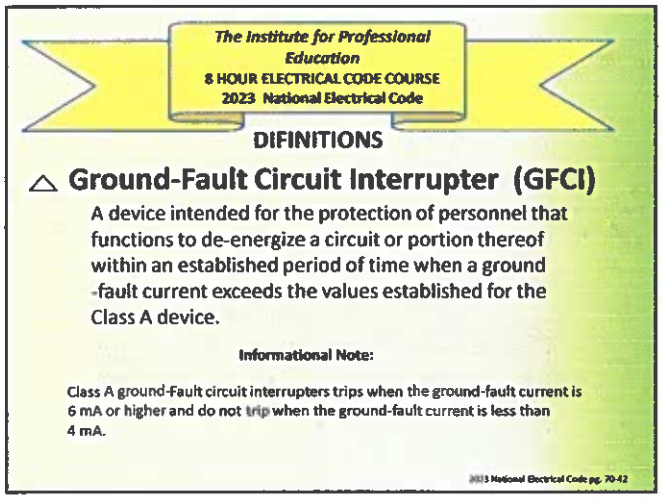
The Institute for Professional Education
8 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code
DIFINITIONS
△ Ground-Fault Circuit Interrupter (GFCI)
A device intended for the protection of personnel that functions to de-energize a circuit or portion thereof within an established period of time when a ground -fault current exceeds the values established for the Class A device.
Informational Note:
Class A ground-Fault circuit interrupters trips when the ground-fault current is 6 mA or higher and do not trip when the ground-fault current is less than 4 mA.
2023 National Electrical Code pg. 70-42

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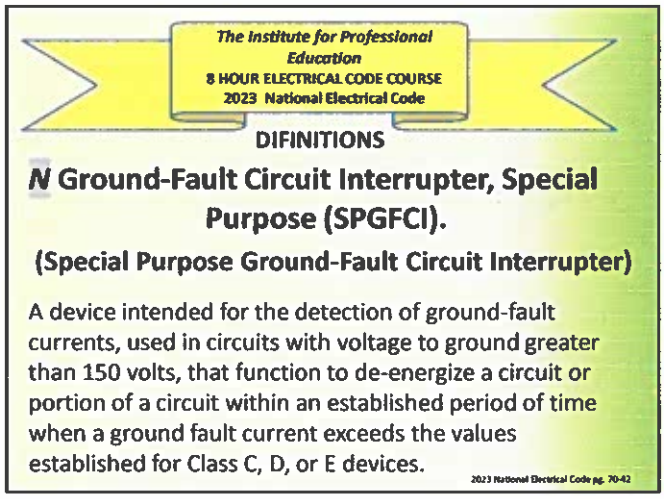
The Institute for Professional Education
8 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code
DIFINITIONS
N Ground-Fault Circuit Interrupter, Special Purpose (SPGFCI).
(Special Purpose Ground-Fault Circuit Interrupter)
A device intended for the detection of ground-fault currents, used in circuits with voltage to ground greater than 150 volts, that function to de-energize a circuit or portion of a circuit within an established period of time when a ground fault current exceeds the values established for Class C, D, or E devices.
2023 National Electrical Code pg. 70-42

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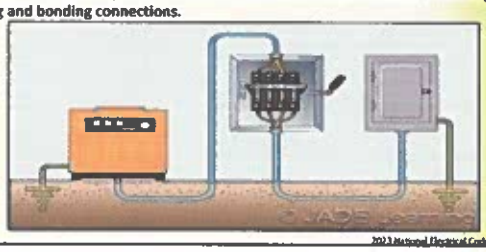
2023 National Electrical Code

DEFINITIONS:

Separately Derived System.

An electrical power supply output, other than a service, having no direct connection(s) to circuit conductors of any other electrical source other than those established by grounding and bonding connections.



2023 National Electrical Code pg. 70-57

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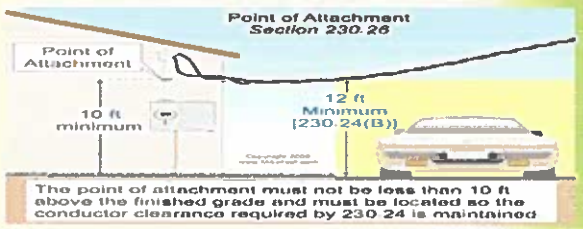
2023 National Electrical Code

DEFINITIONS:

Service Drop.

The overhead conductors between the serving utility and the service point.



2023 National Electrical Code pg. 70-57

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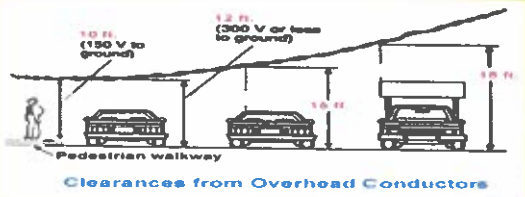
8 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code

DEFINITIONS:

Service Conductors, (Overhead Service Conductors)
The overhead conductors between the service point and the first point of connection to the service-entrance conductors at the building or other structure.



Clearances from Overhead Conductors

2023 National Electrical Code pg. 70-57

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Instructor: Paul Fussner

Phone 1-216-299-9367

2023 National Electrical Code

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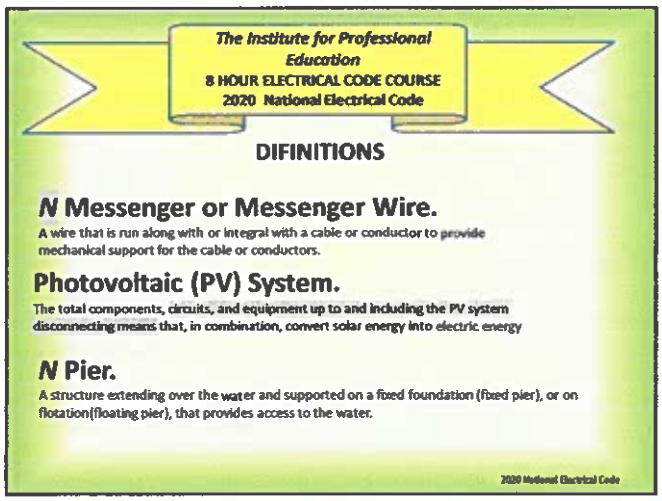
The Institute for Professional Education
8 HOUR ELECTRICAL CODE COURSE
2020 National Electrical Code
DIFINITIONS
N Messenger or Messenger Wire.
A wire that is run along with or integral with a cable or conductor to provide mechanical support for the cable or conductors.
Photovoltaic (PV) System.
The total components, circuits, and equipment up to and including the PV system disconnecting means that, in combination, convert solar energy into electric energy
N Pier.
A structure extending over the water and supported on a fixed foundation (fixed pier), or on flotation(floating pier), that provides access to the water.
2020 National Electrical Code

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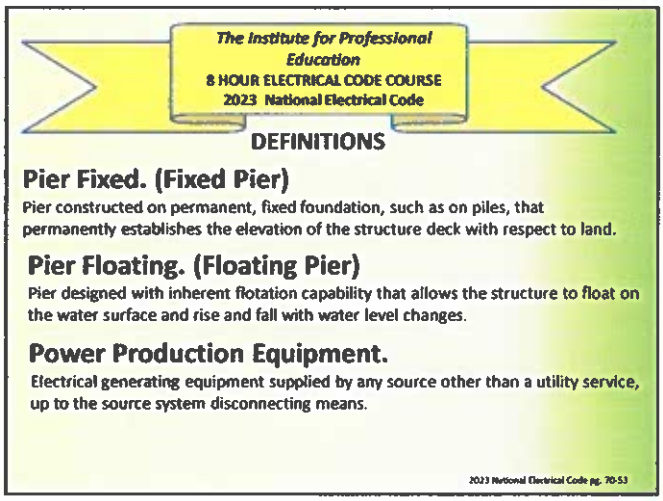
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DEFINITIONS
Pier Fixed. (Fixed Pier)
Pier constructed on permanent, fixed foundation, such as on piles, that permanently establishes the elevation of the structure deck with respect to land.
Pier Floating. (Floating Pier)
Pier designed with inherent flotation capability that allows the structure to float on the water surface and rise and fall with water level changes.
Power Production Equipment.
Electrical generating equipment supplied by any source other than a utility service, up to the source system disconnecting means.
2023 National Electrical Code pg. 70-53

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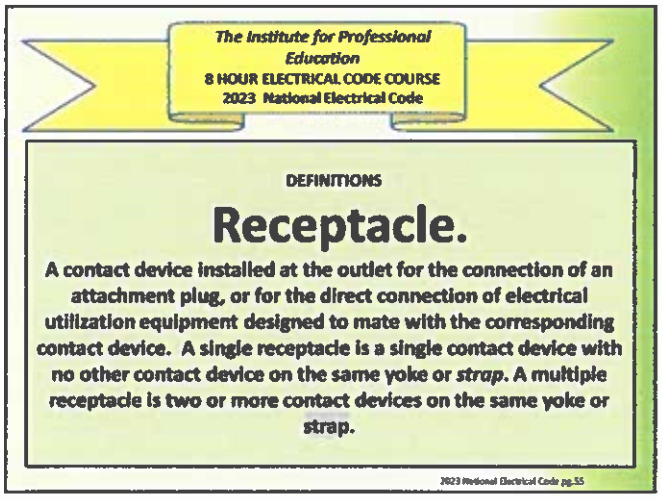
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DEFINITIONS
Receptacle.
A contact device installed at the outlet for the connection of an attachment plug, or for the direct connection of electrical utilization equipment designed to mate with the corresponding contact device. A single receptacle is a single contact device with no other contact device on the same yoke or strap. A multiple receptacle is two or more contact devices on the same yoke or strap.
2023 National Electrical Code pg.55

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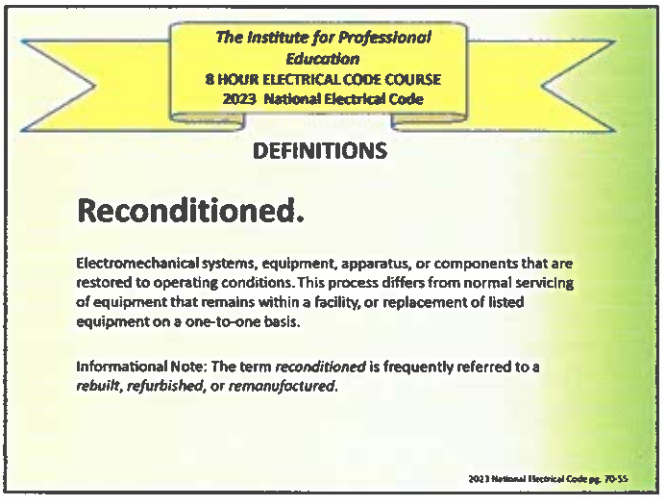
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DEFINITIONS
Reconditioned.
Electromechanical systems, equipment, apparatus, or components that are restored to operating conditions. This process differs from normal servicing of equipment that remains within a facility, or replacement of listed equipment on a one-to-one basis.
Informational Note: The term reconditioned is frequently referred to a rebuilt, refurbished, or remanufactured.
2023 National Electrical Code pg. 70-55

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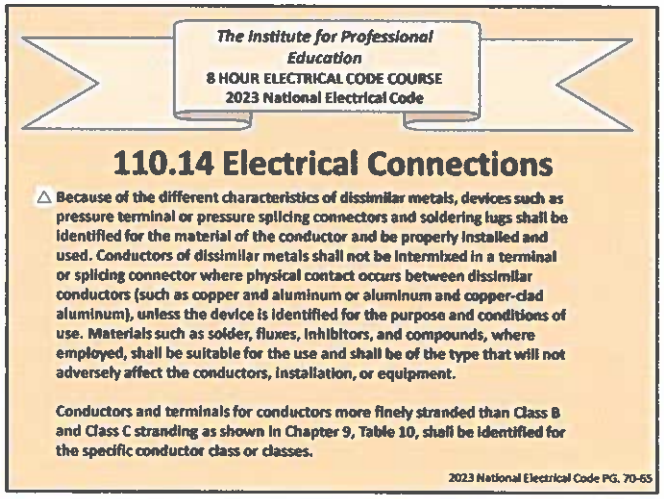
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110.14 Electrical Connections
△ Because of the different characteristics of dissimilar metals, devices such as pressure terminal or pressure splicing connectors and soldering lugs shall be identified for the material of the conductor and be properly installed and used. Conductors of dissimilar metals shall not be intermixed in a terminal or splicing connector where physical contact occurs between dissimilar conductors (such as copper and aluminum or aluminum and copper-clad aluminum), unless the device is identified for the purpose and conditions of use. Materials such as solder, fluxes, inhibitors, and compounds, where employed, shall be suitable for the use and shall be of the type that will not adversely affect the conductors, installation, or equipment.
Conductors and terminals for conductors more finely stranded than Class B and Class C stranding as shown in Chapter 9, Table 10, shall be identified for the specific conductor class or classes.
2023 National Electrical Code PG. 70-65

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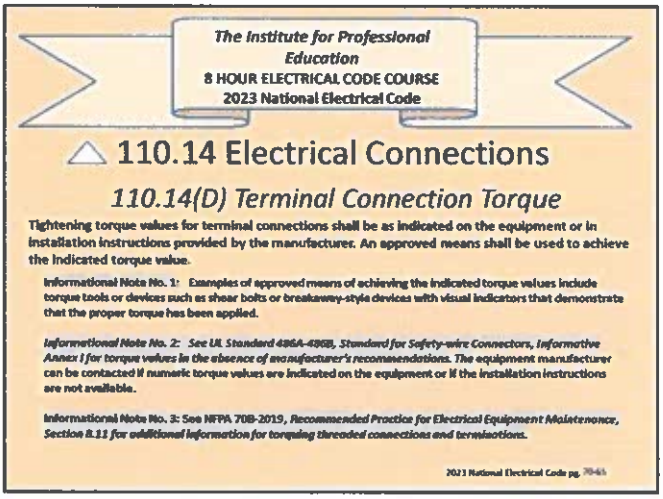
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△ 110.14 Electrical Connections
110.14(D) Terminal Connection Torque
Tightening torque values for terminal connections shall be as indicated on the equipment or in installation instructions provided by the manufacturer. An approved means shall be used to achieve the indicated torque value.
Informational Note No. 1: Examples of approved means of achieving the indicated torque values include torque tools or devices such as shear bolts or breakaway-style devices with visual indicators that demonstrate that the proper torque has been applied.
Informational Note No. 2: See UL Standard 486A-486B, Standard for Safety-wire Connectors, Informative Annex I for torque values in the absence of manufacturer's recommendations. The equipment manufacturer can be contacted if numeric torque values are indicated on the equipment or if the installation instructions are not available.
Informational Note No. 3: See NFPA 70B-2019, Recommended Practice for Electrical Equipment Maintenance, Section 8.11 for additional information for torquing threaded connections and terminations.
2023 National Electrical Code pg. 70-65

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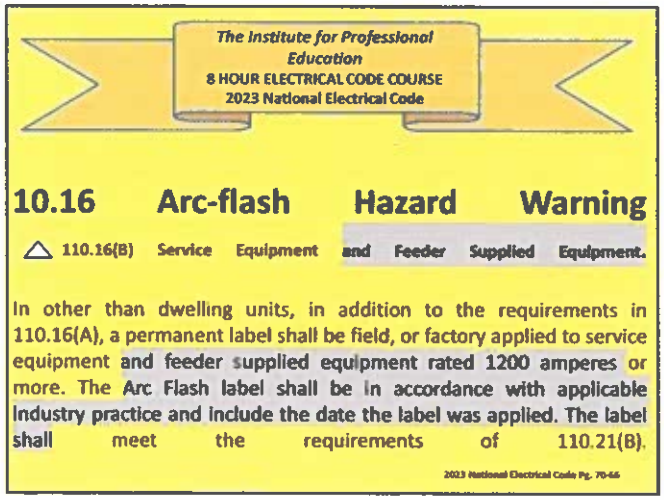
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2023 National Electrical Code
10.16 Arc-flash Hazard Warning
△ 110.16(B) Service Equipment and Feeder Supplied Equipment.
In other than dwelling units, in addition to the requirements in 110.16(A), a permanent label shall be field, or factory applied to service equipment and feeder supplied equipment rated 1200 amperes or more. The Arc Flash label shall be in accordance with applicable industry practice and include the date the label was applied. The label shall meet the requirements of 110.21(B).
2023 National Electrical Code Pg. 70-66

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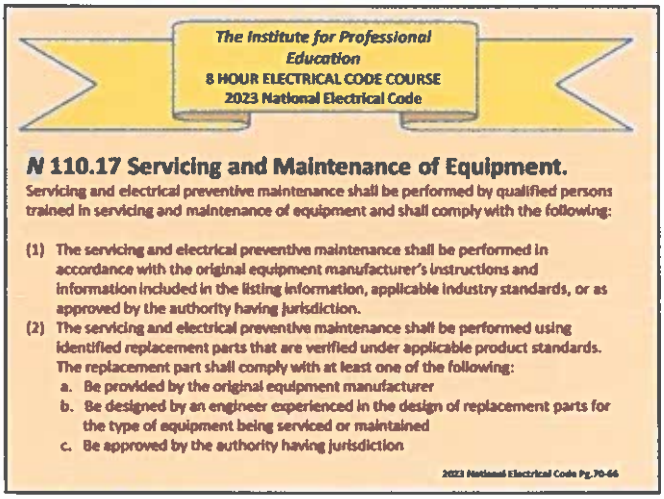
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N 110.17 Servicing and Maintenance of Equipment.
Servicing and electrical preventive maintenance shall be performed by qualified persons trained in servicing and maintenance of equipment and shall comply with the following:
(1) The servicing and electrical preventive maintenance shall be performed in accordance with the original equipment manufacturer's instructions and information included in the listing information, applicable industry standards, or as approved by the authority having jurisdiction.
(2) The servicing and electrical preventive maintenance shall be performed using identified replacement parts that are verified under applicable product standards. The replacement part shall comply with at least one of the following:
a. Be provided by the original equipment manufacturer
b. Be designed by an engineer experienced in the design of replacement parts for the type of equipment being serviced or maintained
c. Be approved by the authority having jurisdiction
2023 National Electrical Code Pg.70-66

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DEFINITIONS:

Service Conductors, Underground. (Underground Service Conductors)

The underground conductors between the service point and the first point of connection to the service-entrance conductors in a terminal box, meter, or other enclosure, inside or outside the building wall.

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DEFINITIONS:

Service Equipment

The necessary equipment, consisting of a circuit breaker(s) or switch(es) and fuse(s) and their accessories, connected to the servicing utility and intended to constitute the main control and disconnect of the serving utility. PG. 70-57

Single-Pole Separable Connector.

A device that is installed at the ends of portable, flexible, single-conductor cable that is used to establish connection or disconnection between two cables or one cable and a single-pole, panel-mounted separable connector. PG.70-58

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△ 110.9 Interrupting Rating.

Equipment intended to interrupt current at fault levels shall have an interrupting rating at nominal circuit voltage at least equal *to* the available fault current at the line terminals of the equipment. Equipment intended to interrupt current at other than fault levels shall have an interrupting rating at nominal circuit voltage *at* least equal *to* the current that must be interrupted.

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110.12 Mechanical Execution of Work

△ 110.12 (C) Cables and Conductors.

Cables and conductors installed exposed on the surfaces of ceilings and sidewalls shall be supported by the building structure in such a manner that the cables and conductors will not be damaged by normal building use. Such cables and conductors shall be secured by hardware including straps, staples, cable ties, hangers, or similar fitting designed and installed so as not to damage the cable. The installation shall also conform with 300.4 and 300.11. Nonmetallic cable ties and other nonmetallic cable accessories used to secure and support cable in other spaces used for environmental air (plenums) shall be listed as having low smoke and heat release properties.

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110.22 Identification of Disconnecting Means.

(A)General

Each disconnecting means shall be legibly marked to indicate its purpose unless located and arranged so the purpose is evident. In other than one, two, or three family dwelling units, the marking shall include the identification and location of the circuit source that supplies the disconnecting means unless located and arranged so the identification and location of the circuit source is evident. The marking shall be of sufficient durability to withstand the environment involved.

Note: *Mark your code book to indicate the State of Ohio Board of Building Standards recognizes one, two, and three-family homes as dwelling units in the Residential Code of Ohio*

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110.24 Available Fault Current.

△ **(A) Field Marking.**

Service equipment at other than dwelling units shall be legibly marked in the field with the available fault current. The field marking(s) shall include the date the fault-current calculation was performed and be of sufficient durability to withstand the environment involved. The calculation shall be documented and made available to those authorized to design, install, inspect, maintain, or operate the system.

Information note No. 2: Values of available fault current for use in determining appropriate minimum short-circuit current and interrupting ratings of service equipment are available from electric utilities in published or other forms.

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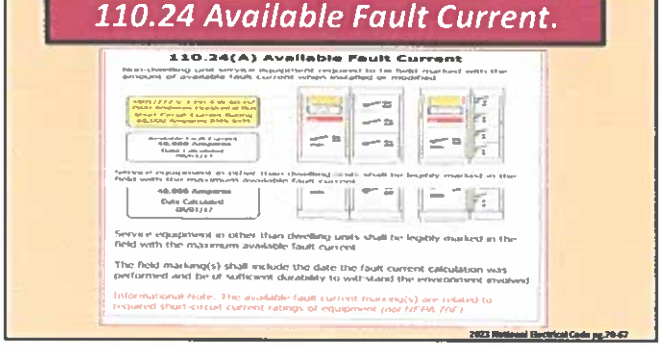
110.24 Available Fault Current.



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110.24 Available Fault Current.

(B) Modifications.

When modifications to the electrical installation occur that effect the available fault current at the service, the available fault current shall be verified or recalculated as necessary to ensure the service equipment ratings are sufficient for the available fault current at the line terminals of the equipment. The required field marking(s) in 110.24(A) shall be adjusted to reflect the new level of available fault current.

Exception: The field marking requirements in 110.24(A) and 110.24(B) shall not be required in industrial installations where conditions of maintenance and supervision ensure that only qualified persons service the equipment.

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110.21 Marking.

(A) Equipment Markings.

△ 110.21(A)(1) General

The manufacturer's name, trademark, or other descriptive marking by which the organization responsible for the product can be identified shall be applied or affixed onto all electrical equipment. Other markings that indicate voltage, current, wattage, or other ratings shall be provided as specified elsewhere in this *Code*. The marking or label shall be of sufficient durability to withstand the environment involved.

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110.21 Marking.

△ (A)(2) Reconditioned Equipment.

110.21(A)(2) Reconditioned Equipment shall be marked with the following:

(1) Name, trademark, or other descriptive marking of the organization that performed the reconditioning
(2) The date of the reconditioning
(3) The term *reconditioned* or approved wording or symbol indicating that the equipment has been reconditioned.

Note: Ohio Law Mandates that all reconditioned equipment shall be approved by the Building Commissioner prior to use

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110.21 Marking.

△ (A)(2) Reconditioned Equipment.

The original listing mark shall be removed or made permanently illegible. The equipment nameplate shall not be required to be removed or made permanently illegible, only the part of the nameplate that includes the listing mark, if applicable. Approval of the reconditioned equipment shall not be based solely on the equipment's original listing.:

Note: Ohio Law Mandates that all reconditioned equipment shall be approved by the Building Commissioner prior to use

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110.21 Marking.

(B) Field-Applied Hazard Markings.

110.21(B) Field-Applied Hazard Markings

DANGER indicates a hazardous situation which, if not avoided, will result in death or serious injury.

DANGER

WARNING indicates a hazardous situation which, if not avoided, could result in death or serious injury.

WARNING

CAUTION indicates a hazardous situation which, if not avoided, may result in minor or moderate injury.

CAUTION

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110.26(A) Working Space

Working space for equipment operating at 1000 vols, nominal, or less to ground and likely to require examination, adjustment, servicing, or maintenance while energized shall comply with the dimensions of 110.26(A)(1). (A)(2), (A)(3), and (A)(4) or as required or permitted elsewhere in this code.

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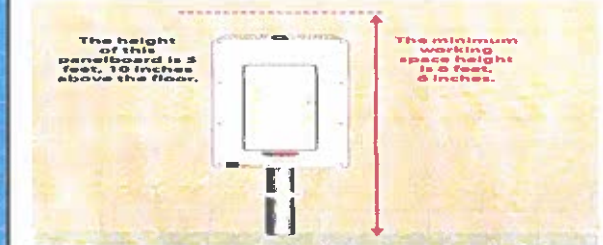
Article 110.26 Spaces about Electrical Equipment

FIGURE 5 MINIMUM WORKING SPACE HEIGHT



The working space shall be clear and extend from the grade, floor or platform to a height of 6½ feet or the height of the equipment, whichever is greater (110.26(A)(3)).

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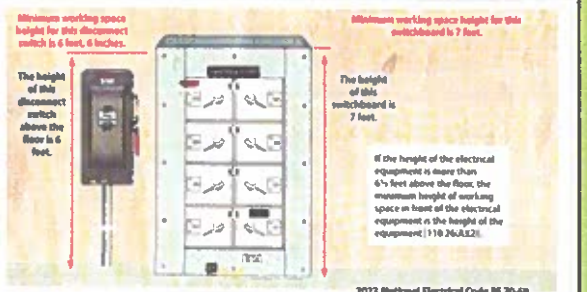
Article 110.26 (A)(3) Height of Working Space

FIGURE 6 HEIGHT OF THE EQUIPMENT



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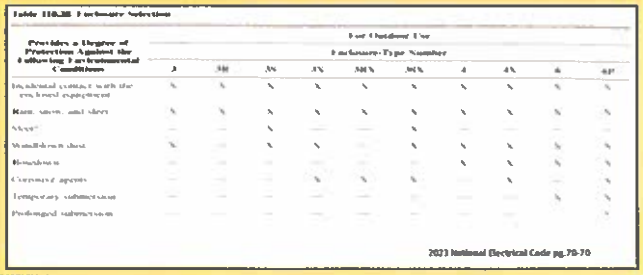
▲ *Table 110.28* Enclosure Types Outdoor use

Provides a Degree of Protection Against the Following Environmental Conditions



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110.25 Lockable Disconnecting Means.

If **a disconnecting means is required to be lockable open elsewhere in this *Code*, it shall be capable of being locked in the open position. The provisions for locking shall remain in place with or without the lock installed.**

Exception: *Locking provisions for a Cord-and-plug connection shall not be required to remain in place without the lock installed.*

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110.25 Lockable Disconnecting Means.

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110.26 Space About Electrical Equipment.

Working space, and access to and egress from working space, shall be provided and maintained about all electrical equipment to permit ready and safe operation and maintenance of such equipment. Open equipment doors shall not impede access to and egress from the working space. Access or egress is impeded if one or more simultaneously opened equipment doors restrict working space access to be less than 610 mm (24 in.) wide and 2.0 m (6 ½ ft) high

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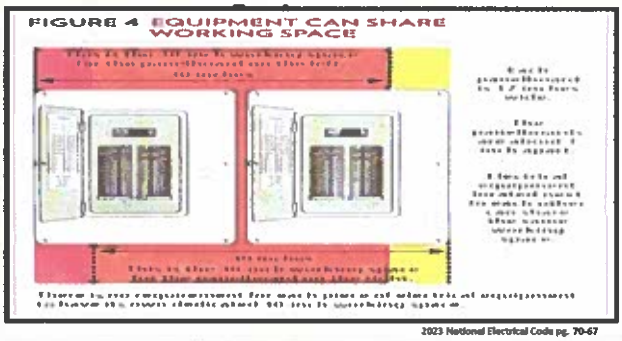
Article 110.26 Spaces about Electrical



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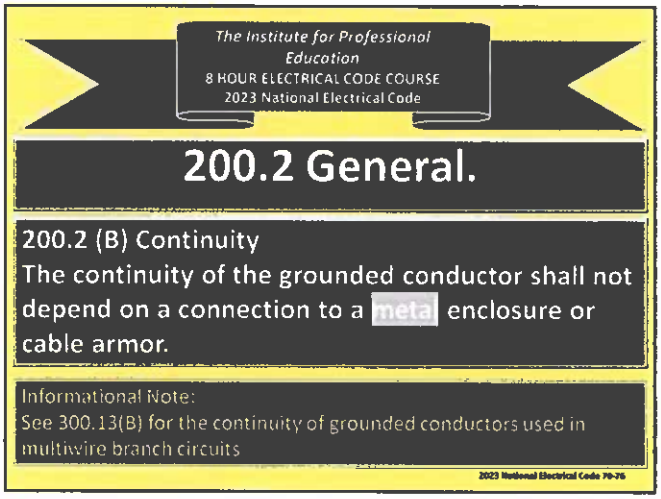
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200.2 General.
200.2 (B) Continuity
The continuity of the grounded conductor shall not depend on a connection to a metal enclosure or cable armor.
Informational Note:
See 300.13(B) for the continuity of grounded conductors used in multiwire branch circuits
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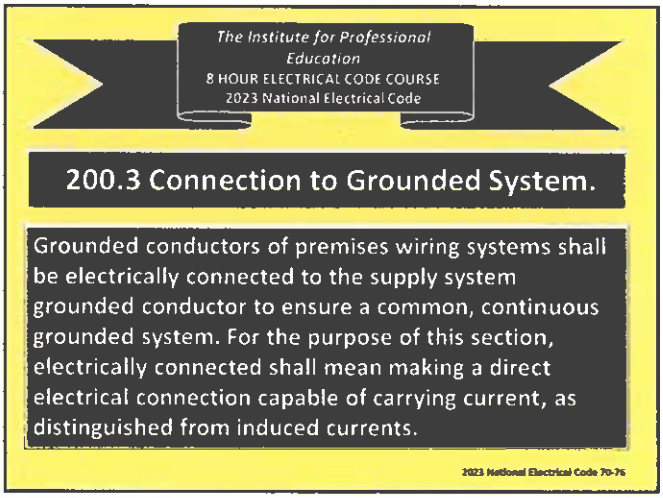
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200.3 Connection to Grounded System.
Grounded conductors of premises wiring systems shall be electrically connected to the supply system grounded conductor to ensure a common, continuous grounded system. For the purpose of this section, electrically connected shall mean making a direct electrical connection capable of carrying current, as distinguished from induced currents.
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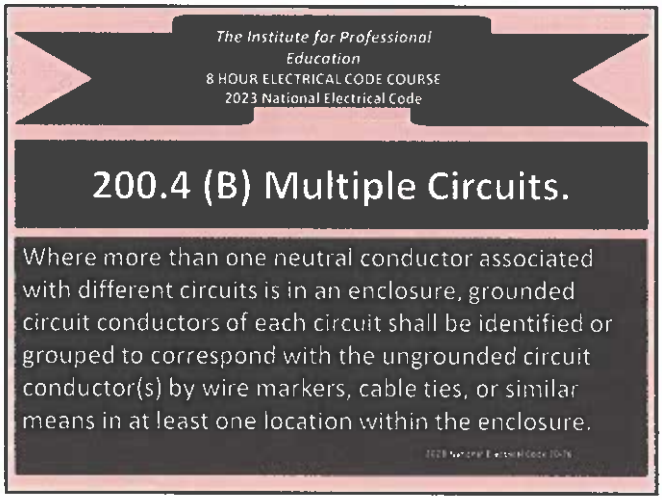
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200.4 (B) Multiple Circuits.
Where more than one neutral conductor associated with different circuits is in an enclosure, grounded circuit conductors of each circuit shall be identified or grouped to correspond with the ungrounded circuit conductor(s) by wire markers, cable ties, or similar means in at least one location within the enclosure.

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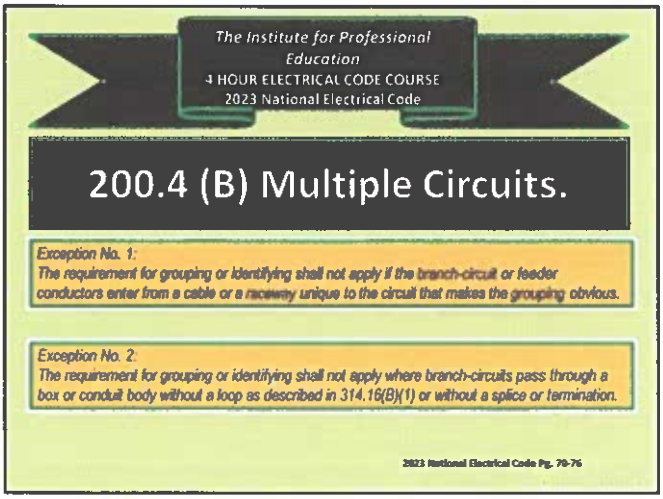
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2023 National Electrical Code
200.4 (B) Multiple Circuits.
Exception No. 1:
The requirement for grouping or identifying shall not apply if the branch-circuit or feeder conductors enter from a cable or a raceway unique to the circuit that makes the grouping obvious.
Exception No. 2:
The requirement for grouping or identifying shall not apply where branch-circuits pass through a box or conduit body without a loop as described in 314.16(B)(1) or without a splice or termination.
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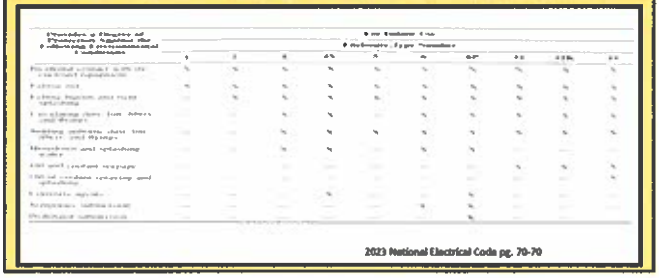
Table 110.28 Enclosure Types Indoor use

Provides a Degree of Protection Against the Following Environmental Conditions



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110.32 Work Space About Equipment

Sufficient space shall be provided and maintained about electrical equipment to permit ready and safe operation and maintenance of such equipment. Where energized parts are exposed, the minimum clear workspace shall be not less than 2.0 m, (6 ½ ft) high (measured vertically from the floor or platform) and the width of the equipment or 914 mm (3 ft) wide (measured parallel to the equipment), whichever is greater. The depth shall be as required in 110.34(A). In all cases, the workspace shall permit at least 90-degree opening of doors or hinged panels. Within the height requirements of this section, other equipment that is associated with the electrical installation and is located above or below the electrical equipment shall be permitted to extend not more than 150 mm (6 in.) beyond the front of the electrical equipment. Working space required by this section shall not be used for storage. When normally enclosed live parts are exposed for inspection or servicing, the working space if in a passageway or general open space, shall be suitably guarded.

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200.2 General.

200.2 (A) Insulation
Grounded conductors shall comply with 200.2 (A) and (B)

(A) Insulation. The grounded conductor, if insulated, shall have insulation that complies with either one of the following:

(1) Is suitably rated, other than color, for any ungrounded conductor of the same circuit for systems of 1000 volts or less.

(2) Is rated not less than 600 volts for solidly grounded neutral systems of over 1000 volts in accordance with 250.184(A)

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200.3 Connection to Grounded System.

Grounded conductors of premises wiring systems shall be electrically connected to the supply system grounded conductor to ensure a common, continuous grounded system. For the purpose of this section, *electrically connected* shall mean making a direct electrical connection capable of carrying current, as distinguished from induced currents.

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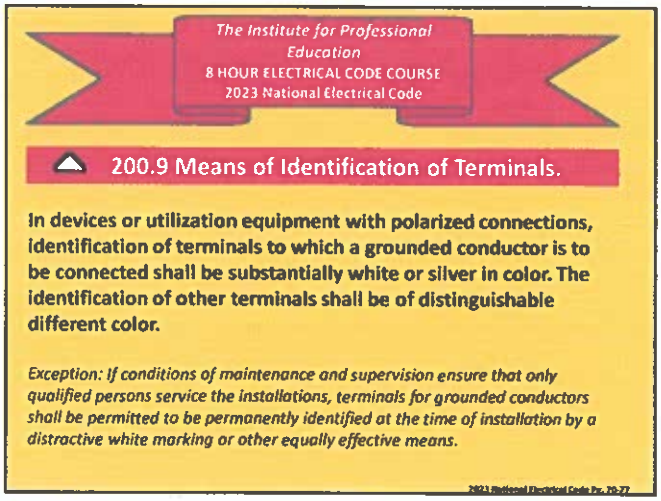
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200.9 Means of Identification of Terminals.
In devices or utilization equipment with polarized connections, identification of terminals to which a grounded conductor is to be connected shall be substantially white or silver in color. The identification of other terminals shall be of distinguishable different color.
Exception: If conditions of maintenance and supervision ensure that only qualified persons service the installations, terminals for grounded conductors shall be permitted to be permanently identified at the time of installation by a distractive white marking or other equally effective means.

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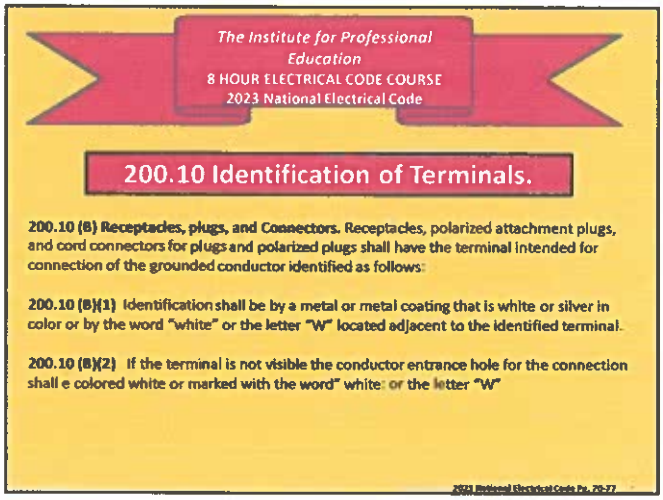
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200.10 Identification of Terminals.
200.10 (B) Receptacles, plugs, and Connectors. Receptacles, polarized attachment plugs, and cord connectors for plugs and polarized plugs shall have the terminal intended for connection of the grounded conductor identified as follows:
200.10 (B)(1) Identification shall be by a metal or metal coating that is white or silver in color or by the word "white" or the letter "W" located adjacent to the identified terminal.
200.10 (B)(2) If the terminal is not visible the conductor entrance hole for the connection shall e colored white or marked with the word" white: or the letter "W"

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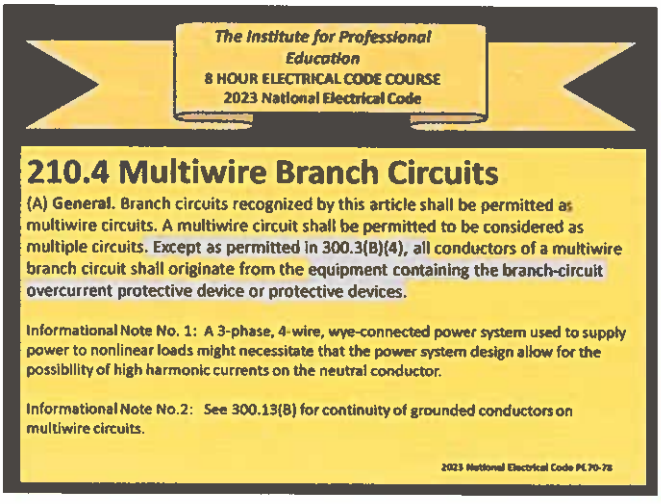
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210.4 Multiwire Branch Circuits
(A) General. Branch circuits recognized by this article shall be permitted as multiwire circuits. A multiwire circuit shall be permitted to be considered as multiple circuits. Except as permitted in 300.3(B)(4), all conductors of a multiwire branch circuit shall originate from the equipment containing the branch-circuit overcurrent protective device or protective devices.
Informational Note No. 1: A 3-phase, 4-wire, wye-connected power system used to supply power to nonlinear loads might necessitate that the power system design allow for the possibility of high harmonic currents on the neutral conductor.
Informational Note No.2: See 300.13(B) for continuity of grounded conductors on multiwire circuits.

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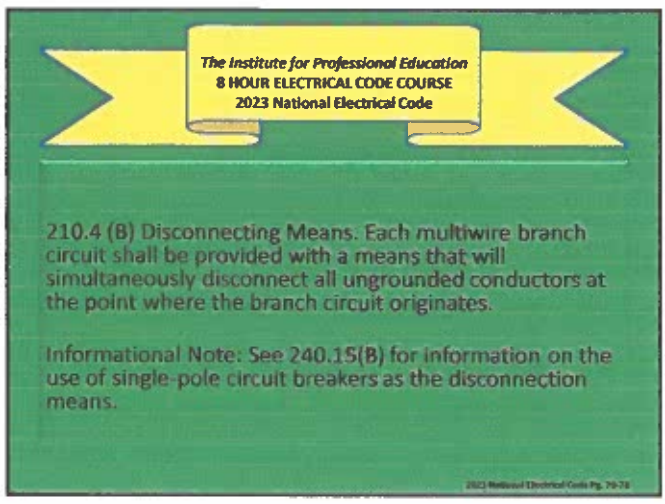
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210.4 (B) Disconnecting Means. Each multiwire branch circuit shall be provided with a means that will simultaneously disconnect all ungrounded conductors at the point where the branch circuit originates.
Informational Note: See 240.15(B) for information on the use of single-pole circuit breakers as the disconnection means.

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200.6 Means of Identifying Grounded Conductors

△ 200.6(A) Sizes 6 AWG or Smaller.

The insulation of grounded conductors of 6 AWG or smaller shall be identified by one of the following means:

(1) A continuous white outer finish
(2) A continuous gray outer finish.
(3) Three continuous white or gray stripes along the conductor's entire length on other than green insulation.
(4) Conductors with white or gray insulation and colored tracer threads in the braid identifying the source of manufacture.
(5) A single-conductor sunlight-resistant, outdoor-rated cable used as a solidly grounded conductor in photovoltaic power systems, as permitted in 690.31(C)(1), shall be identified at the time of installation by marking at terminations in accordance with 200.6(A)(1) through (A)(4).

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200.6 Means of Identifying Grounded Conductors

△ 200.6(A) Sizes 6 AWG or Smaller.

The insulation of grounded conductors of 6 AWG or smaller shall be identified by one of the following means:

(6) The grounded conductor of a mineral-insulated, metal-sheathed cable (Type MI) shall be identified at the time of installation by a distinctive white or gray marking at its terminations. The marking shall encircle the conductor insulation.
(7) Fixture wire shall comply with the requirements for grounded conductor identification in accordance with 402.8.
(8) For aerial cable, the identification shall comply with one of the methods in 200.6(A)(1) through (A)(5), or by means of a ridge located on the exterior of the cable so as to identify it.

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200.6 Means of Identifying Grounded Conductors

200.6(E) Grounded Conductors of Multiconductor Cables.

The insulated grounded conductor(s) in a multiconductor cable shall be identified by a continuous white or gray outer finish or by three continuous white or gray stripes on other than green insulation along its entire length. For conductors that are 4 AWG or larger in cables, identification of the grounded conductor shall be permitted to comply with 200.6(B). For multiconductor flat cable with conductors that are 4 AWG or larger, an external ridge shall be permitted to identify the grounded conductor.

Exception No.1: Conductors within multiconductor cables shall be permitted to be re-identified at their terminations at the time of installation by a distinctive white or gray marking or other equally effective means.

Exception No.2: The grounded conductor of a multiconductor varnished-cloth-insulated cable shall be permitted to be identified at its terminations at the time of installation by a distinctive white marking or other equally effective means.

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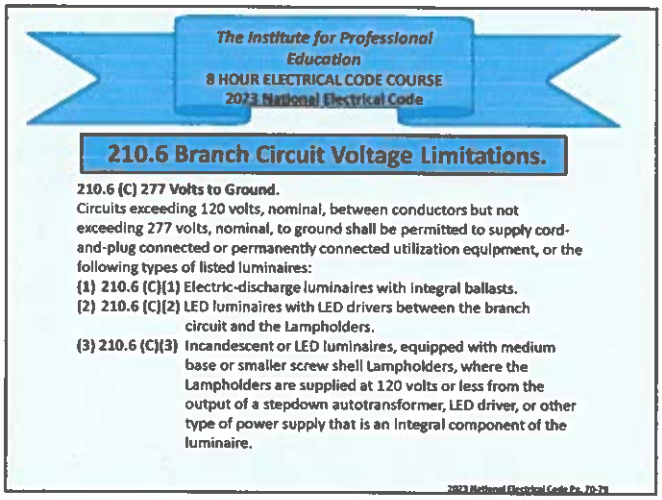
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210.6 Branch Circuit Voltage Limitations.
210.6 (C) 277 Volts to Ground.
Circuits exceeding 120 volts, nominal, between conductors but not exceeding 277 volts, nominal, to ground shall be permitted to supply cord-and-plug connected or permanently connected utilization equipment, or the following types of listed luminaires:
(1) 210.6 (C)(1) Electric-discharge luminaires with integral ballasts.
(2) 210.6 (C)(2) LED luminaires with LED drivers between the branch circuit and the Lampholders.
(3) 210.6 (C)(3) Incandescent or LED luminaires, equipped with medium base or smaller screw shell Lampholders, where the Lampholders are supplied at 120 volts or less from the output of a stepdown autotransformer, LED driver, or other type of power supply that is an integral component of the luminaire.

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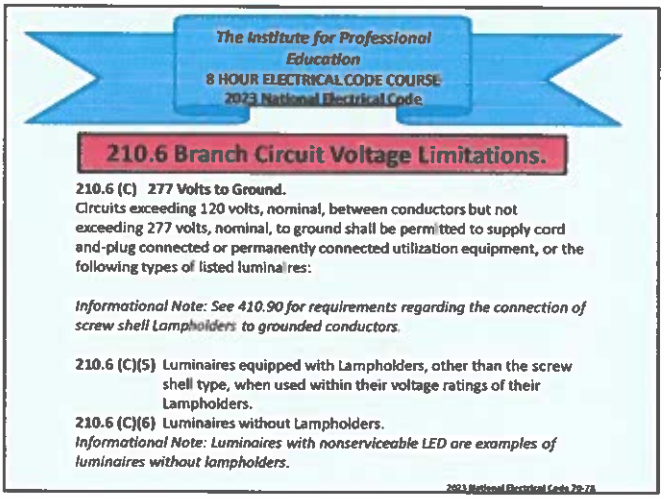
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210.6 Branch Circuit Voltage Limitations.
210.6 (C) 277 Volts to Ground.
Circuits exceeding 120 volts, nominal, between conductors but not exceeding 277 volts, nominal, to ground shall be permitted to supply cord and-plug connected or permanently connected utilization equipment, or the following types of listed luminaires:
Informational Note: See 410.90 for requirements regarding the connection of screw shell Lampholders to grounded conductors.
210.6 (C)(5) Luminaires equipped with Lampholders, other than the screw shell type, when used within their voltage ratings of their Lampholders.
210.6 (C)(6) Luminaires without Lampholders.
Informational Note: Luminaires with nonserviceable LED are examples of luminaires without lampholders.

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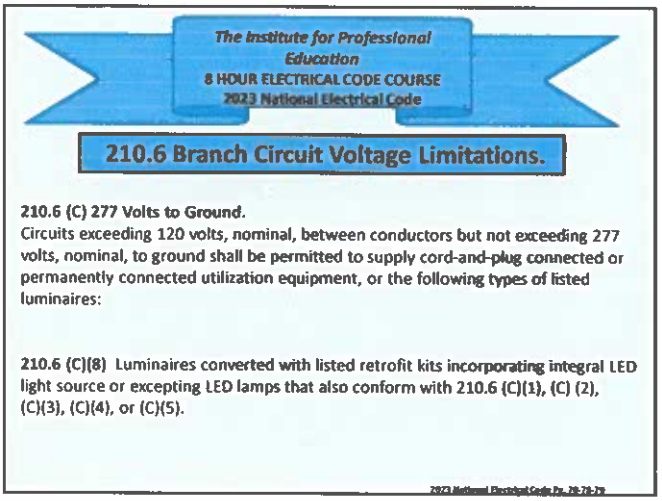
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210.6 Branch Circuit Voltage Limitations.
210.6 (C) 277 Volts to Ground.
Circuits exceeding 120 volts, nominal, between conductors but not exceeding 277 volts, nominal, to ground shall be permitted to supply cord-and-plug connected or permanently connected utilization equipment, or the following types of listed luminaires:
210.6 (C)(8) Luminaires converted with listed retrofit kits incorporating integral LED light source or excepting LED lamps that also conform with 210.6 (C)(1), (C) (2), (C)(3), (C)(4), or (C)(5).

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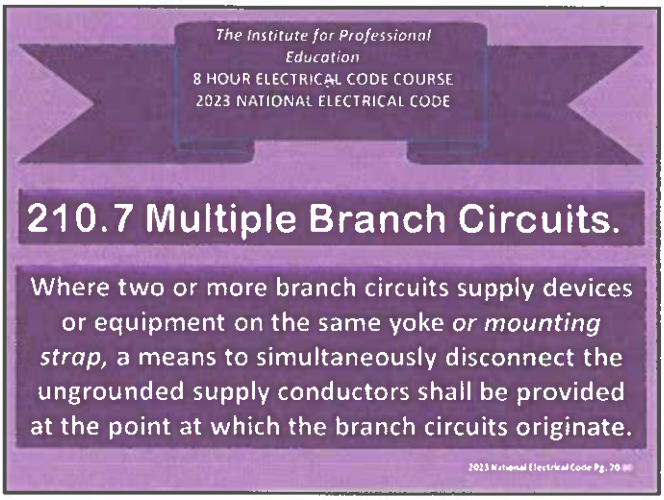
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210.7 Multiple Branch Circuits.
Where two or more branch circuits supply devices or equipment on the same yoke or mounting strap, a means to simultaneously disconnect the ungrounded supply conductors shall be provided at the point at which the branch circuits originate.

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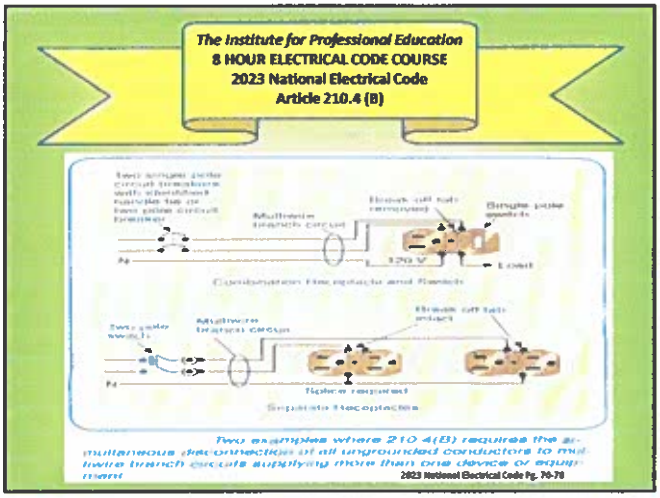
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Article 210.4 (B)

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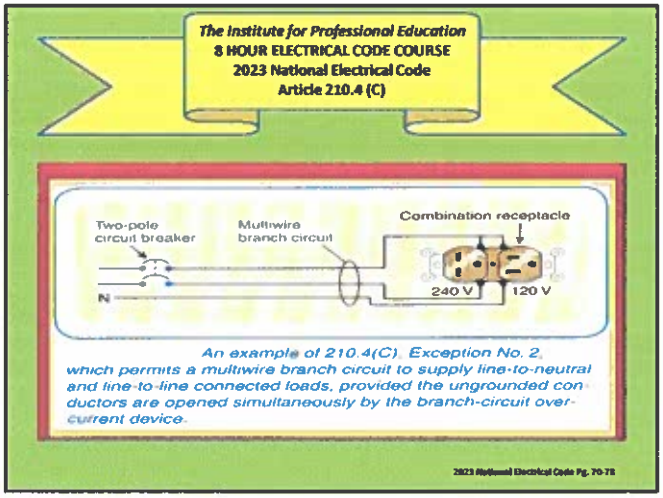
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2023 National Electrical Code
Article 210.4 (C)
Two-pole circuit breaker
Multiwire branch circuit
Combination receptacle
240 V
120 V
N
An example of 210.4(C), Exception No. 2, which permits a multiwire branch circuit to supply line-to-neutral and line-to-line connected loads, provided the ungrounded conductors are opened simultaneously by the branch-circuit overcurrent device.

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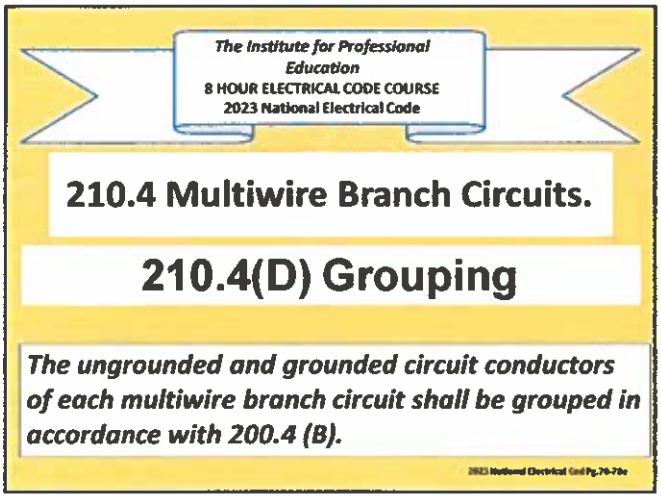
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2023 National Electrical Code
210.4 Multiwire Branch Circuits.
210.4(D) Grouping
The ungrounded and grounded circuit conductors of each multiwire branch circuit shall be grouped in accordance with 200.4 (B).

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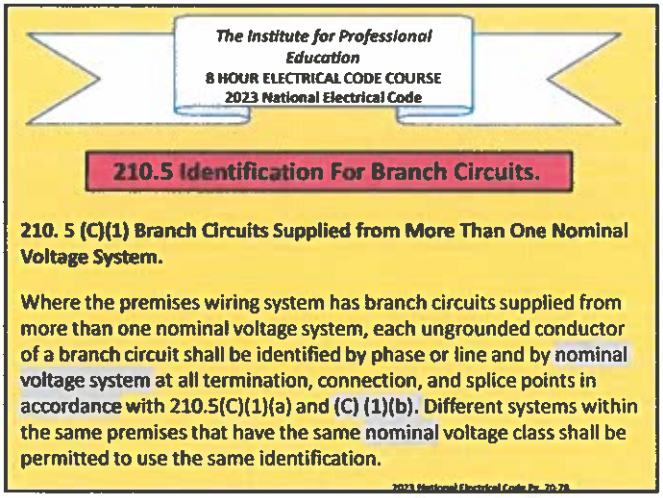
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210.5 Identification For Branch Circuits.
210. 5 (C)(1) Branch Circuits Supplied from More Than One Nominal Voltage System.
Where the premises wiring system has branch circuits supplied from more than one nominal voltage system, each ungrounded conductor of a branch circuit shall be identified by phase or line and by nominal voltage system at all termination, connection, and splice points in accordance with 210.5(C)(1)(a) and (C) (1)(b). Different systems within the same premises that have the same nominal voltage class shall be permitted to use the same identification.

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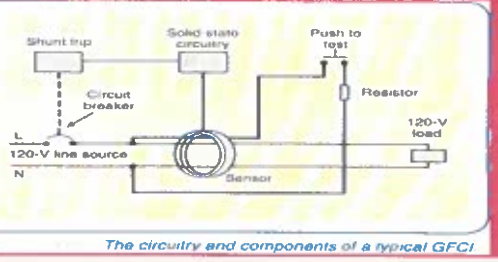
Typical G.F.C.I. Circuitry



The circuitry and components of a typical GFCI

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△ 210.8 (A) Dwelling Units

All 125-volt, single phase, 15-and-20 ampere receptacles installed in locations specified in 210.8 (A)(1) through (A)(12) are to have ground-fault circuit-interrupter protection for personnel. This change is mandated by the Ohio Board of Building Standards

(8) Sinks – where receptacles are installed within 1.8m (6ft) from the top inside edge of the bowl of the sink
(9) Boathouses
(10) Bathtubs or shower stalls – where receptacles are installed within 1.8m (6ft) of the outside edge of the bathtub or shower stall
(11) Laundry areas
(12) Indoor damp and wet locations

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△ 210.8 (A) Dwelling Units

All 125-volt, single phase, 15-and-20 ampere receptacles installed in locations specified in 210.8 (A)(1) through (A)(12) are to have ground-fault circuit-interrupter protection for personnel. This change is mandated by the Ohio Board of Building Standards

(1) Bathrooms
(2) Garages and also accessory buildings that have a floor located at or below grade level not intended as habitable rooms and limited to storage areas, work areas, and areas of similar use.
(3) Outdoors
(4) Crawl Spaces – at or below grade
(5) Basements
(6) Kitchens
(7) Areas with sinks and permanent provisions for food preparation, beverage preparation, or cooking

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210.8 (A) Dwelling Units

Exception No. 1: Receptacles that are not readily accessible and are supplied by a branch circuit dedicated to electric snow-melting, deicing, or pipeline and vessel heating equipment shall be permitted to be installed in accordance with 426.28 or 427.22 as applicable.

Exception No. 2: A receptacle supplying only a permanently installed premises security system shall be permitted to omit ground-fault circuit interrupter protection.

Exception No. 3: Listed weight-supporting ceiling receptacles (WSCR) utilized in combination with compatible weight-supporting attachment fittings (WSAF) installed for the purpose of supporting a ceiling luminaire or ceiling-suspended fan shall be permitted to omit ground-fault circuit-interrupter protection. If a general-purpose convenience receptacle is integral to the ceiling luminaire or ceiling—suspended fan, GFCI protection shall be provided.

Exception No. 4: Factory-installed receptacles that are not readily accessible and are mounted internally to bathroom exhaust fan assemblies shall not require GFCI protection unless required by the installation instructions or listing.

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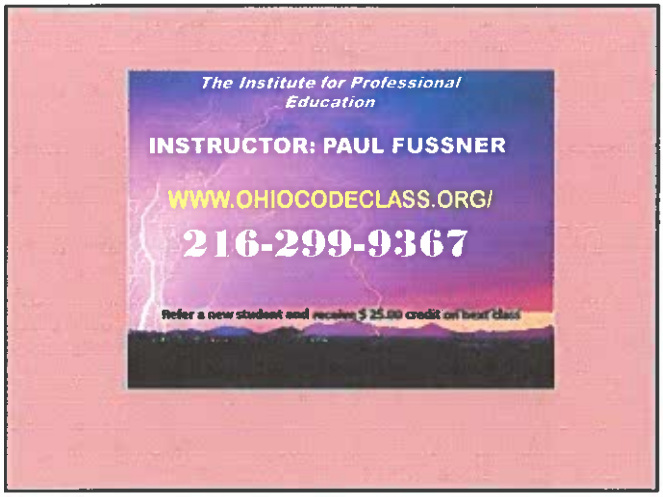

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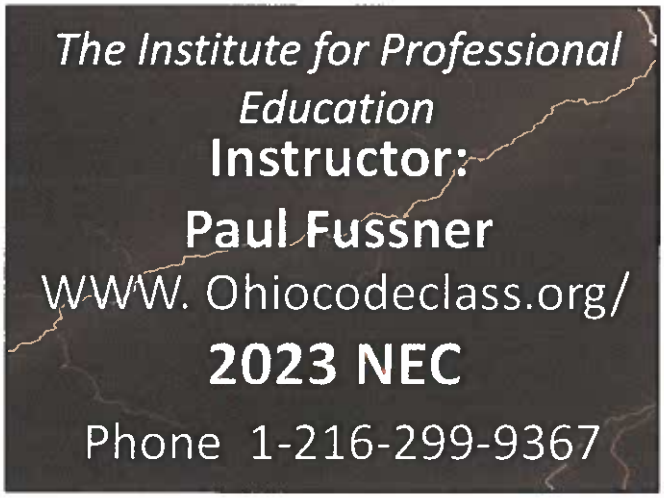

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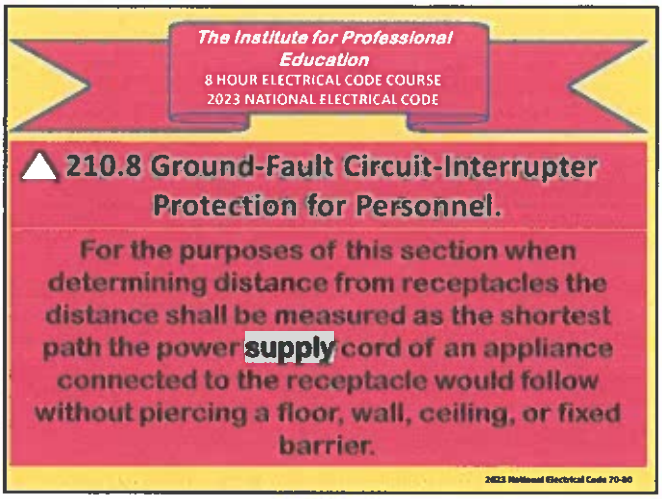

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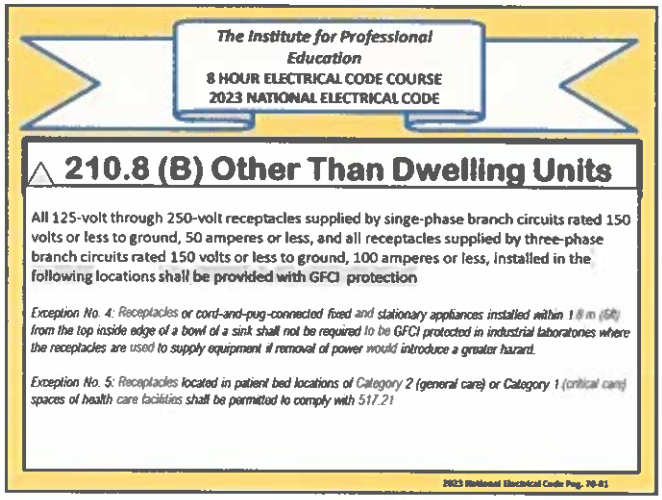

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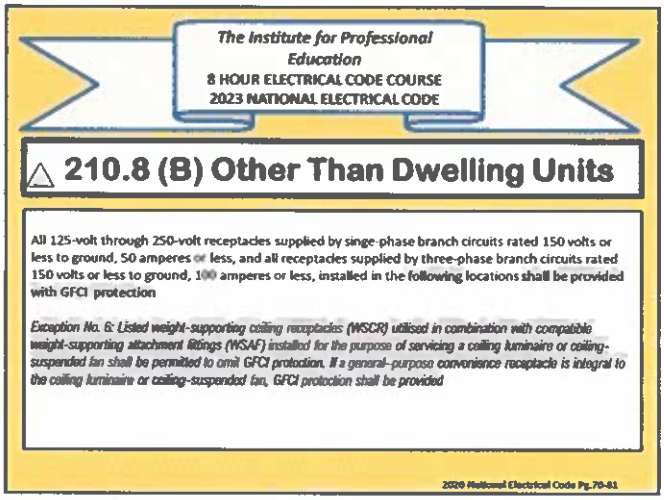

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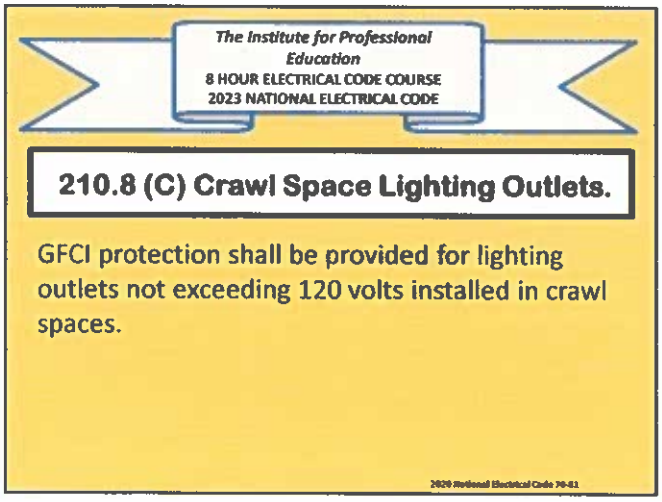

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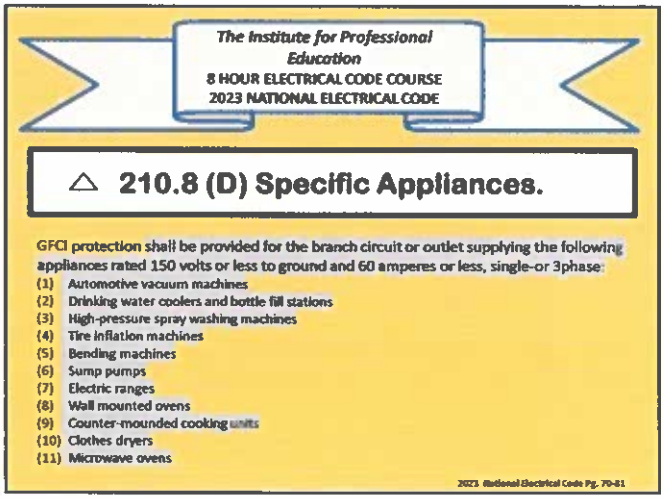

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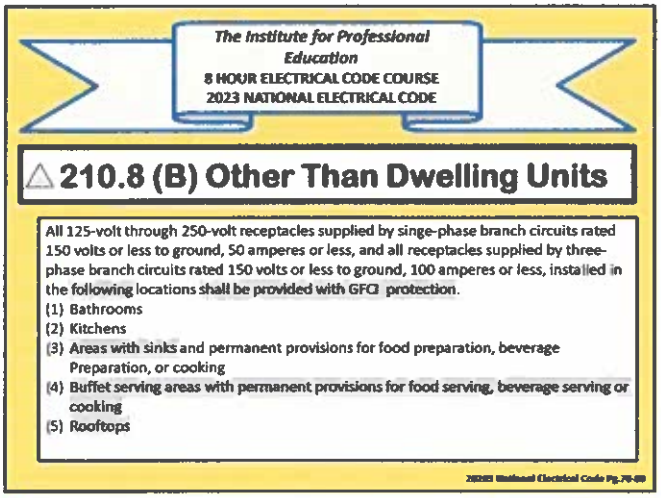

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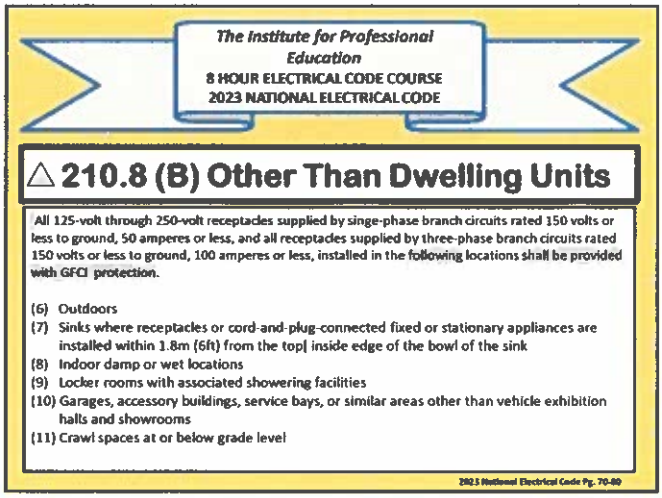

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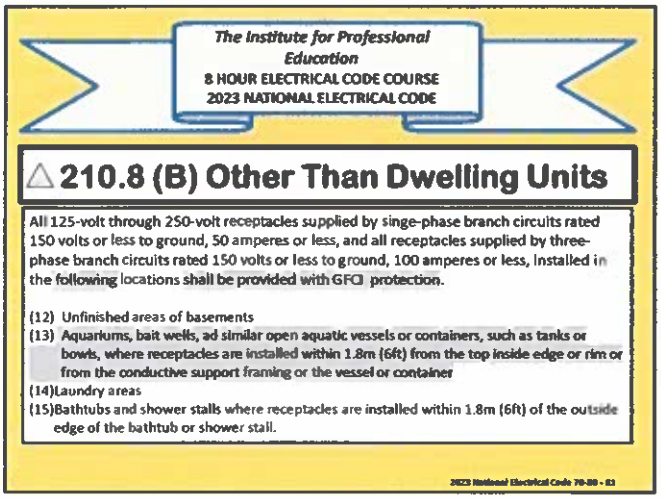

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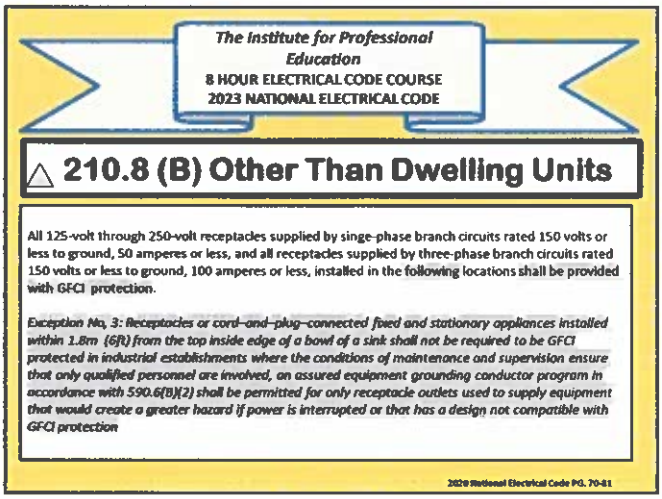

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210.12
Arc-Fault Circuit-Interrupter Protection

Arc-fault circuit-interrupter (AFCI) protection shall be installed in accordance with 210.12(B) through (E) by any of the means described in 210.12 (A)(1) through (A)(6). The AFCI shall be listed and installed in a readily accessible location.

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△ 210.12 (A) Means of Protection

AFCI protection shall be provided by any of the following means:

(1) A listed combination-type AFCI installed to provide protection of the entire branch circuit.
(2) A listed branch/feeder-type AFCI installed at the origin of the branch circuit in combination with a listed outlet branch-circuit type AFCI installed on the branch circuit at the first outlet box, which shall be marked to indicate that it is the first outlet o the branch circuit.

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△ 210.12 (A) Means of Protection

AFCI protection shall be provided by any of the following means:

(3) A listed supplemental arc protection circuit breaker installed at the origin of the branch circuit in combination with a listed branch-circuit-type AFCI installed on the branch circuit at the first outlet box if all of the following conditions are met:
a. The branch-circuit wiring shall be continuous from the branch-circuit overcurrent device to the outlet branch-circuit AFCI.
b. The maximum length of the branch-circuit wiring from the branch-circuit overcurrent device to the first outlet shall not exceed 15.2m (50 ft) for a 14AWG conductor or 21.3m (70ft) for a 12 AWG conductor.
c. The first outlet box shall be marked to indicate that it is the first outlet of the branch circuit.

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△ 210.12 (A) Means of Protection

AFCI protection shall be provided by any of the following means:

(4) A listed outlet branch-circuit-type AFCI installed on the branch circuit at the first outlet in combination with a listed branch-circuit overcurrent protective device if all of the following conditions are met:
a. The branch-circuit wiring shall be continuous from the branch-circuit overcurrent device to the outlet branch-circuit AFCI.
b. The maximum length of the branch-circuit wiring from the branch-circuit overcurrent device to the first outlet shall not exceed 15.2 m (50ft) for a 14AWG conductor or 2.3m (70ft) for a 12 AWG conductor.
c. The first outlet box shall be marked to indicate that it is the first outlet of the branch circuit.
d. The combination of the branch-circuit overcurrent device and outlet branch-circuit AFCI shall be identified as meeting the requirements for a system combination-type AFCI and listed as such.

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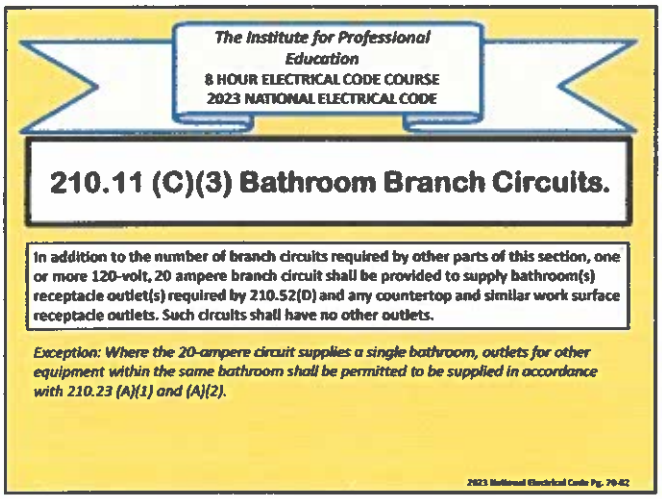

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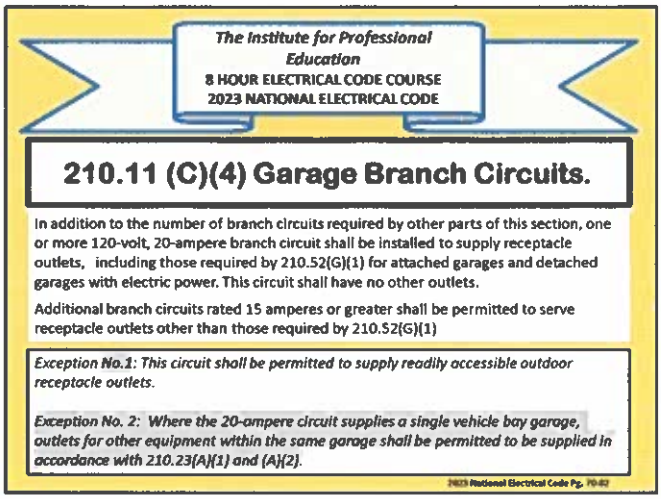

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210.12 (C) Dormitory Units.

All 120-volt, single-phase, 10-,15-, and 20-ampere branch circuits supplying outlets or devices installed in the following locations shall be protected by any of the means described in 219.12 (A)(1) through (A)(6):

(1) Bedrooms
(2) Living rooms
(3) Hallways
(4) Closets
(5) Bathrooms
(6) Similar rooms

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210.12 (D) Other Occupancies.

All 120-volt, single-phase, 10-,15-, and 20-ampere branch circuits supplying outlets or devices installed in the following locations shall be protected by any of the means described in 219.12 (A)(1) through (A)(6):

(1) Guest rooms and guest suites of hotels and motels
(2) Areas used exclusively at patient sleeping rooms in nursing homes and limited-care facilities
(3) Areas designed for use exclusively as sleeping quarters in fire stations, police stations, ambulance stations, rescue stations, ranger stations, and similar locations

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210.12 (E) Branch Circuit Wiring Extensions, Modifications, or Replacements.

If branch-circuit wiring for any of the areas specified in 210.12(B), (C), or (D) is modified, replaced, or extended, the branch circuit shall be protected by one of the following:

(1) By any of the means described in 210.12(A) (1) through (A)(6)
(2) A listed outlet branch0circuit-type AFCU located at the first receptacle outlet of the existing branch circuit.

Exception: AFCI protection shall not be required where the extension of the existing branch-circuit conductors is not more than 1.8 m ((6ft) and does not include any additional outlets or devices, other than splicing devices. This measurement shall not include the conductors inside an enclosure, cabinet, or junction box.

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210.17 Guest Rooms and Guest Suites.

Guest rooms and guest suites in the following occupancies that are provided with permanent provisions for cooking shall have branch circuits installed to meet the rules for dwelling units.

(1) Hotels
(2) Motels
(3) Assisted living facilities

Informational Note No. 1: See 210.11(C)(2) and 210.52(F) Exception No. 2, for information on laundry branch circuits and receptacle outlets.

Informational Note. No. 2: See NFPA 101-2021, *Life Safety Code*, 3.3.198.12(5), for the definition of *assisted living facilities*.

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△ 210.12 (A) Means of Protection

AFCI protection shall be provided by any of the following means:

(5) If metal raceway, metal wireways, metal auxiliary gutters, or Tye MC or Type AC cable meeting the applicable requirements of 250.118, with metal boxes, metal conduit bodies, and metal enclosures are installed for the portion of the branch circuit between the branch-circuit overcurrent device and the first outlet. It shall be permitted to install a listed outlet branch-circuit type AFCI at the first outlet to provide protection for the remaining portion of the branch circuit.

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△ 210.12 (A) Means of Protection

AFCI protection shall be provided by any of the following means:

(6) Where a listed metal or nonmetallic conduit or tubing or Type MC cable is encased in not less than 50mm (2in) of concrete for the portion of the branch circuit between the branch-circuit overcurrent device and the first outlet, it shall be permitted to install a listed outlet branch-circuit –type AFCI at the first outlet to provide protection for the remaining portion of the branch circuit.

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N 210.12 (B) Dwelling Units.

All 120-volt, single-phase, 10-,15-, and 20-ampere branch circuits supplying outlets or devices installed in the following locations shall be protected by any of the means described in 219.12 (A)(1) through (A)(6):

(1) Kitchens
(2) Family rooms
(3) Dining rooms
(4) Living rooms
(5) Parlors
(6) Libraries
(7) Dens
(8) Bedrooms
(9) Sunrooms
(10) Recreation rooms
(11) Closets
(12) Hallways
(13) Laundry areas
(14) Similar areas

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2023 NATIONAL ELECTRICAL CODE

N 210.12 (B) Dwelling Units.

Exception No.1: AFCI protection shall not be required for an individual branch circuit supplying a fire alarm system installed in accordance with 760.41(B) or 760.141(B). The branch circuit shall be installed in a metal raceway, metal auxiliary gutter, steel-armored cable, or Type MC or Tye AC cable meeting the applicable requirements of 250.118, with metal boxes, conduit bodies, and enclosures.

Exception No. 2: AFCI protection shall not be required for the individual branch circuit supplying an outlet for arc welding equipment in a dwelling unit until January 1, 2025

2023 National Electrical Code Pg. 70-82-83

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Table 210.21(B)(3) Receptacle Ratings for Various Size Circuits

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△ 210.23 Permissible Loads, Multiple-Outlet Branch Circuits.

In no case shall the load exceed the branch-circuit ampere rating. A branch circuit supplying two or more outlets or receptacles shall supply only the loads specified according to its size in accordance with 210.23(A) through (E) and as summarized in 210.24

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N 210.23(A) 10-Ampere Branch Circuit

A 10-ampere branch circuit shall comply with the requirements of 210.23 (A)(1) and (A)(2)

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Part 11 Branch Circuit Ratings
210.18 Ratings.

Branch circuits recognized by this article shall be rated in accordance with the maximum permitted ampere rating or setting of the overcurrent device. The rating for other than individual branch circuits shall be 15, 20, 30, 40, and 50 amperes. Where conductors of higher ampacity are used for any reason, the ampere rating or setting of the specified overcurrent device shall determine the circuit rating.

Exception No. 1: Multioutlet branch circuits greater than 50 amperes shall be permitted to supply nonlighting outlet loads in locations where conditions of maintenance and supervision ensure that only qualified persons service the equipment.

Exception No. 2: Branch circuits rated 10 amperes shall not supply receptacle outlets.

2023 National Electrical Code Pg. 70-83

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210.20
Overcurrent Protection

Branch circuit conductors and equipment for circuits not exceeding 1000 volts ac or 1500 volts dc shall be protected by overcurrent protective devices that have a rating or setting that complies with 210.20(A) through (D).

2023 National Electrical Code PG. 70-84

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210.20 (A)
Continuous and Non-continuous Loads

Where a branch circuit supplies continuous loads or any combination of continuous and noncontinuous loads, the rating of the overcurrent device shall not be less than the noncontinuous load plus 125 percent of the continuous load.

Exception: Where the assembly, including the overcurrent devices protecting the branch circuit(s), is listed for operation at 100 percent of its rating, the ampere rating of the overcurrent device shall be permitted to be not less than the sum of the continuous load plus the noncontinuous load.

2023 National Electrical Code Pg. 70-84

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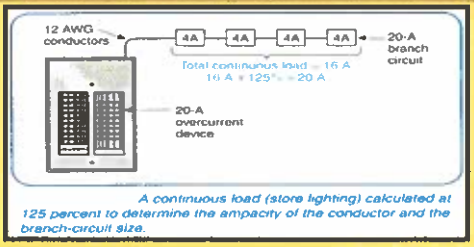
210.20 (A)
Continuous and Non-continuous Loads



A continuous load (store lighting) calculated at 125 percent to determine the ampacity of the conductor and the branch-circuit size.

2023 National Electrical Code Pg. 70-84

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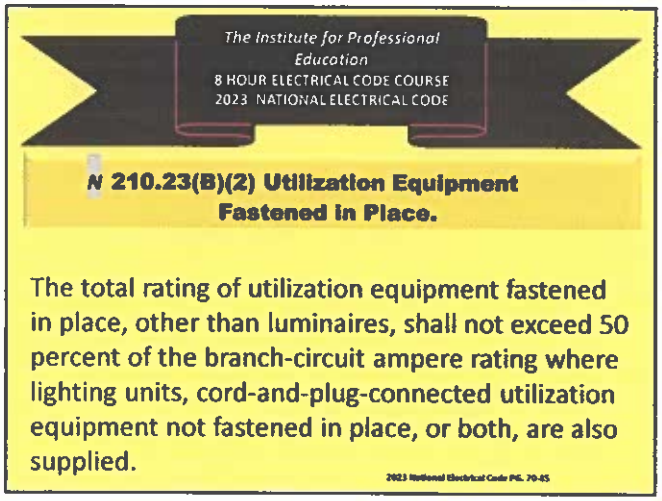

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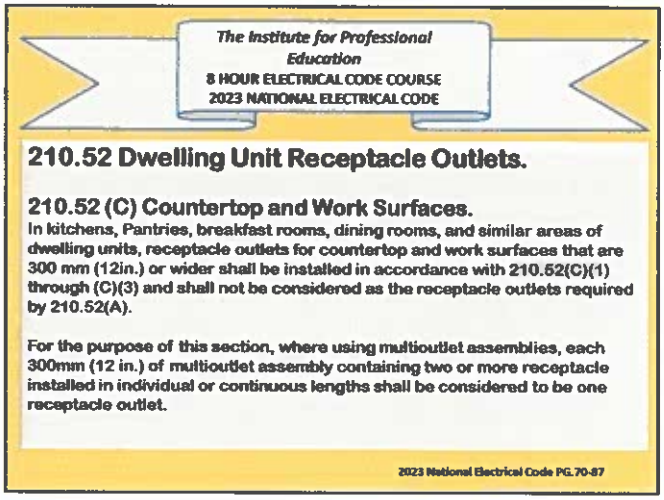

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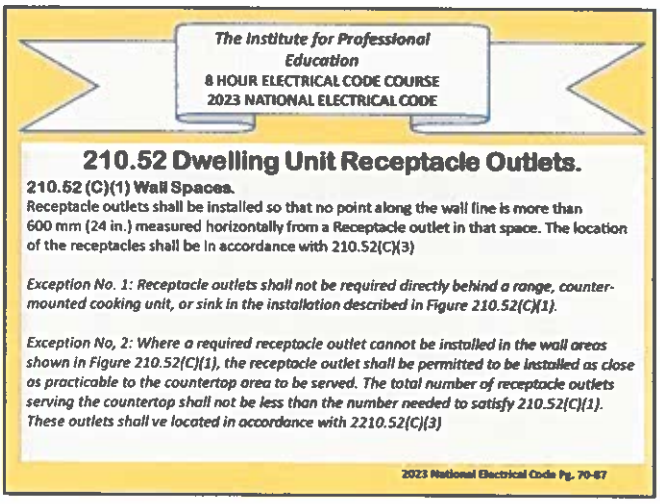

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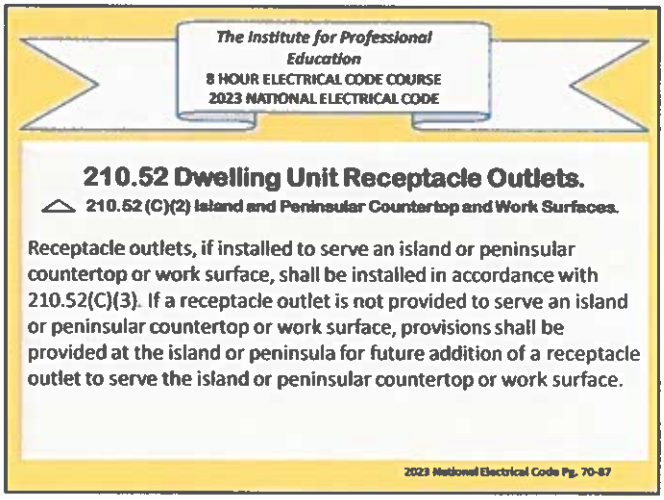

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N 210.23(A)(1) Loads permitted for 10-Ampere Branch Circuits.

A 10-ampere branch circuit shall be permitted to supply one or more of the following:

(1) Lighting loads
(2) Dwelling unit exhaust fans on bathroom or laundry room lighting circuits
(3) A gas fireplace unit supplied by an individual branch circuit

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N 210.23(A)(2) Loads Not Permitted for 10-Ampere Branch Circuits.

A 10-ampere branch circuit shall not supply any of the following:

(1) Receptacle outlets
(2) Fixed appliances, except as permitted for individual branch circuits
(3) Garage door openers
(4) Laundry equipment

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N 210.23(B) 15- and 20-ampere Branch Circuits.

A 15- or 20-ampere branch circuit shall be permitted to supply lighting outlets, lighting units, or other utilization equipment, or any combination of them, and shall comply with 210.23(B)(1) and (B) (2).

Exception: The small-appliance branch circuits, laundry branch circuits, and bathroom branch circuits required in a dwelling unit(s) by 210.11 (C)(1), (C)(2), and (C)(3) shall supply only the receptacle outlets specified in that section.

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N 210.23(B)(1) Cord and Plug-Connected Equipment Not Fastened in Place.

The rating of any one cord-and-plug-connected utilization equipment not fastened in place shall not exceed 80 percent of the branch-circuit ampere rating.

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210.52 Dwelling Unit Receptacle Outlets.
210.52 (D) BATHROOMS

At least one receptacle outlet shall be installed in bathrooms within 900 mm (3 ft) of the outside edge of each sink. The receptacle outlet shall be located on a wall or partition that is adjacent to the sink or sink countertop, located on the countertop, or installed on the side or face of the sink cabinet. In no case shall the receptacle be located more than 300 mm (12 in.) below the sink or sink countertop. Receptacle outlet assemblies listed for use in countertops shall be permitted to be installed in the countertop.

Informational Note: See 406.5(E) and 406.5(G) for requirements for installation of receptacles in countertops.

2023 National Electrical Code PG. 70-88

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210.52 (G) Basements, Garages, and Accessory Buildings .

For one-, Two-and *Three Family* dwellings, and multifamily dwellings, at least one receptacle outlet shall be installed in areas specified in 210.52 (G)(1) through(G)(3). These receptacles shall be in addition to receptacles required for specific equipment. Receptacles supplying only a permanently installed premises security system shall not be considered as meeting these requirements

Note: Ohio Board of Building Standards allows up to three family dwelling to be considered as a residential dwelling unit, covered by: the Residential Code of Ohio (RCO). All structure with more than three dwellings in one building is covered under: The Ohio Building Code (OBC)

2023 National Electrical Code Pg. 70-88

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210.52 (G)(1) Garages.

In each attached garage and in each detached garage with electric power, at least on receptacle outlet shall be installed in each vehicle bay and not more than 1.7m ($5^{1/2}$ft) above the floor.

Exception: Garage spaces not attached to an individual dwelling unit of a multifamily dwelling shall not require a receptacle outlet in each vehicle bay.

2023 National Electrical Code PG. 70-88

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210.52(G)(1) Dwelling Unit Garages

The branch circuit supplying this receptacle(s) shall not supply outlets outside of the garage.

At least one receptacle outlet shall be installed for each car space

2023 National Electrical Code PG. 70-88

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210.52 Dwelling Unit Receptacle Outlets.

210.52 (C)(3) Receptacle Outlet Locations

Receptacle outlets shall be located in one or more of the following:

(1) On or above, but not more than 500mm (20in) above a countertop or work surface
(2) In a countertop using receptacle outlet assemblies listed for us in countertops
(3) In a work surface using a receptacle outlet assemblies listed for use in work surfaces or listed for use in countertops

Receptacle outlets rendered not readily accessible by appliances fastened in place, appliance garages, sinks, or rangetops as covered in 210.52(C)(1), Exception No.1, or appliances occupying assigned spaces shall not be considered as these required outlets.

2023 National Electrical Code Pg. 70-67

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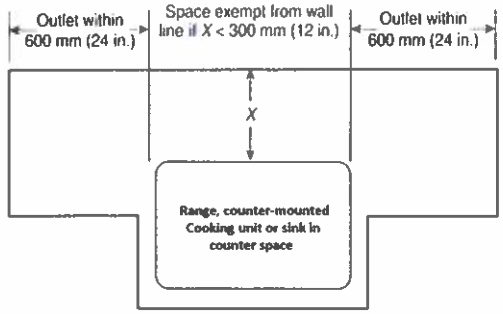
△ FIGURE 210.52 (C)(1)
Determination of Area Behind a Range, Counter-Mounted Cooking Unit or Sink



Range, counter-mounted cooking unit extending from face of counter

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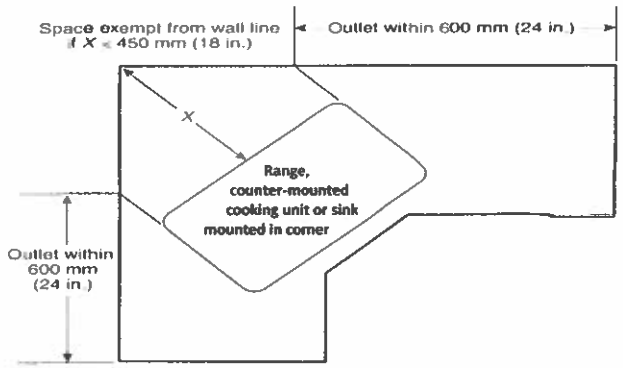
△ FIGURE 210.52 (C)(1)
Determination of Area Behind a Range, Counter-Mounted Cooking Unit or Sink



Range, counter-mounted cooking unit mounted in corner

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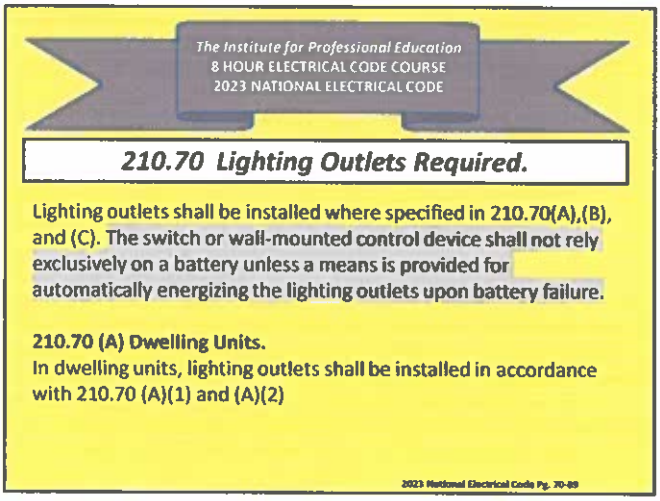

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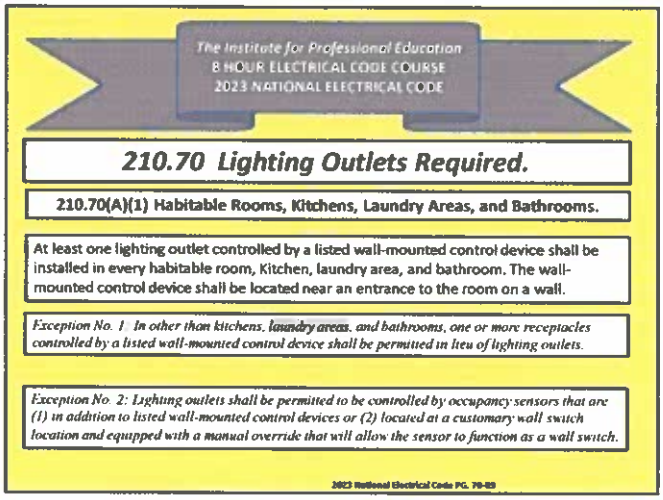

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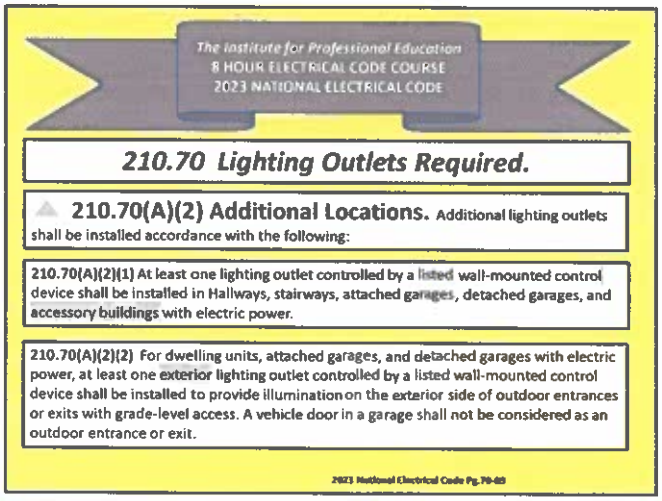

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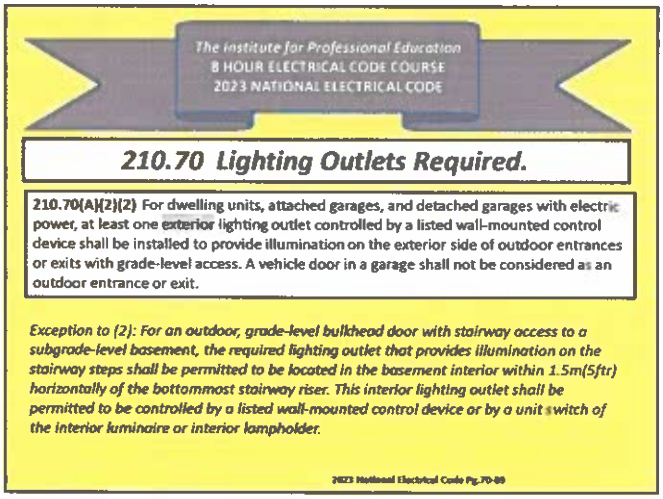

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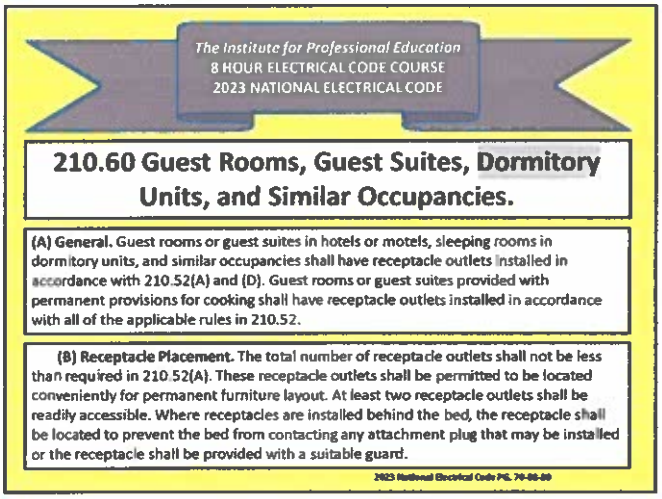

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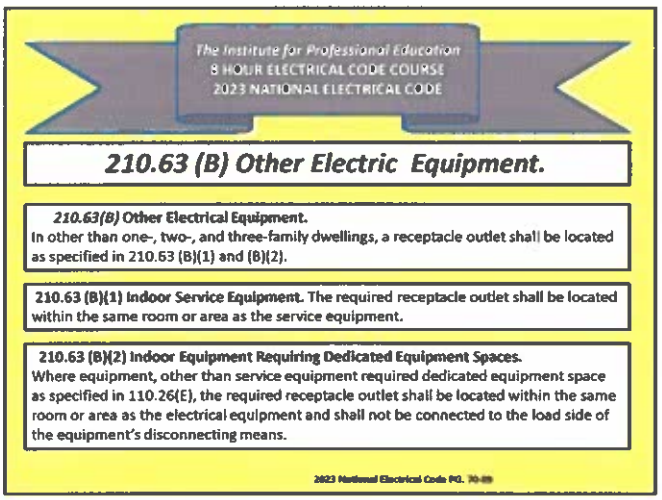

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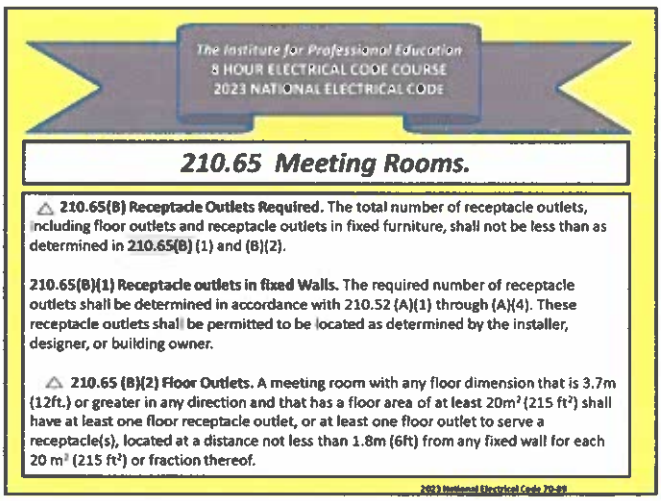

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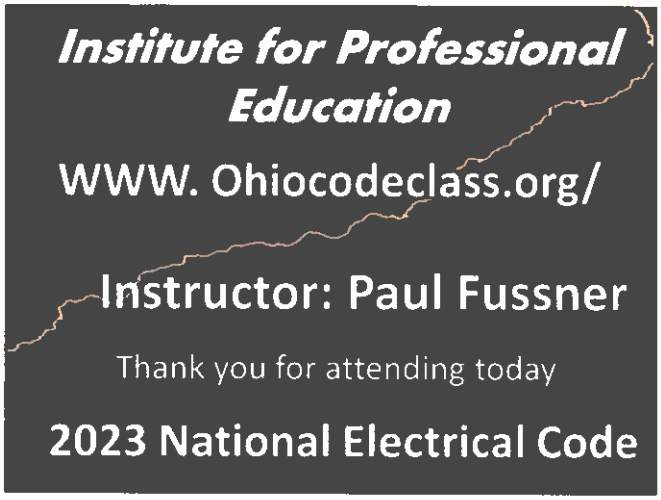
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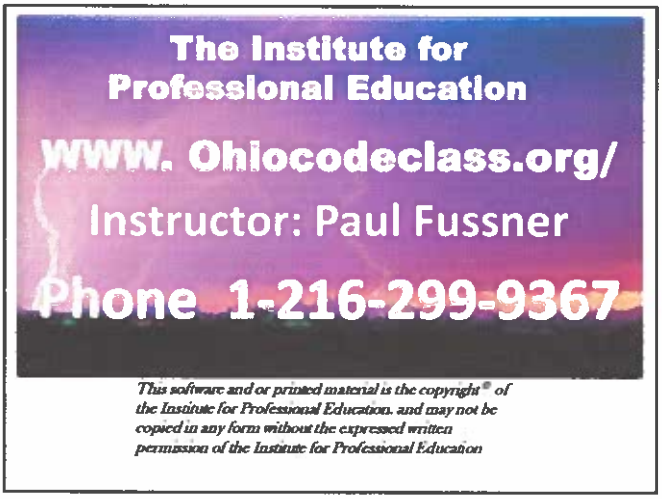
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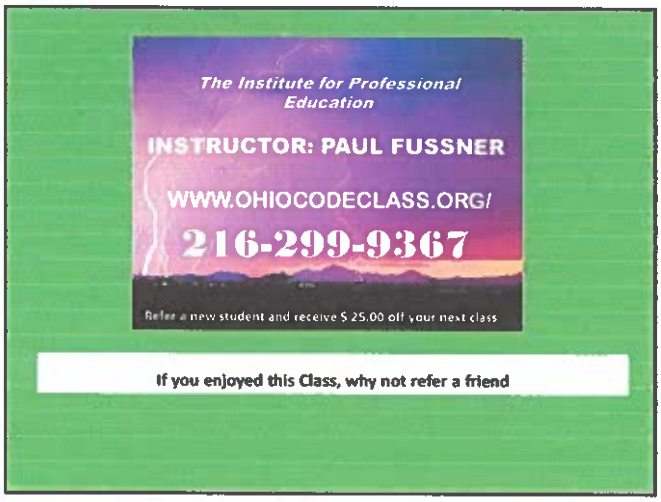
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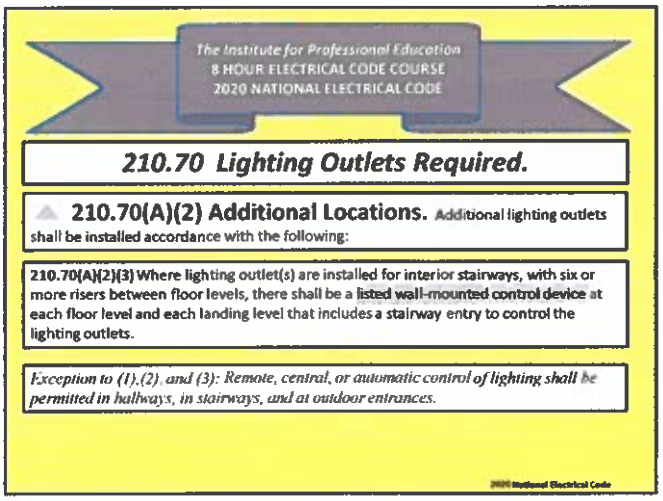

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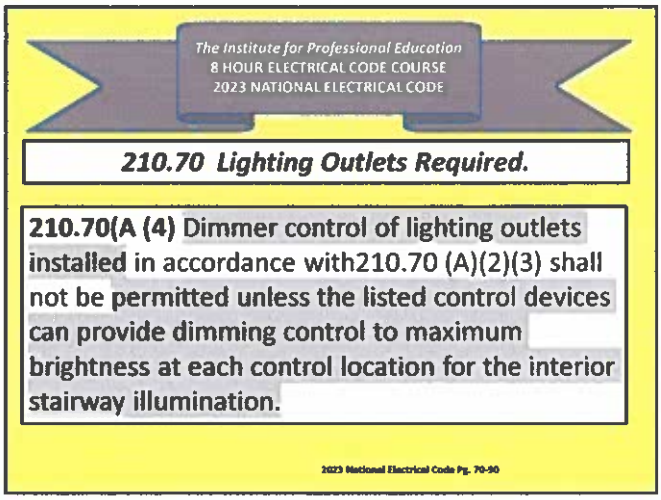

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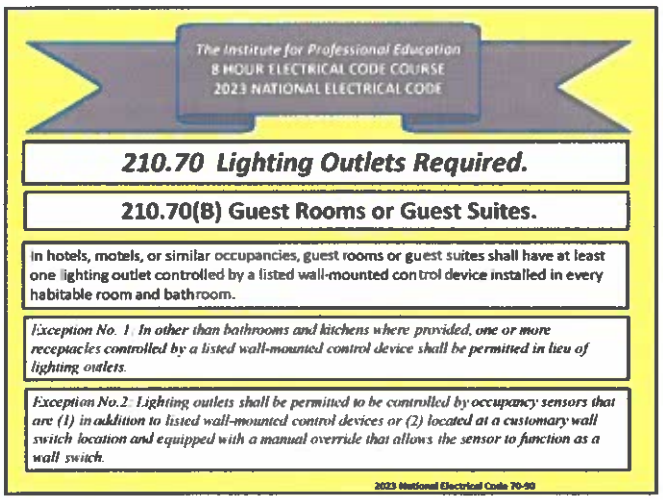

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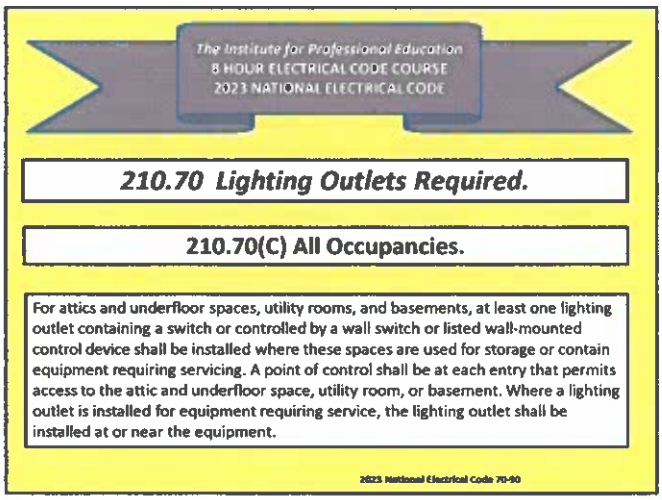

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File Attachments for Item:

ER-6 2023 NEC Articles 90-210 (Institute for Professional Education)

All certifications (8 hours)

Staff Notes:

ESIAC Recommendation:

Committee Recommendation:

Mike DeWine, Governor
Jon Husted, Lt. Governor

Board of Building Standards

Application for Continuing Education Course Approval

Provider Information:

Name: Paul R. Fussner BBS #504

Organization: The Institute for Professional Education

Address: 30508 Ronald Drive, Willowick, Ohio 44095

E-mail: WWW.ohiocodeclass.org/ Telephone: 216-299-9367

Website: WWW.ohiocodeclass.org/

Conference Sponsor (if applicable) Elaine's Educational Services, LLC Conference Email: vfussner1955@gmail.com

Check here if Course Renewal: _____ Prior course number _____ *(i.e. BBS2018-429)*

Renewals will only be granted for identical content and certifications, within the current code cycle. Attach a copy of prior course approval letter for confirmation. No further information is required.

New Course Information:

Course title: 2023 National Electrical Code Articles 90-200

Course instructor: Paul R. Fussner

Course description: 4-Hour PowerPoint Presentation with questions and answers covering the 2023 National Electrical code Articles 90-200 with ten minute break at the top of each hours. This course will be offered in the am or pm depending on the proposed schedule, and will be offered throughout the calendar year either on location live or utilizing Virtual Zoom software sessions .

Instructional hours per session: 4-hours Number of Sessions: one

Course Date(s) and Location: See attached 2024 tentive live and on line Zoom Virtual schedule

Special Content:

Code Administration: ____

Existing Buildings: ____

Electrical Instruction: X

Plumbing Instruction: ____

Conference Course: Course will be offered live and on Zoom

Conference Name: 4-Hour Power Point Presentation NEC Articles 90-200

Conference location: To Be determined throughout the calendar year

Course to be offered online? Yes **On Demand** ____ **Webinar** Virtual Live on line Zoom Sessions

Course Website: WWW.ohiocodeclass.org/

Detail online course participation confirmation method *(i.e. test, quizlets, participant activity confirmation)*:

Each student must show BBS Certificate and Valid Photo ID

Course applicable for the following certifications

Residential Certifications Only: ____ Commercial Certifications: ____

Administrative Course, All Certifications: X

Application materials included:

X Course Outline or Course Learning Objectives

X Presentation Materials/Slides (not required for roundtable courses)

____ Assessment Materials (for online courses)

X Presenter Bio

Please submit application and materials in .pdf format to: michael.lane@com.ohio.gov or BBS@com.ohio.gov

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INSTRUCTOR QUALIFICATIONS:

- State Certified Electrical Safety Inspector #504
- State Certified Building Inspector #504
- Building Official #504
- Residential Building Official #504
- Board of Building Standards Instructor, Electrical Safety Inspector Re-certification, established in 1999.
- OCILB Instructor, state-licensed, electrical, plumbing, HVAC, and Hydronics contractors continuing education courses, established in 1999.

50 years of experience in the building and electrical trades, as Founder and President of the Gibson Robert Company, Inc. I expedited all new work including researching and ordering the proper electrical equipment required for a safe, efficient installation, while meeting the requirements of The NFPA 70 Electrical Code, The B.O.C.A. Code, and The Ohio Building Code.

29 years of experience as a State Certified Electrical Safety Inspector, 24 years experience as a State Certified Building Inspector with 12 years of departmental management experience.

14 years as Building Official #504

Former Chairman, Western Reserve Chapter International Association of Electrical Inspectors. Two years as Education Chairman, Western Reserve Chapter of the IAEI.

Owner of The Institute for Professional Education, a State of Ohio Training Agency for the Mandatory Continuing Education Credits for Electrical Safety Inspectors and State Licensed Electrical Contractors. Accredited by the Ohio Board of Building Standards and the Ohio Construction industry licensing board. established 1999.

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Paul Robert Fussner, dba

THE INSTITUTE FOR PROFESSIONAL EDUCATION

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pfussner.@paulfussner.onmicrosoft.com

November 21, 2023

Ohio Board of Building Standards
6606 Tussing Rd
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REGARDING: Course Syllabus Electrical Contractor. 4-Hour Study of 2023 National Electrical Code Changes PowerPoint Presentation covering Articles 90-200

In-person student classes utilize the normal sign-in method of showing a picture ID and BBS ID card before signing the BBS registration sheet, sign-in begins 30 minutes before the session start time.

Computer sign-in and registration(s) begin 30 minutes before the session, utilizing the Zoom login link assigned to each student who has pre-registered by mail or online. Students may log-in with a computer, tablet, or smart phone.

Sessions are timed as shown below, (please note the session(s) may be scheduled for 8:00 am or 1:00 pm Start times

8:00 am or 1:00 pm	Beginning of PowerPoint presentation and review of: Articles 90 through 200 of the 2023 National Electrical Code
8:50 am or 1:50 pm	Ten-minute break. 50 minutes per hour of study of the PowerPoint presentation.
9:50 am or 2:50 pm	Ten-minute break. 50 minutes per hour of study of the PowerPoint presentation.
10:50 am or 3:50 pm	Ten-minute break. 50 minutes per hour of study of the PowerPoint presentation.
12:00 pm or 5:00 pm	Students Dismissed

Note: 4-hour online sessions may be given in the morning or afternoon according to the schedule to be established in November 2023 for the 2024 calendar year.

2024 IN-PERSON and ONLINE ZOOM SESSION(S) SCHEDULE for all OCILB. Contractors and BBS Certifications

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January 13	**8-Hr Online Virtual Zoom Session** 2023 NEC Article 250 Understanding Grounding and Bonding	**Course # 3750064**
February 17	**4-hr Online Virtual Zoom Session** 7:45 am-12:00 pm 2023 NEC Articles 90-200	**Course # 3750066**
	4-Hr Online Virtual Zoom Session 1:00 pm - 5:00 pm 2023 NEC Articles 230-242	**Course # 3750060**
	2-Hr Online Virtual Zoom Session 5:00 pm - 7:00 pm 2019 RCO Chapter 113 Existing	**Course # 3750061**
March 23	**8-Hr Online Virtual Zoom Session** 2023 National Electrical Code Article's 230 – 314	**Course # 3750062**
April 27	**4-Hr Online Virtual Zoom Session** 7:45 am-12:00 pm 2023 NEC Articles 90-200	**Course # 3750066**
	4-Hr Online Virtual Zoom Session 1:00 pm - 5:00 pm 2023 NEC Articles 230-242	**Course # 3750060**
	2-Hr Online Virtual Zoom Session 5:00 pm - 7:00 pm 2019 RCO Chapter 3401.1(2)(1)	**Course # 3750065**
May 18	**8-Hr Online Virtual Zoom Session** 2023 National Electrical Code Article's 90 – 210	**Course # 3750063**
June 17	**8-Hr Live in-person session** 2023 NEC Article 250 Understanding Grounding and Bonding	**Course # 3750064**
	Location: Grace Church 36300 Ridge Rd, Willoughby, Ohio 44094 **Rear Lower Level Entrance**	
July 27	**8-Hr Online Virtual Zoom Session** 2023 National Electrical Code Article's 230 – 314	**Course # 3750062**
August 14	**4-Hr Weekday Virtual Zoom Session** 7:45 am-12:00 pm 2023 NEC Articles 90-200	**Course # 3750066**
August 21	**4-Hr Weekday Virtual Zoom Session** 7:45 am-12:00 pm 2023 NEC Articles 230-242	**Course # 3750060**
September 7	**4-Hr Live in Person Session** 7:45 am-12:00 pm 2023 NEC Articles 90-200	**Course # 3750066**
	4-Hr Live in Person Session 1:00 pm - 5:00 pm 2023 NEC Articles 230-242	**Course # 3750060**
	2-Hr Live in Person Session 5:00 pm - 7:00 pm 2019 RCO Chapter 113 Existing	**Course # 3750061**
	Location: Cretan Party Center 13853 W. 168th Street & Lorain Rd, Cleveland, Ohio 44111	
October 19	**4-Hr Live in Person Session** 7:45 am-12:00 pm 2023 NEC Articles 90-200	**Course # 3750066**
	4-Hr Live in Person Session 1:00 pm - 5:00 pm 2023 NEC Articles 230-242	**Course # 3750060**
	2-Hr Live in Person Session 5:00 pm - 7:00 pm 2019 RCO Chapter 3401.1(2)(1)	**Course # 3750065**
	Location: Huntsburg Civic Center 12396 Madison Rd. (Rt,528 & 322) Middlefield, Ohio 44062 Use the rear entrance	
November 16	**8-Hr Online Virtual Zoom Session** 2023 National Electrical Code Article 250 Grounding and Bonding	**Course # 3750064**
December 7	**4-Hr Live in Person Session** 7:45 am-12:00 pm 2023 NEC Articles 90-200	**Course # 3750066**
	4-Hr Live in Person Session 1:00 pm - 5:00 pm 2023 NEC Articles 230-242	**Course # 3750060**
	2-Hr Live in Person Session 5:00 pm - 7:00 pm 2019 RCO Chapter 113 Existing	**Course # 3750061**

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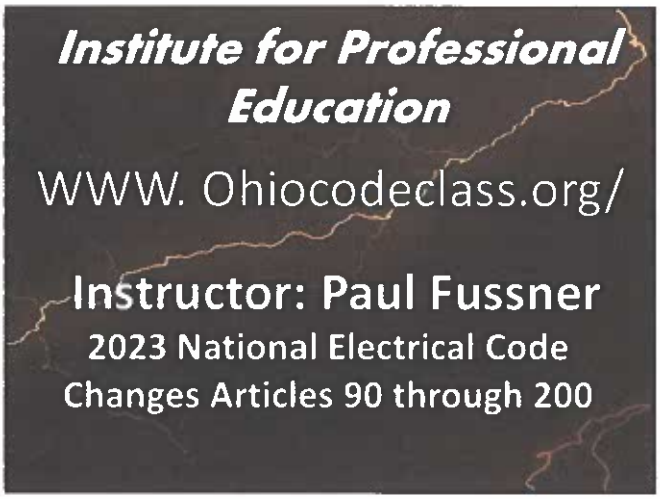
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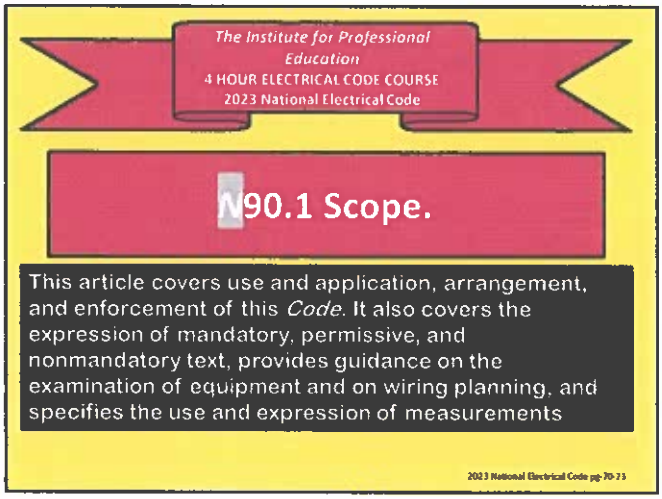
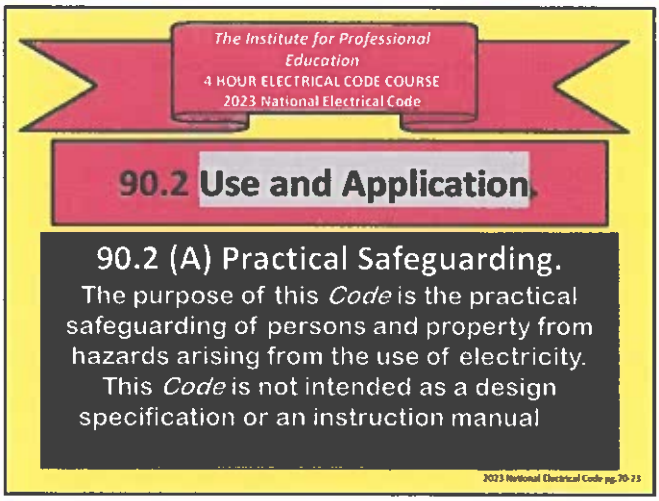
WWW. Ohiocodeclass.org/
Instructor: Paul Fussner
2023 National Electrical Code
Changes Articles 90 through 200

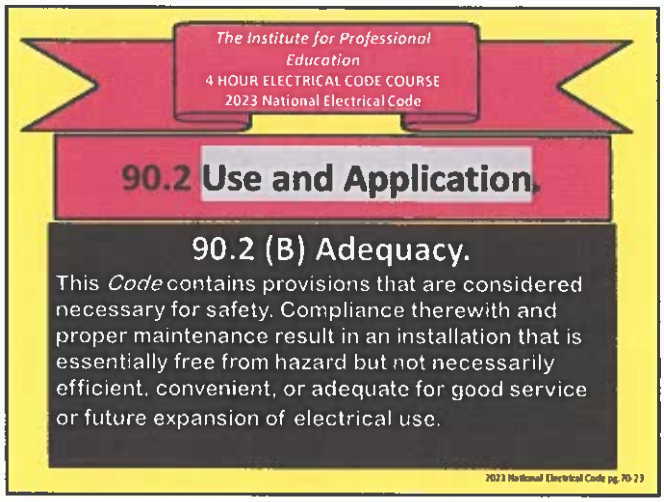
1


The Institute for Professional Education
4 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code
90.1 Scope.
This article covers use and application, arrangement, and enforcement of this Code. It also covers the expression of mandatory, permissive, and nonmandatory text, provides guidance on the examination of equipment and on wiring planning, and specifies the use and expression of measurements
2023 National Electrical Code pg 70-23

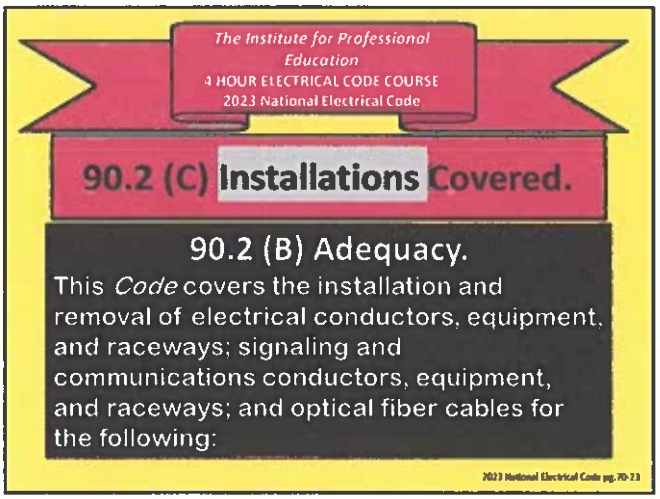
2


The Institute for Professional Education
4 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code
90.2 Use and Application.
90.2 (A) Practical Safeguarding.
The purpose of this Code is the practical safeguarding of persons and property from hazards arising from the use of electricity. This Code is not intended as a design specification or an instruction manual
2023 National Electrical Code pg. 70-23

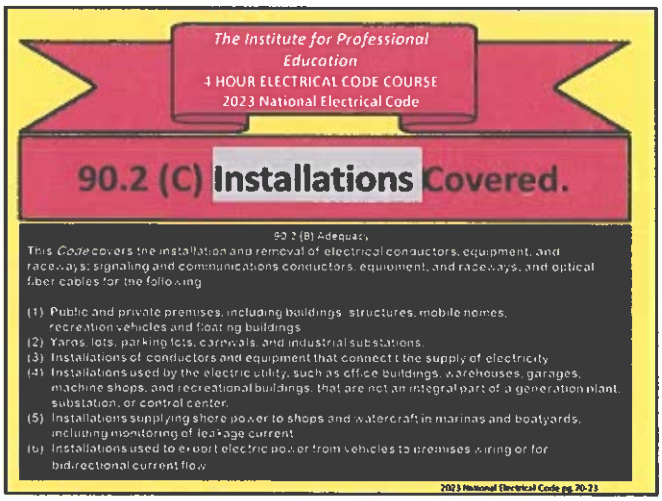
3


The Institute for Professional Education
4 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code
90.2 Use and Application.
90.2 (B) Adequacy.
This Code contains provisions that are considered necessary for safety. Compliance therewith and proper maintenance result in an installation that is essentially free from hazard but not necessarily efficient, convenient, or adequate for good service or future expansion of electrical use.
2023 National Electrical Code pg. 70-23

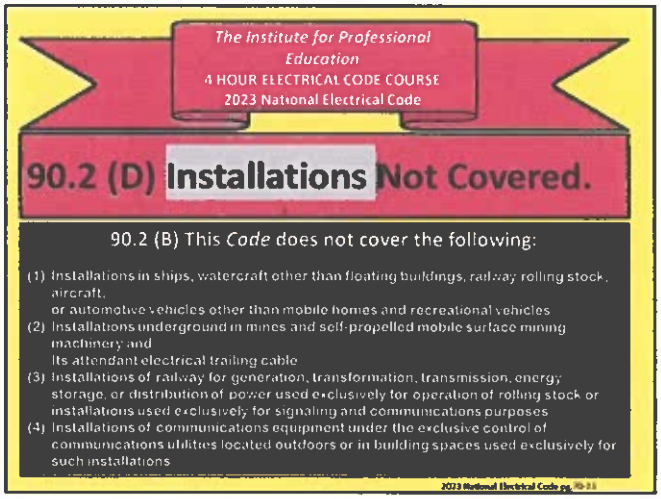
4


The Institute for Professional Education
4 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code
90.2 (C) Installations Covered.
90.2 (B) Adequacy.
This Code covers the installation and removal of electrical conductors, equipment, and raceways; signaling and communications conductors, equipment, and raceways; and optical fiber cables for the following:
2023 National Electrical Code pg. 70-23

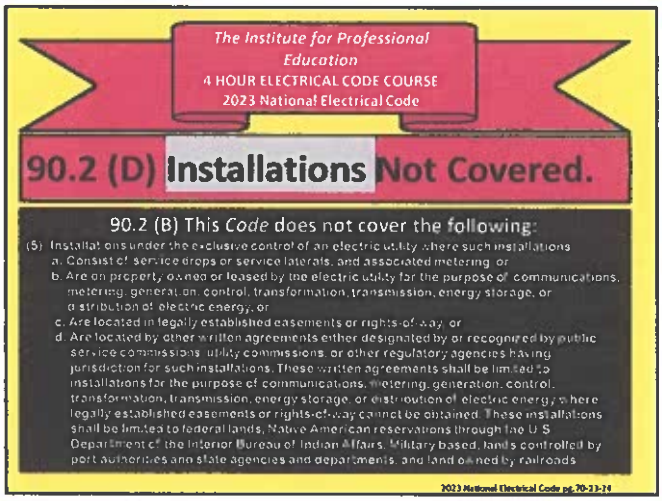
5


The Institute for Professional Education
4 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code
90.2 (C) Installations Covered.
90.2 (B) Adequacy.
This Code covers the installation and removal of electrical conductors, equipment, and raceways; signaling and communications conductors, equipment, and raceways; and optical fiber cables for the following
(1) Public and private premises, including buildings, structures, mobile homes, recreation vehicles and floating buildings
(2) Yards, lots, parking lots, carnivals, and industrial substations
(3) Installations of conductors and equipment that connect the supply of electricity
(4) Installations used by the electric utility, such as office buildings, warehouses, garages, machine shops, and recreational buildings, that are not an integral part of a generation plant, substation, or control center
(5) Installations supplying shore power to ships and watercraft in marinas and boatyards, including monitoring of leakage current
(6) Installations used to export electric power from vehicles to premises wiring or for bidirectional current flow
2023 National Electrical Code pg. 70-23

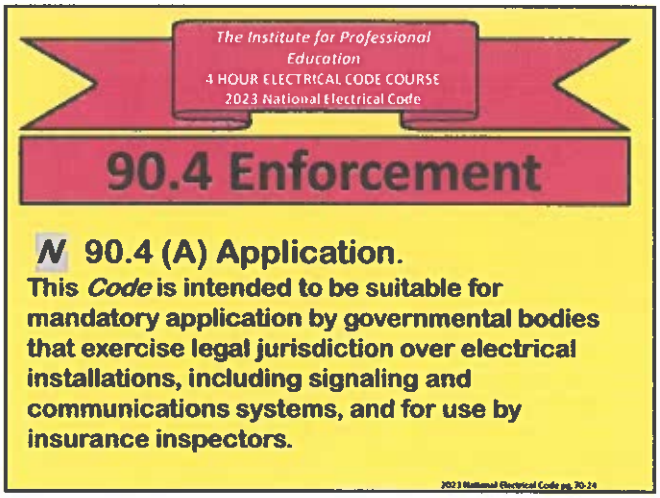
6


The Institute for Professional Education
4 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code
90.2 (D) Installations Not Covered.
90.2 (B) This Code does not cover the following:
(1) Installations in ships, watercraft other than floating buildings, railway rolling stock, aircraft, or automotive vehicles other than mobile homes and recreational vehicles
(2) Installations underground in mines and self-propelled mobile surface mining machinery and its attendant electrical trailing cable
(3) Installations of railway for generation, transformation, transmission, energy storage, or distribution of power used exclusively for operation of rolling stock or installations used exclusively for signaling and communications purposes
(4) Installations of communications equipment under the exclusive control of communications utilities located outdoors or in building spaces used exclusively for such installations

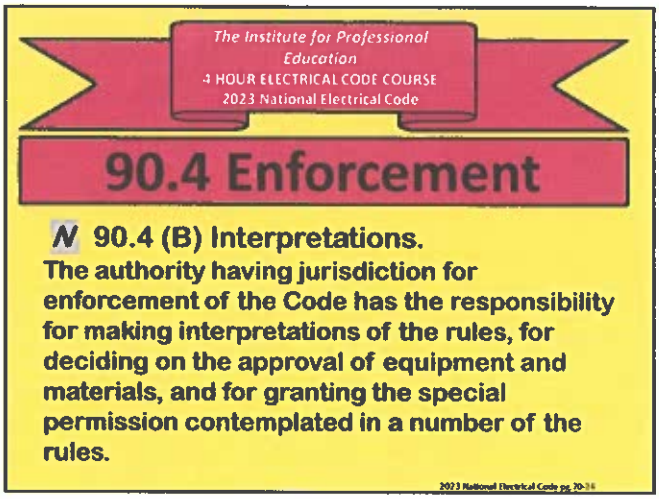
7


The Institute for Professional Education
4 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code
90.2 (D) Installations Not Covered.
90.2 (B) This Code does not cover the following:
(5) Installations under the exclusive control of an electric utility where such installations
a. Consist of service drops or service laterals, and associated metering, or
b. Are on property owned or leased by the electric utility for the purpose of communications, metering, generation, control, transformation, transmission, energy storage, or distribution of electric energy, or
c. Are located in legally established easements or rights-of-way, or
d. Are located by other written agreements either designated by or recognized by public service commissions, utility commissions, or other regulatory agencies having jurisdiction for such installations. These written agreements shall be limited to installations for the purpose of communications, metering, generation, control, transformation, transmission, energy storage, or distribution of electric energy, where legally established easements or rights-of-way cannot be obtained. These installations shall be limited to federal lands, Native American reservations through the U.S. Department of the Interior Bureau of Indian Affairs, Military based, lands controlled by port authorities and state agencies and departments, and land owned by railroads
2023 National Electrical Code pg. 70-23-24

8


The Institute for Professional Education
4 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code
90.4 Enforcement
N 90.4 (A) Application.
This Code is intended to be suitable for mandatory application by governmental bodies that exercise legal jurisdiction over electrical installations, including signaling and communications systems, and for use by insurance inspectors.

9


The Institute for Professional Education
4 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code
90.4 Enforcement
N 90.4 (B) Interpretations.
The authority having jurisdiction for enforcement of the Code has the responsibility for making interpretations of the rules, for deciding on the approval of equipment and materials, and for granting the special permission contemplated in a number of the rules.

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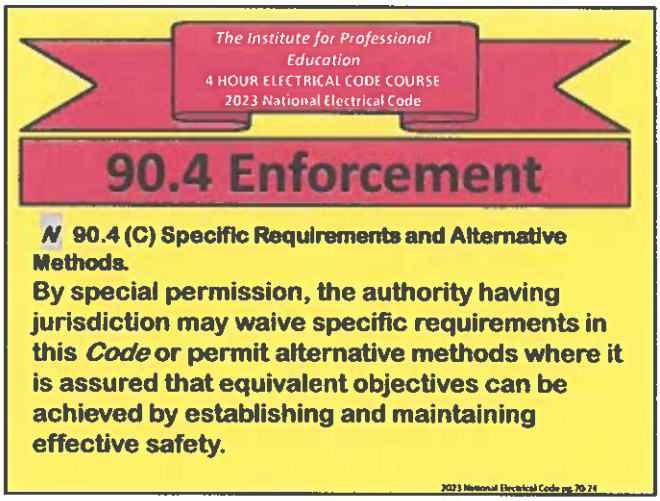
The Institute for Professional Education
4 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code
90.4 Enforcement
N 90.4 (C) Specific Requirements and Alternative Methods.
By special permission, the authority having jurisdiction may waive specific requirements in this Code or permit alternative methods where it is assured that equivalent objectives can be achieved by establishing and maintaining effective safety.

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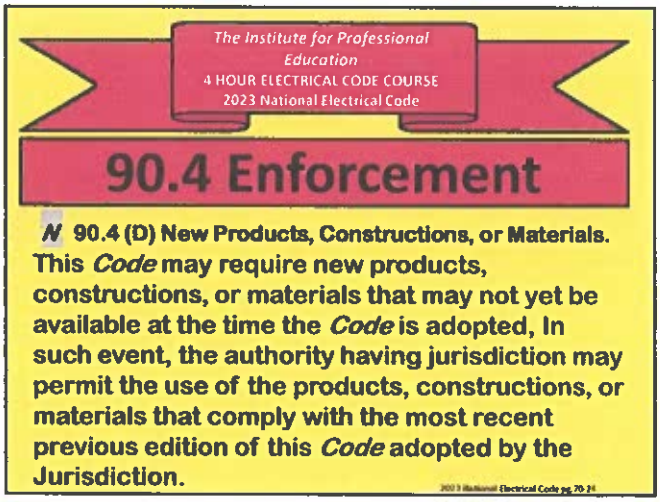
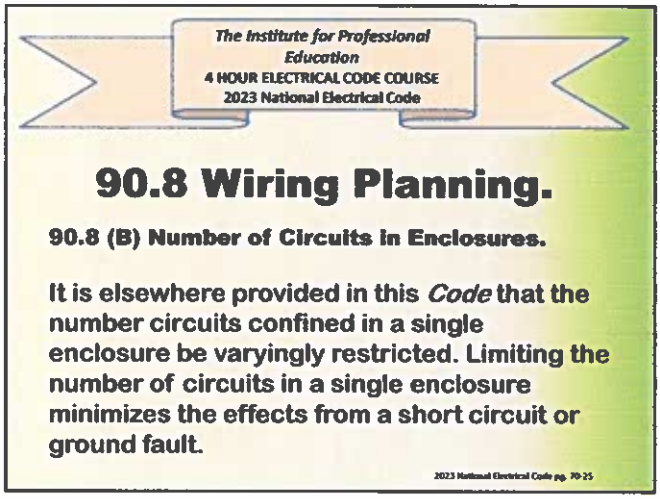

The Institute for Professional Education
4 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code
90.4 Enforcement
N 90.4 (D) New Products, Constructions, or Materials.
This Code may require new products, constructions, or materials that may not yet be available at the time the Code is adopted. In such event, the authority having jurisdiction may permit the use of the products, constructions, or materials that comply with the most recent previous edition of this Code adopted by the Jurisdiction.

12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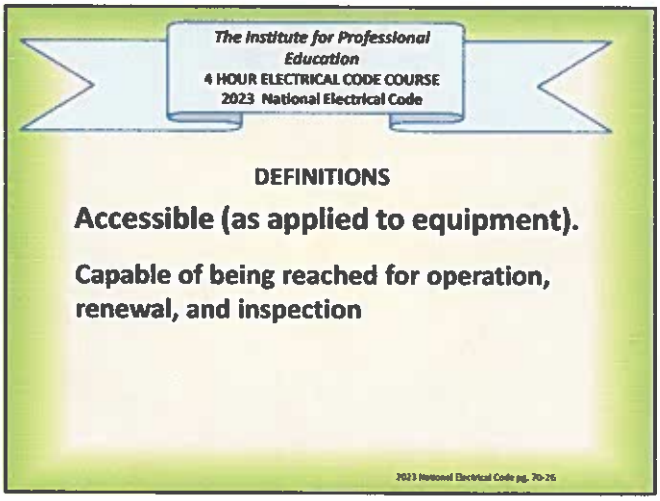
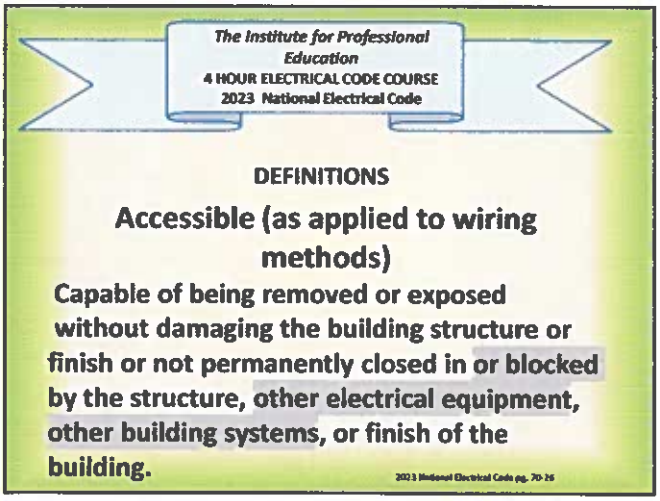
4 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code
90.8 Wiring Planning.
90.8 (B) Number of Circuits in Enclosures.
It is elsewhere provided in this Code that the number circuits confined in a single enclosure be varyingly restricted. Limiting the number of circuits in a single enclosure minimizes the effects from a short circuit or ground fault.
2023 National Electrical Code pg. 70-25

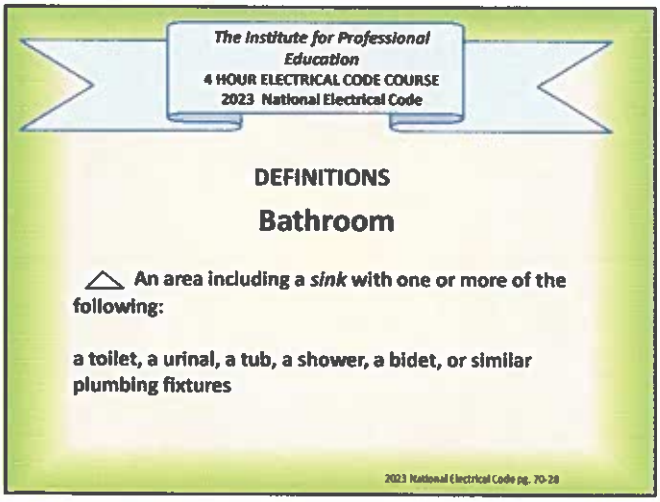
13


The Institute for Professional Education
4 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code
DEFINITIONS
Accessible (as applied to equipment).
Capable of being reached for operation, renewal, and inspection
2023 National Electrical Code pg. 70-26

14


The Institute for Professional Education
4 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code
DEFINITIONS
Accessible (as applied to wiring methods)
Capable of being removed or exposed without damaging the building structure or finish or not permanently closed in or blocked by the structure, other electrical equipment, other building systems, or finish of the building.
2023 National Electrical Code pg. 70-26

15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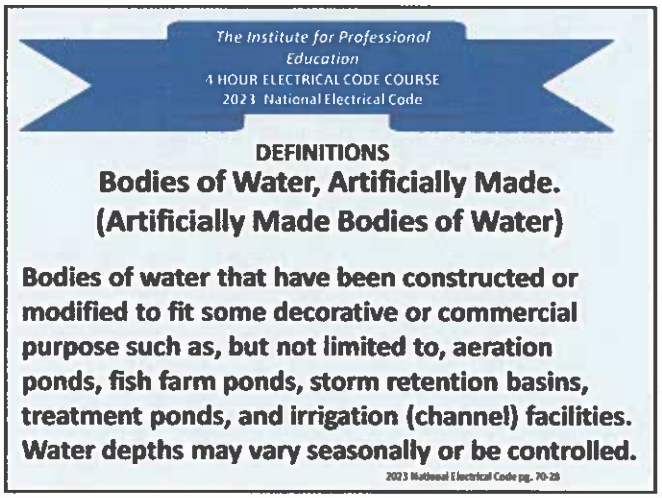
2023 National Electrical Code
DEFINITIONS
Bathroom
An area including a sink with one or more of the following:
a toilet, a urinal, a tub, a shower, a bidet, or similar plumbing fixtures
2023 National Electrical Code pg. 70-28

16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2023 National Electrical Code
DEFINITIONS
Bodies of Water, Artificially Made.
(Artificially Made Bodies of Water)
Bodies of water that have been constructed or modified to fit some decorative or commercial purpose such as, but not limited to, aeration ponds, fish farm ponds, storm retention basins, treatment ponds, and irrigation (channel) facilities. Water depths may vary seasonally or be controlled.
2023 National Electrical Code pg. 70-28

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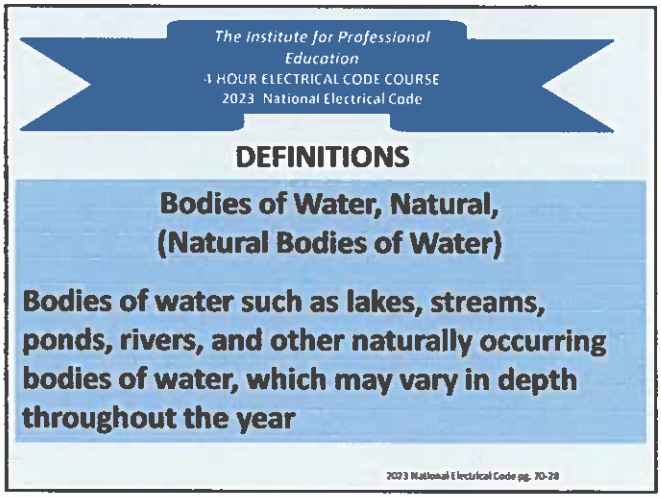
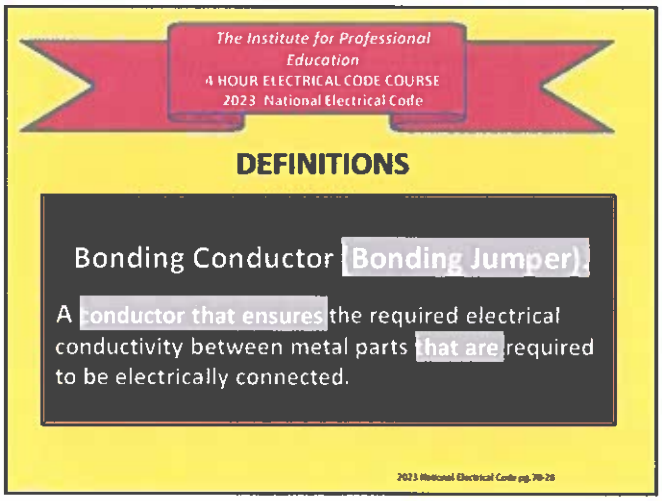
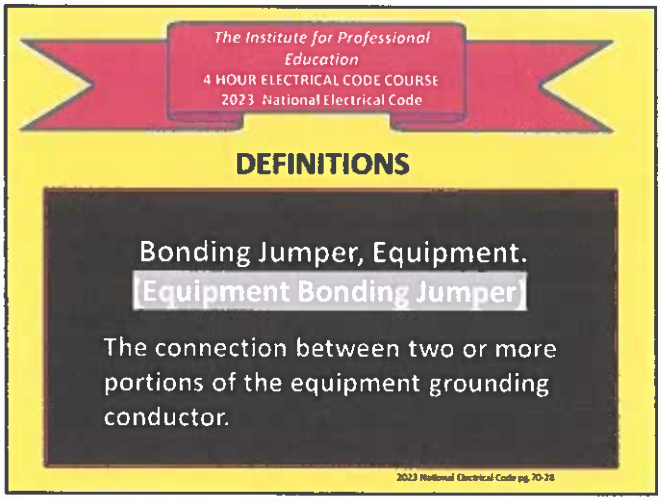

The Institute for Professional Education
4 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code
DEFINITIONS
Bodies of Water, Natural,
(Natural Bodies of Water)
Bodies of water such as lakes, streams, ponds, rivers, and other naturally occurring bodies of water, which may vary in depth throughout the year
2023 National Electrical Code pg. 70-28

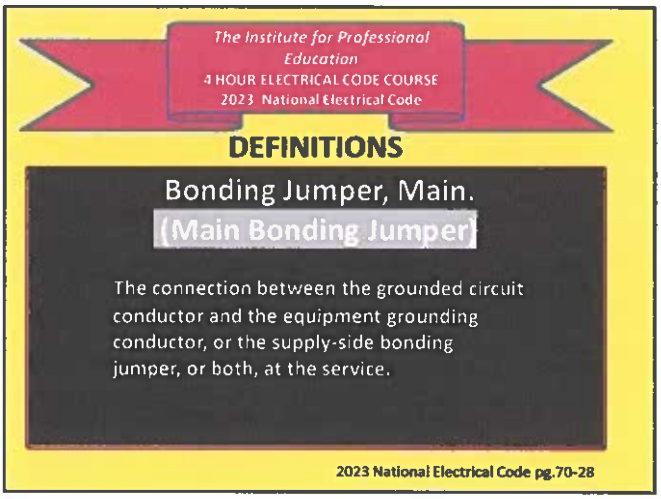
18


The Institute for Professional Education
4 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code
DEFINITIONS
Bonding Conductor (Bonding Jumper).
A conductor that ensures the required electrical conductivity between metal parts that are required to be electrically connected.
2023 National Electrical Code pg. 70-28

19


The Institute for Professional Education
4 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code
DEFINITIONS
Bonding Jumper, Equipment.
(Equipment Bonding Jumper)
The connection between two or more portions of the equipment grounding conductor.
2023 National Electrical Code pg. 70-28

20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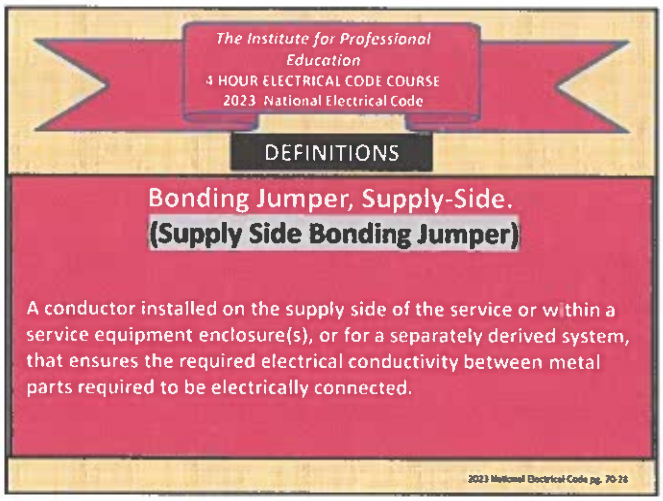
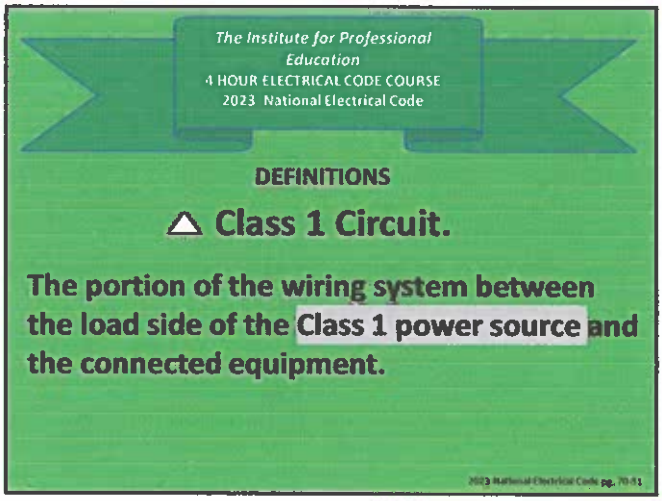
4 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code
DEFINITIONS
Bonding Jumper, Main.
(Main Bonding Jumper)
The connection between the grounded circuit conductor and the equipment grounding conductor, or the supply-side bonding jumper, or both, at the service.
2023 National Electrical Code pg.70-28

21


The Institute for Professional Education
4 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code
DEFINITIONS
Bonding Jumper, Supply-Side.
(Supply Side Bonding Jumper)
A conductor installed on the supply side of the service or within a service equipment enclosure(s), or for a separately derived system, that ensures the required electrical conductivity between metal parts required to be electrically connected.

22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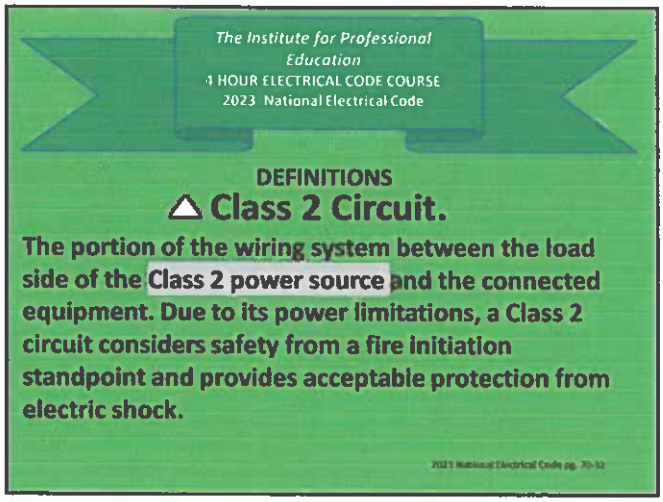
2023 National Electrical Code
DEFINITIONS
Class 1 Circuit.
The portion of the wiring system between the load side of the Class 1 power source and the connected equipment.

23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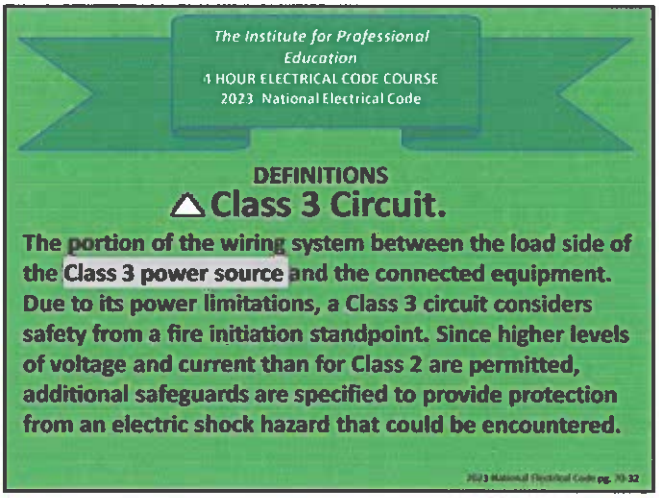
2023 National Electrical Code
DEFINITIONS
Class 2 Circuit.
The portion of the wiring system between the load side of the Class 2 power source and the connected equipment. Due to its power limitations, a Class 2 circuit considers safety from a fire initiation standpoint and provides acceptable protection from electric shock.

24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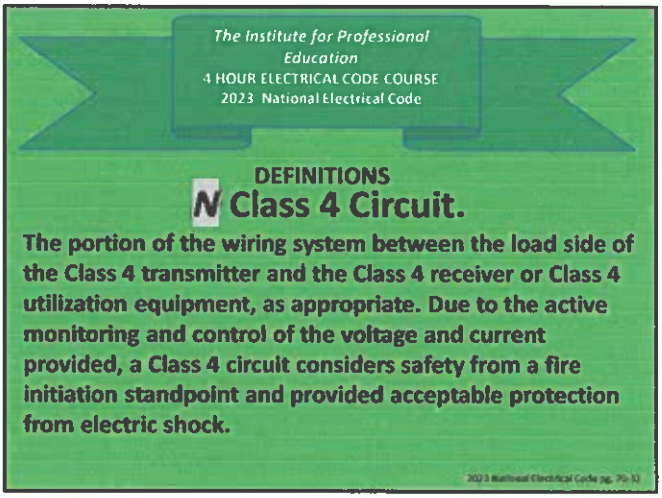
2023 National Electrical Code
DEFINITIONS
Class 3 Circuit.
The portion of the wiring system between the load side of the Class 3 power source and the connected equipment. Due to its power limitations, a Class 3 circuit considers safety from a fire initiation standpoint. Since higher levels of voltage and current than for Class 2 are permitted, additional safeguards are specified to provide protection from an electric shock hazard that could be encountered.

25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2023 National Electrical Code
DEFINITIONS
N Class 4 Circuit.
The portion of the wiring system between the load side of the Class 4 transmitter and the Class 4 receiver or Class 4 utilization equipment, as appropriate. Due to the active monitoring and control of the voltage and current provided, a Class 4 circuit considers safety from a fire initiation standpoint and provided acceptable protection from electric shock.

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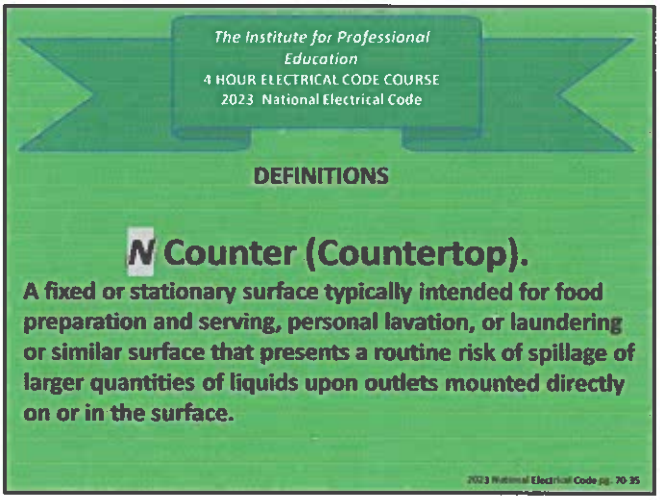
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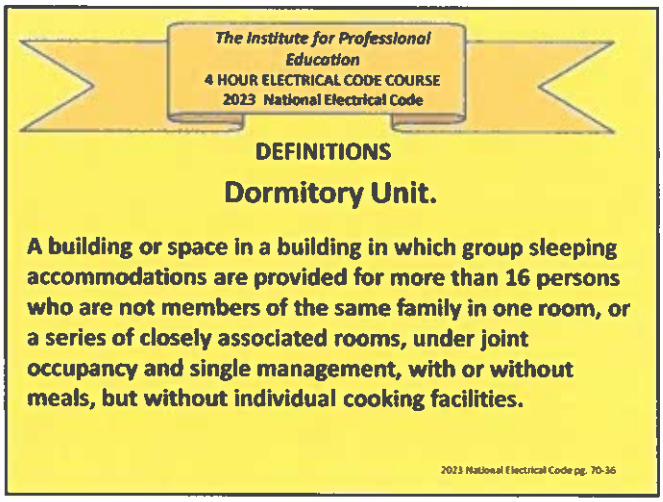
2023 National Electrical Code
DEFINITIONS
N Counter (Countertop).
A fixed or stationary surface typically intended for food preparation and serving, personal lavation, or laundering or similar surface that presents a routine risk of spillage of larger quantities of liquids upon outlets mounted directly on or in the surface.

27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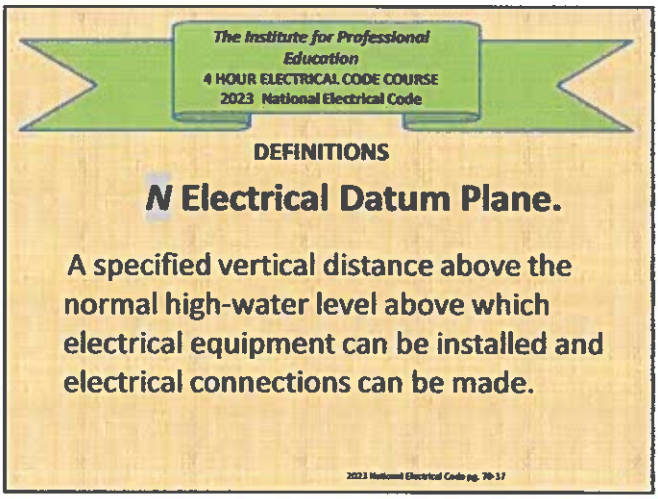
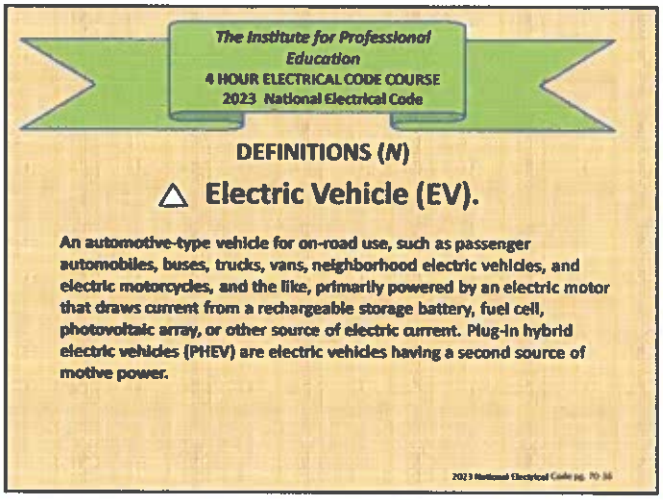
2023 National Electrical Code
DEFINITIONS
Dormitory Unit.
A building or space in a building in which group sleeping accommodations are provided for more than 16 persons who are not members of the same family in one room, or a series of closely associated rooms, under joint occupancy and single management, with or without meals, but without individual cooking facilities.
2023 National Electrical Code pg. 70-36

28


The Institute for Professional Education
4 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code
DEFINITIONS
N Electrical Datum Plane.
A specified vertical distance above the normal high-water level above which electrical equipment can be installed and electrical connections can be made.

29


The Institute for Professional Education
4 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code
DEFINITIONS (N)
△ Electric Vehicle (EV).
An automotive-type vehicle for on-road use, such as passenger automobiles, buses, trucks, vans, neighborhood electric vehicles, and electric motorcycles, and the like, primarily powered by an electric motor that draws current from a rechargeable storage battery, fuel cell, photovoltaic array, or other source of electric current. Plug-in hybrid electric vehicles (PHEV) are electric vehicles having a second source of motive power.

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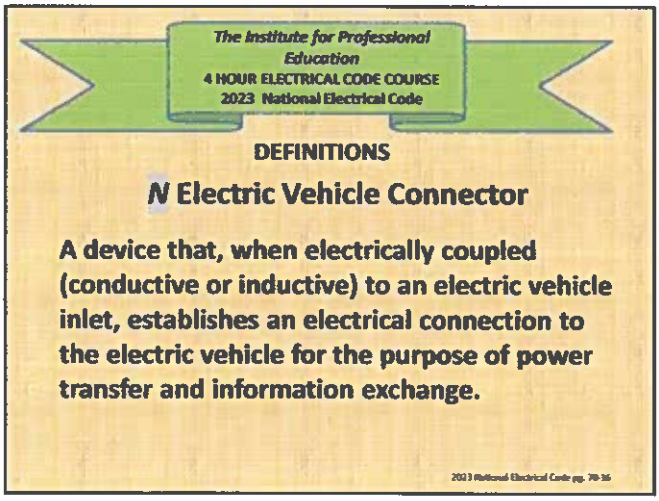
The Institute for Professional Education
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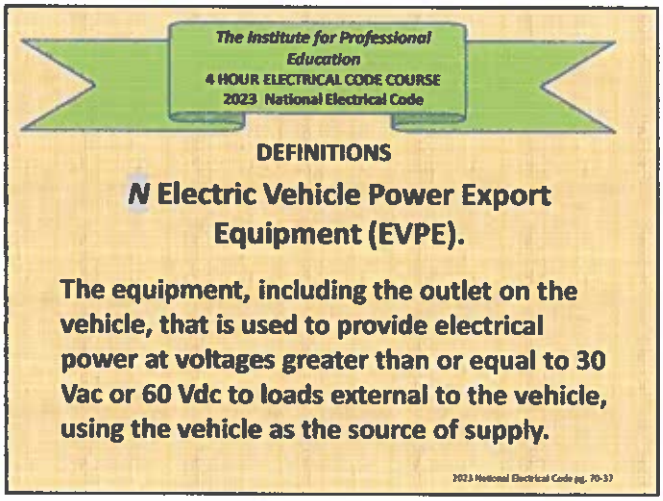
2023 National Electrical Code
DEFINITIONS
N Electric Vehicle Connector
A device that, when electrically coupled (conductive or inductive) to an electric vehicle inlet, establishes an electrical connection to the electric vehicle for the purpose of power transfer and information exchange.

31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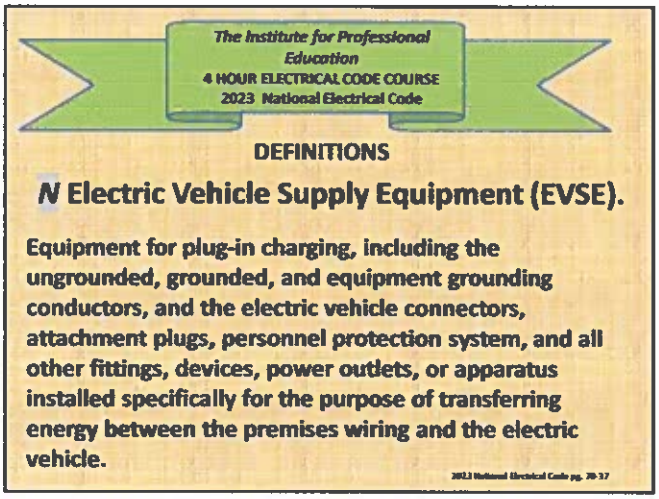
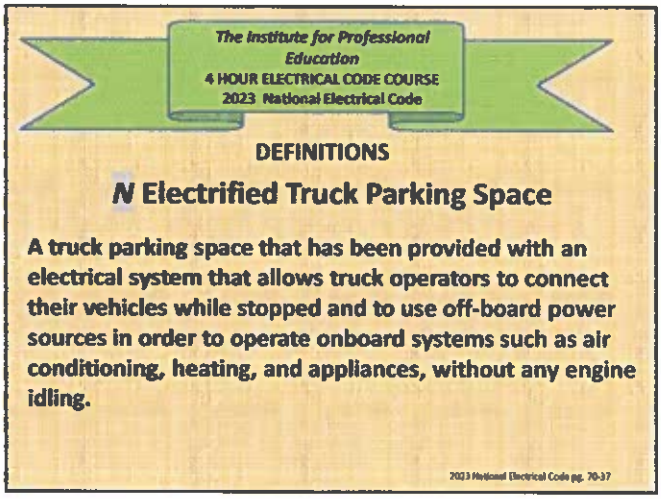
2023 National Electrical Code
DEFINITIONS
N Electric Vehicle Power Export Equipment (EVPE).
The equipment, including the outlet on the vehicle, that is used to provide electrical power at voltages greater than or equal to 30 Vac or 60 Vdc to loads external to the vehicle, using the vehicle as the source of supply.

32


The Institute for Professional Education
4 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code
DEFINITIONS
N Electric Vehicle Supply Equipment (EVSE).
Equipment for plug-in charging, including the ungrounded, grounded, and equipment grounding conductors, and the electric vehicle connectors, attachment plugs, personnel protection system, and all other fittings, devices, power outlets, or apparatus installed specifically for the purpose of transferring energy between the premises wiring and the electric vehicle.

33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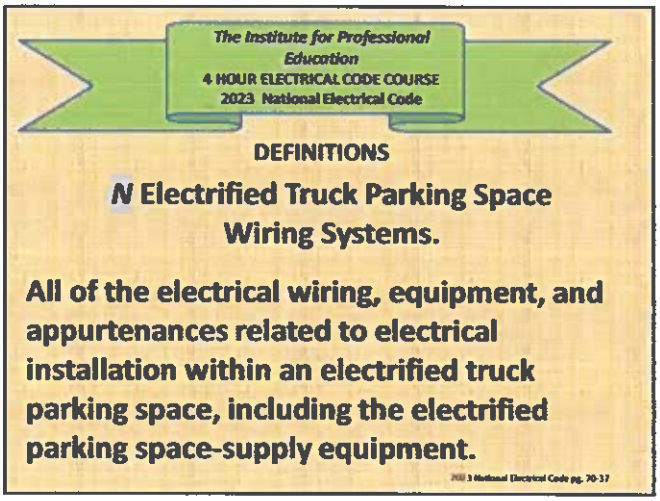
DEFINITIONS
N Electrified Truck Parking Space
A truck parking space that has been provided with an electrical system that allows truck operators to connect their vehicles while stopped and to use off-board power sources in order to operate onboard systems such as air conditioning, heating, and appliances, without any engine idling.

34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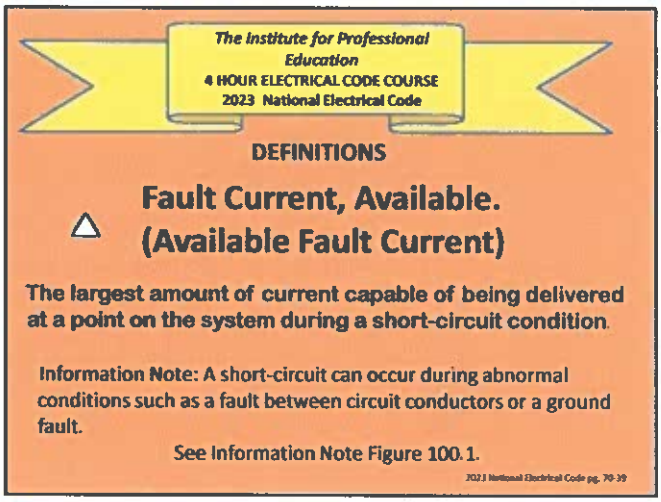
DEFINITIONS
N Electrified Truck Parking Space Wiring Systems.
All of the electrical wiring, equipment, and appurtenances related to electrical installation within an electrified truck parking space, including the electrified parking space-supply equipment.

35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DEFINITIONS
Δ Fault Current, Available. (Available Fault Current)
The largest amount of current capable of being delivered at a point on the system during a short-circuit condition.
Information Note: A short-circuit can occur during abnormal conditions such as a fault between circuit conductors or a ground fault.
See Information Note Figure 100.1.

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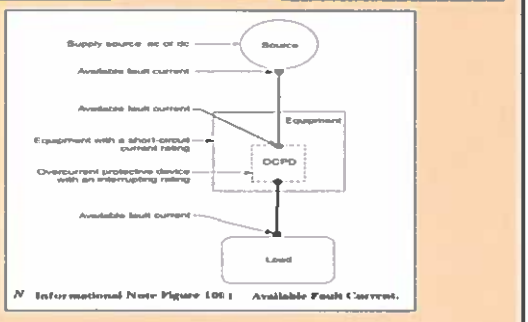

N Informational Note Figure 100.1 Available Fault Current.

2023 National Electrical Code 70-39

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DIFINITIONS

Free Air (as applied to conductors).

Open or ventilated environment that allows for heat dissipation and air flow around an installed conductor.

Fuel Cell.

An electrochemical system that consumes fuel to produce an electric current. In such cells, the main chemical reaction used for producing electric power is not combustion. However, there may be sources of combustion used within the overall cell system, such as reformers/fuel processors.

2023 National Electrical Code 70-41

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DIFINITIONS (*N*)

Fuel Cell System.

The complete aggregate of equipment used to convert chemical fuel into usable electricity and typically consisting of a reformer, stack, power inverter, and auxiliary equipment.

Generating Capacity, Inverter.
(Inverter Generating Capacity)

The sum of paralled-connected inverter maximum continuous output power at 40°C in watts, kilowatts, Volt-amperes, or kilovolt-amperes.

2023 National Electrical Code 70-41

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DIFINITIONS

△ **Ground-Fault Circuit Interrupter (GFCI)**

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

Informational Note:

Class A ground-Fault circuit interrupters trips when the ground-fault current is 6 mA or higher and do not trip when the ground-fault current is less than 4 mA.

2023 National Electrical Code pg. 70-42

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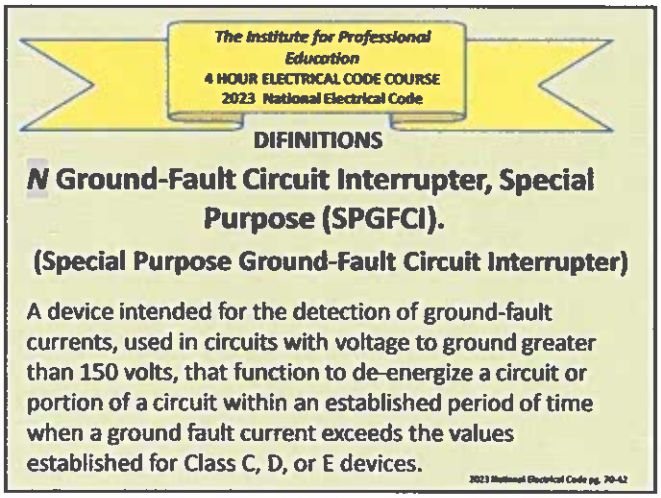
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DIFINITIONS
N Ground-Fault Circuit Interrupter, Special Purpose (SPGFCI).
(Special Purpose Ground-Fault Circuit Interrupter)
A device intended for the detection of ground-fault currents, used in circuits with voltage to ground greater than 150 volts, that function to de-energize a circuit or portion of a circuit within an established period of time when a ground fault current exceeds the values established for Class C, D, or E devices.

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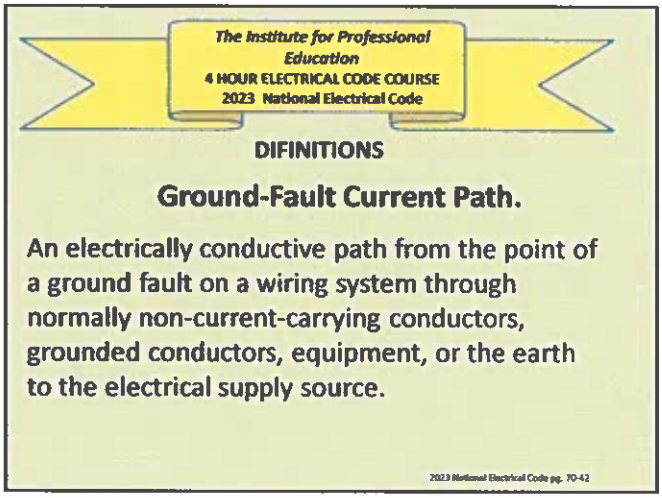
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DIFINITIONS
Ground-Fault Current Path.
An electrically conductive path from the point of a ground fault on a wiring system through normally non-current-carrying conductors, grounded conductors, equipment, or the earth to the electrical supply source.

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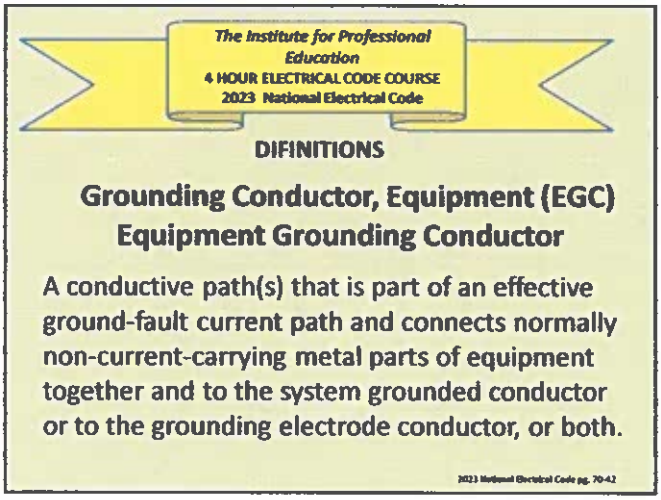
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DIFINITIONS
Grounding Conductor, Equipment (EGC)
Equipment Grounding Conductor
A conductive path(s) that is part of an effective ground-fault current path and connects normally non-current-carrying metal parts of equipment together and to the system grounded conductor or to the grounding electrode conductor, or both.

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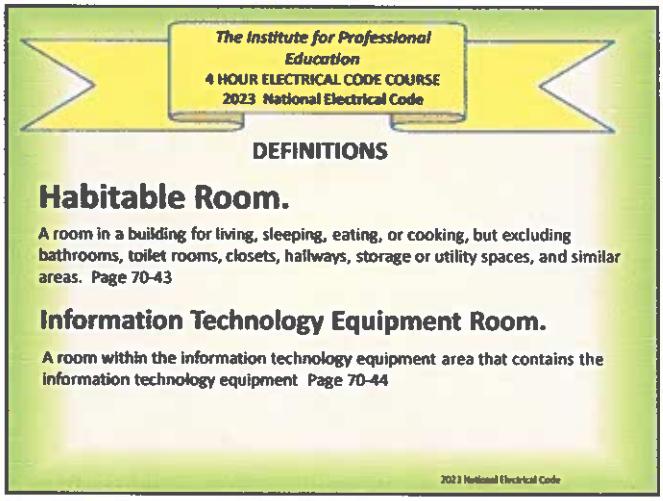
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DEFINITIONS
Habitable Room.
A room in a building for living, sleeping, eating, or cooking, but excluding bathrooms, toilet rooms, closets, hallways, storage or utility spaces, and similar areas. Page 70-43
Information Technology Equipment Room.
A room within the information technology equipment area that contains the information technology equipment Page 70-44

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2023 National Electrical Code

DIFINITIONS

Intersystem Bonding Termination. IBT

A device that provides a means for connecting intersystem bonding conductors for communications systems to the grounding electrode system.

2023 National Electrical Code pg. 70-44

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2023 National Electrical Code

DIFINITIONS

Messenger Wire. (Messenger)

A wire that is run along with or integral with a cable or conductor to provide mechanical support for the cable or conductors. Page 70-48

△ Multioutlet Assembly

A surface, flush, or freestanding assemblage with a raceway and fitting or other enclosure provided with one or more receptacles, for the purpose of supplying power to utilization equipment. Page 70-49

Pier.

A structure extending over the water and supported on a fixed foundation (fixed pier), or on flotation(floating pier), that provides access to the water. Page 70-53

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DEFINITIONS

Pier Fixed. (Fixed Pier)

Pier constructed on permanent, fixed foundation, such as on piles, that permanently establishes the elevation of the structure deck with respect to land.

Pier Floating. (Floating Pier)

Pier designed with inherent flotation capability that allows the structure to float on the water surface and rise and fall with water level changes.

Power Production Equipment.

Electrical generating equipment supplied by any source other than a utility service, up to the source system disconnecting means.

2023 National Electrical Code pg. 70-53

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DEFINITIONS

Receptacle.

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

2023 National Electrical Code pg.55

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DEFINITIONS

Reconditioned.

Electromechanical systems, equipment, apparatus, or components that are restored to operating conditions. This process differs from normal servicing of equipment that remains within a facility, or replacement of listed equipment on a one-to-one basis.

Informational Note: The term *reconditioned* is frequently referred to a *rebuilt, refurbished,* or *remanufactured.*

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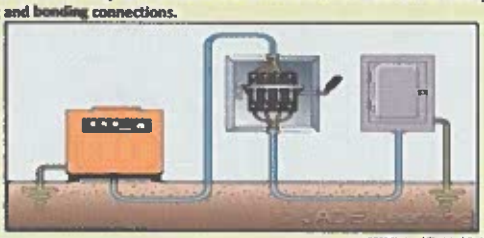
DEFINITIONS:

Separately Derived System.

An electrical power supply output, other than a service, having no direct connection(s) to circuit conductors of any other electrical source other than those established by grounding and bonding connections.



2023 National Electrical Code pg. 70-57

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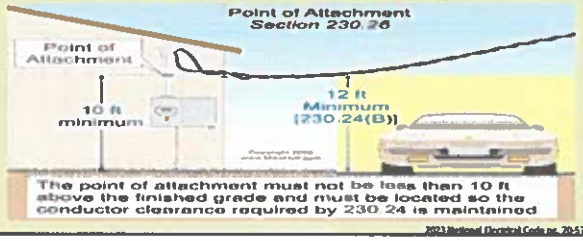
DEFINITIONS:

Service Drop.

The overhead conductors between the serving utility and the service point.



2023 National Electrical Code pg. 70-57

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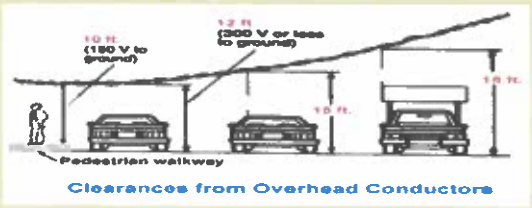
DEFINITIONS:
Service Conductors, (Overhead Service Conductors)
The overhead conductors between the service point and the first point of connection to the service-entrance conductors at the building or other structure.



Clearances from Overhead Conductors

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DEFINITIONS:

Service Conductors, Underground. (Underground Service Conductors)

The underground conductors between the service point and the first point of connection to the service-entrance conductors in a terminal box, meter, or other enclosure, inside or outside the building wall.

2023 National Electrical Code Pg. 70-57

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DEFINITIONS:

Service Equipment

The necessary equipment, consisting of a circuit breaker(s) or switch(es) and fuse(s) and their accessories, connected to the servicing utility and intended to constitute the main control and disconnect of the serving utility. PG. 70-57

Single-Pole Separable Connector.

A device that is installed at the ends of portable, flexible, single-conductor cable that is used to establish connection or disconnection between two cables or one cable and a single-pole, panel-mounted separable connector. PG.70-58

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△ 110.9 Interrupting Rating.

Equipment intended to interrupt current at fault levels shall have an interrupting rating at nominal circuit voltage at least equal *to* the available fault current at the line terminals of the equipment. Equipment intended to interrupt current at other than fault levels shall have an interrupting rating at nominal circuit voltage *at* least equal *to* the current that must be interrupted.

2023 National Electrical Code Pg. 70-64

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110.12 Mechanical Execution of Work

△ 110.12 (C) Cables and Conductors.

Cables and conductors installed exposed on the surfaces of ceilings and sidewalls shall be supported by the building structure in such a manner that the cables and conductors will not be damaged by normal building use. Such cables and conductors shall be secured by hardware including straps, staples, cable ties, hangers, or similar fitting designed and installed so as not to damage the cable. The installation shall also conform with 300.4 and 300.11. Nonmetallic cable ties and other nonmetallic cable accessories used to secure and support cable in other spaces used for environmental air (plenums) shall be listed as having low smoke and heat release properties.

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110.14 Electrical Connections

△ Because of the different characteristics of dissimilar metals, devices such as pressure terminal or pressure splicing connectors and soldering lugs shall be identified for the material of the conductor and be properly installed and used. Conductors of dissimilar metals shall not be intermixed in a terminal or splicing connector where physical contact occurs between dissimilar conductors (such as copper and aluminum or aluminum and copper-clad aluminum), unless the device is identified for the purpose and conditions of use. Materials such as solder, fluxes, inhibitors, and compounds, where employed, shall be suitable for the use and shall be of the type that will not adversely affect the conductors, installation, or equipment.

Conductors and terminals for conductors more finely stranded than Class B and Class C stranding as shown in Chapter 9, Table 10, shall be identified for the specific conductor class or classes.

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△ 110.14 Electrical Connections

110.14(D) Terminal Connection Torque

Tightening torque values for terminal connections shall be as indicated on the equipment or in installation instructions provided by the manufacturer. An approved means shall be used to achieve the indicated torque value.

Informational Note No. 1: Examples of approved means of achieving the indicated torque values include torque tools or devices such as shear bolts or breakaway-style devices with visual indicators that demonstrate that the proper torque has been applied.

Informational Note No. 2: See UL Standard 486A-486B, Standard for Safety-wire Connectors, Informative Annex I for torque values in the absence of manufacturer's recommendations. The equipment manufacturer can be contacted if numeric torque values are indicated on the equipment or if the installation instructions are not available.

Informational Note No. 3: See NFPA 70B-2019, *Recommended Practice for Electrical Equipment Maintenance, Section 8.11 for additional information for torquing threaded connections and terminations.*

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10.16 Arc-flash Hazard Warning

110.16(B) Service Equipment and Feeder Supplied Equipment.

In other than dwelling units, in addition to the requirements in 110.16(A), a permanent label shall be field, or factory applied to service equipment and feeder supplied equipment rated 1200 amperes or more. The Arc Flash label shall be in accordance with applicable industry practice and include the date the label was applied. The label shall meet the requirements of 110.21(B).

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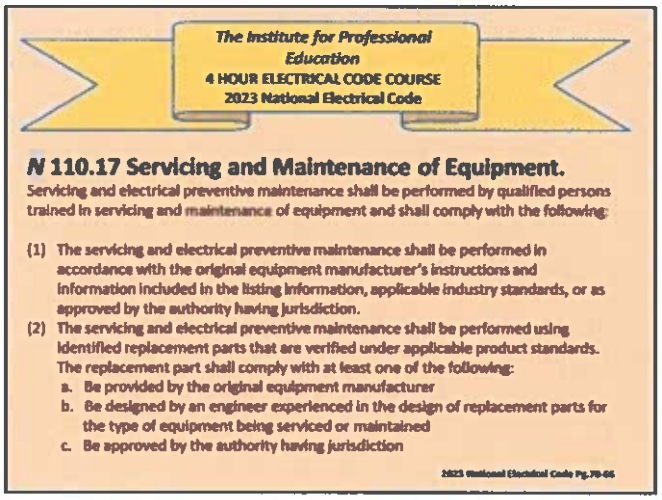
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N 110.17 Servicing and Maintenance of Equipment.
Servicing and electrical preventive maintenance shall be performed by qualified persons trained in servicing and maintenance of equipment and shall comply with the following:
(1) The servicing and electrical preventive maintenance shall be performed in accordance with the original equipment manufacturer's instructions and information included in the listing information, applicable industry standards, or as approved by the authority having jurisdiction.
(2) The servicing and electrical preventive maintenance shall be performed using identified replacement parts that are verified under applicable product standards. The replacement part shall comply with at least one of the following:
a. Be provided by the original equipment manufacturer
b. Be designed by an engineer experienced in the design of replacement parts for the type of equipment being serviced or maintained
c. Be approved by the authority having jurisdiction

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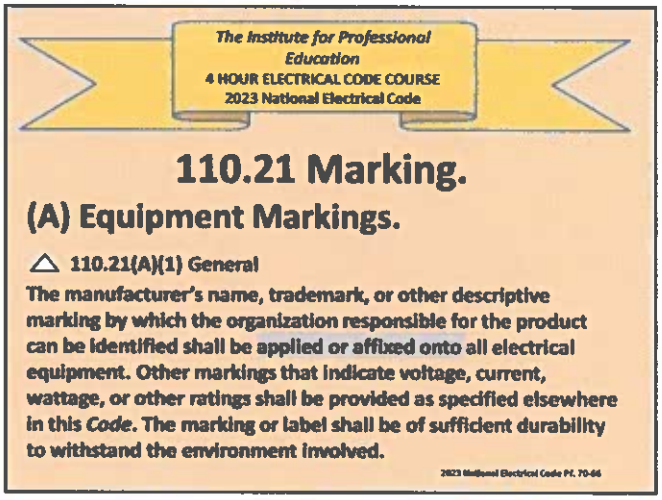
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110.21 Marking.
(A) Equipment Markings.
△ 110.21(A)(1) General
The manufacturer's name, trademark, or other descriptive marking by which the organization responsible for the product can be identified shall be applied or affixed onto all electrical equipment. Other markings that indicate voltage, current, wattage, or other ratings shall be provided as specified elsewhere in this Code. The marking or label shall be of sufficient durability to withstand the environment involved.

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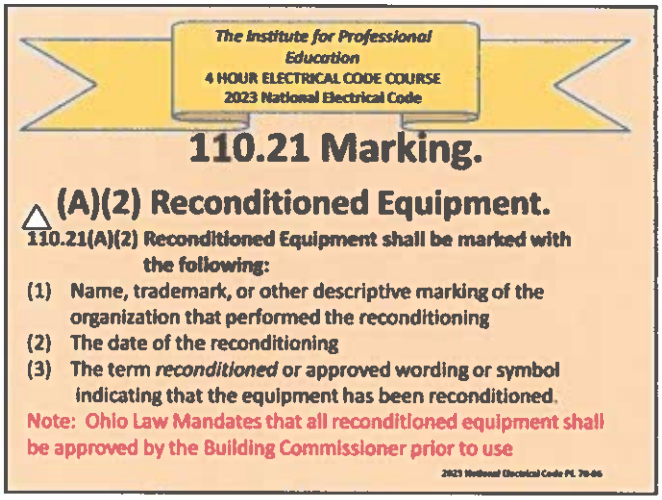
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110.21 Marking.
△ (A)(2) Reconditioned Equipment.
110.21(A)(2) Reconditioned Equipment shall be marked with the following:
(1) Name, trademark, or other descriptive marking of the organization that performed the reconditioning
(2) The date of the reconditioning
(3) The term reconditioned or approved wording or symbol indicating that the equipment has been reconditioned.
Note: Ohio Law Mandates that all reconditioned equipment shall be approved by the Building Commissioner prior to use

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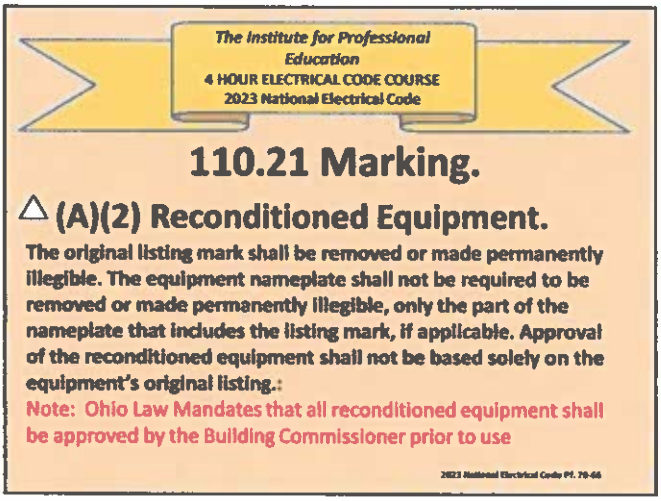
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2023 National Electrical Code
110.21 Marking.
△ (A)(2) Reconditioned Equipment.
The original listing mark shall be removed or made permanently illegible. The equipment nameplate shall not be required to be removed or made permanently illegible, only the part of the nameplate that includes the listing mark, if applicable. Approval of the reconditioned equipment shall not be based solely on the equipment's original listing.
Note: Ohio Law Mandates that all reconditioned equipment shall be approved by the Building Commissioner prior to use

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110.21 Marking.
(B) Field-Applied Hazard Markings.

110.21(B) Field-Applied Hazard Markings

DANGER indicates a hazardous situation which, if not avoided, will result in death or serious injury.

DANGER

WARNING indicates a hazardous situation which, if not avoided, could result in death or serious injury.

WARNING

CAUTION indicates a hazardous situation which, if not avoided, may result in minor or moderate injury.

CAUTION

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110.22 Identification of Disconnecting Means.

(A)General

Each disconnecting means shall be legibly marked to indicate its purpose unless located and arranged so the purpose is evident. In other than one, two, or three family dwelling units, the marking shall include the identification and location of the circuit source that supplies the disconnecting means unless located and arranged so the identification and location of the circuit source is evident. The marking shall be of sufficient durability to withstand the environment involved.

Note: *Mark your code book to indicate the State of Ohio Board of Building Standards recognizes one, two, and three-family homes as dwelling units in the Residential Code of Ohio*

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110.24 Available Fault Current.

△ **(A) Field Marking.**

Service equipment at other than dwelling units shall be legibly marked in the field with the available fault current. The field marking(s) shall include the date the fault-current calculation was performed and be of sufficient durability to withstand the environment involved. The calculation shall be documented and made available to those authorized to design, install, inspect, maintain, or operate the system.

Information note No. 2: Values of available fault current for use in determining appropriate minimum short-circuit current and interrupting ratings of service equipment are available from electric utilities in published or other forms.

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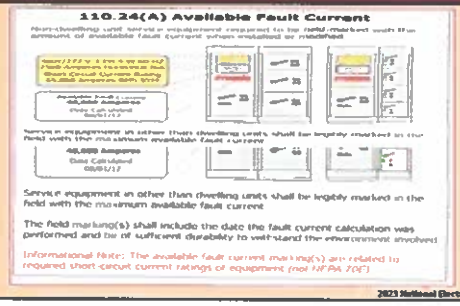
110.24 Available Fault Current.



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110.24 Available Fault Current.

(B) Modifications.

When modifications to the electrical installation occur that effect the available fault current at the service, the available fault current shall be verified or recalculated as necessary to ensure the service equipment ratings are sufficient for the available fault current at the line terminals of the equipment. The required field marking(s) in 110.24(A) shall be adjusted to reflect the new level of available fault current.

Exception: The field marking requirements in 110.24(A) and 110.24(B) shall not be required in industrial installations where conditions of maintenance and supervision ensure that only qualified persons service the equipment.

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110.25 Lockable Disconnecting Means.

If a disconnecting means is required to be lockable open elsewhere in this *Code*, it shall be capable of being locked in the open position. The provisions for locking shall remain in place with or without the lock installed.

Exception: *Locking provisions for a Cord-and-plug connection shall not be required to remain in place without the lock installed.*

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110.25 Lockable Disconnecting Means.

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110.26 Space About Electrical Equipment.

Working space, and access to and egress from working space, shall be provided and maintained about all electrical equipment to permit ready and safe operation and maintenance of such equipment. Open equipment doors shall not impede access to and egress from the working space. Access or egress is impeded if one or more simultaneously opened equipment doors restrict working space access to be less than 610 mm (24 in.) wide and 2.0 m (6 ½ ft) high

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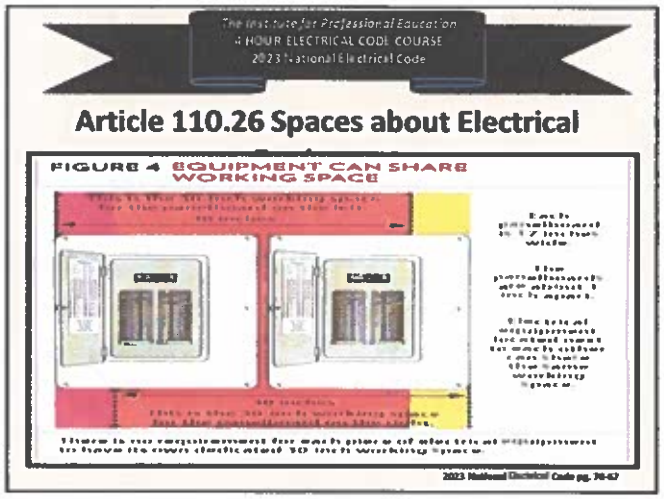
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Article 110.26 Spaces about Electrical
FIGURE 4 EQUIPMENT CAN SHARE WORKING SPACE

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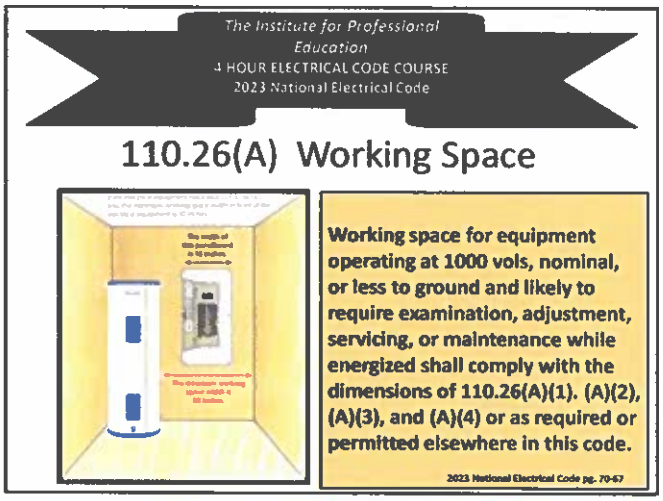
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110.26(A) Working Space
Working space for equipment operating at 1000 vols, nominal, or less to ground and likely to require examination, adjustment, servicing, or maintenance while energized shall comply with the dimensions of 110.26(A)(1). (A)(2), (A)(3), and (A)(4) or as required or permitted elsewhere in this code.
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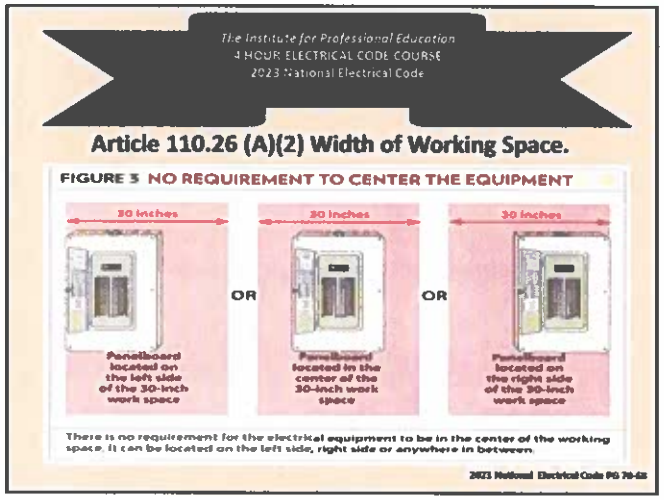
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2023 National Electrical Code
Article 110.26 (A)(2) Width of Working Space.
FIGURE 3 NO REQUIREMENT TO CENTER THE EQUIPMENT
30 inches
30 inches
30 inches
OR
OR
Panelboard located on the left side of the 30-inch work space
Panelboard located in the center of the 30-inch work space
Panelboard located on the right side of the 30-inch work space
There is no requirement for the electrical equipment to be in the center of the working space. It can be located on the left side, right side or anywhere in between.

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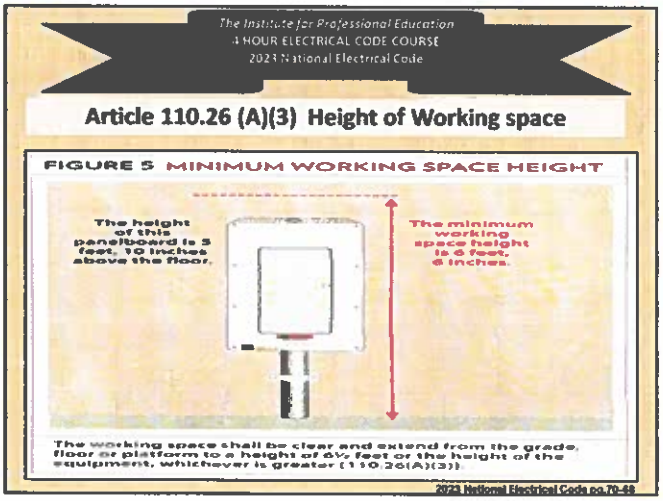
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4 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code
Article 110.26 (A)(3) Height of Working space
FIGURE 5 MINIMUM WORKING SPACE HEIGHT
The height of this panelboard is 5 feet, 10 inches above the floor.
The minimum working space height is 6 feet, 6 inches.
The working space shall be clear and extend from the grade, floor or platform to a height of 6½ feet or the height of the equipment, whichever is greater (110.26(A)(3))
2023 National Electrical Code pg.70-68

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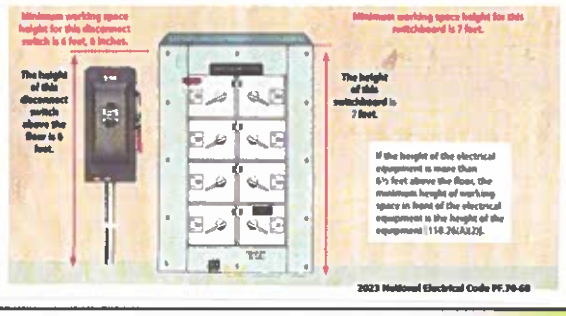
The Institute for Professional Education
4 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code

Article 110.26 (A)(3) Height of Working Space

FIGURE 6 HEIGHT OF THE EQUIPMENT



2023 National Electrical Code PP.70-68

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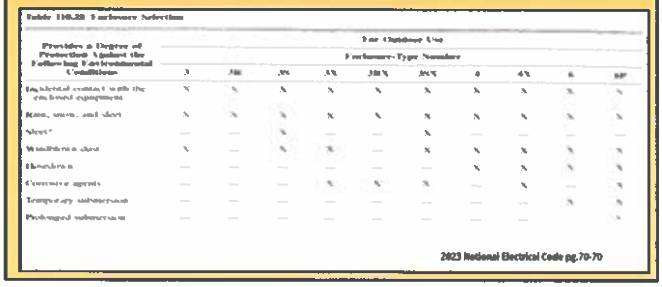
2023 National Electrical Code

Table 110.28 Enclosure Types Outdoor use

Provides a Degree of Protection Against the Following Environmental Conditions



2023 National Electrical Code pg.70-70

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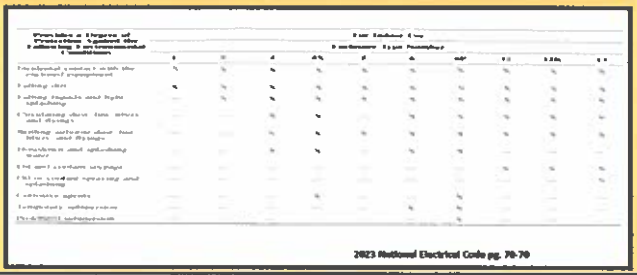
4 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code

Table 110.28 Enclosure Types Indoor use

Provides a Degree of Protection Against the Following Environmental Conditions



2023 National Electrical Code pg. 70-70

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2023 National Electrical Code

110.32 Work Space About Equipment

Sufficient space shall be provided and maintained about electrical equipment to permit ready and safe operation and maintenance of such equipment. Where energized parts are exposed, the minimum clear workspace shall be not less than 2.0 m, (6 ½ ft) high (measured vertically from the floor or platform) and the width of the equipment or 914 mm (3 ft) wide (measured parallel to the equipment), whichever is greater. The depth shall be as required in 110.34(A). In all cases, the workspace shall permit at least 90-degree opening of doors or hinged panels. Within the height requirements of this section, other equipment that is associated with the electrical installation and is located above or below the electrical equipment shall be permitted to extend not more than 150 mm (6 in.) beyond the front of the electrical equipment. Working space required by this section shall not be used for storage. When normally enclosed live parts are exposed for inspection or servicing, the working space if in a passageway or general open space, shall be suitably guarded.

2023 National Electrical Code pg.70-72

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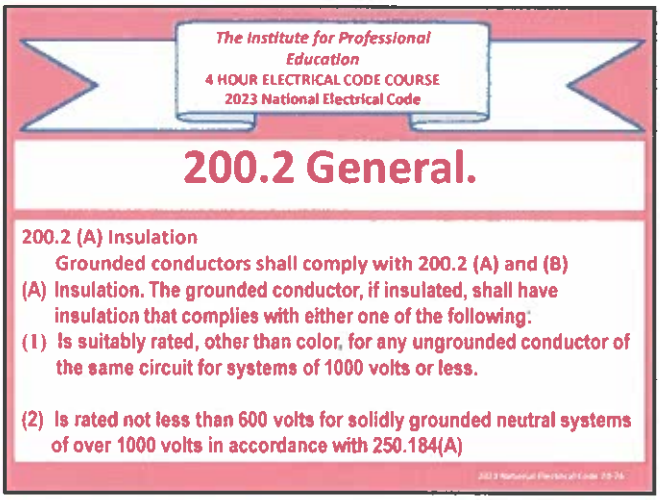
The Institute for Professional Education
4 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code
200.2 General.
200.2 (A) Insulation
Grounded conductors shall comply with 200.2 (A) and (B)
(A) Insulation. The grounded conductor, if insulated, shall have insulation that complies with either one of the following:
(1) Is suitably rated, other than color, for any ungrounded conductor of the same circuit for systems of 1000 volts or less.
(2) Is rated not less than 600 volts for solidly grounded neutral systems of over 1000 volts in accordance with 250.184(A)

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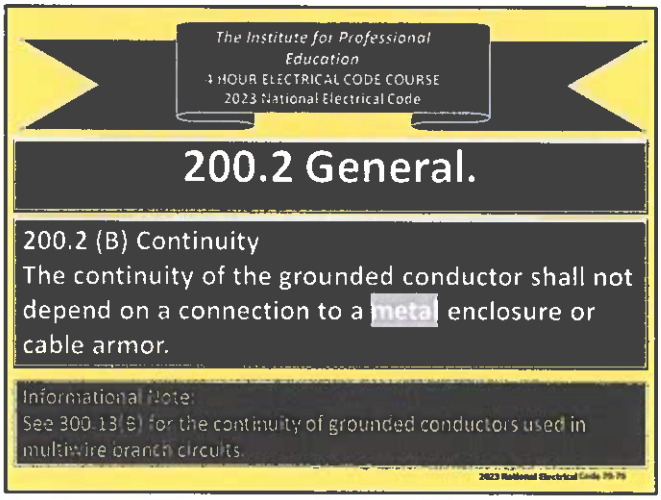
The Institute for Professional Education
4 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code
200.2 General.
200.2 (B) Continuity
The continuity of the grounded conductor shall not depend on a connection to a metal enclosure or cable armor.
Informational Note:
See 300.13(B) for the continuity of grounded conductors used in multiwire branch circuits.

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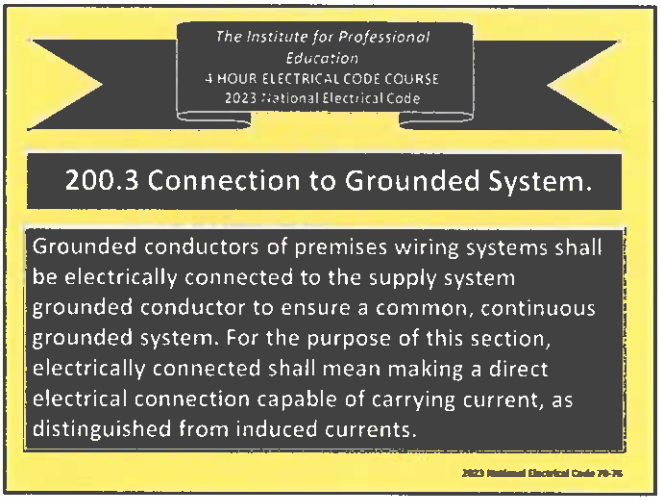
The Institute for Professional Education
4 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code
200.3 Connection to Grounded System.
Grounded conductors of premises wiring systems shall be electrically connected to the supply system grounded conductor to ensure a common, continuous grounded system. For the purpose of this section, electrically connected shall mean making a direct electrical connection capable of carrying current, as distinguished from induced currents.

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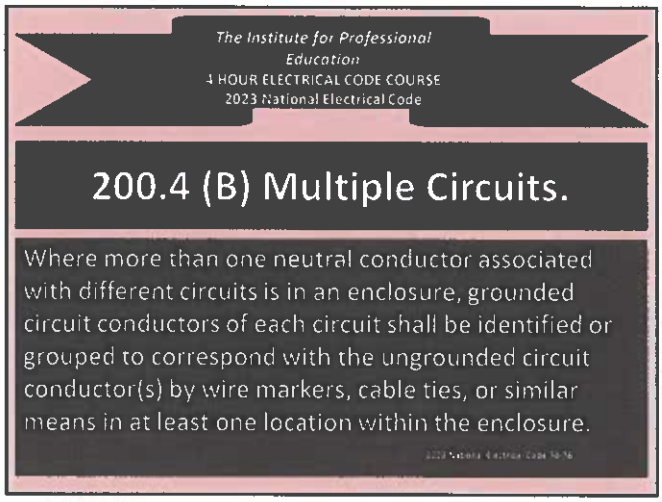
The Institute for Professional Education
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2023 National Electrical Code
200.4 (B) Multiple Circuits.
Where more than one neutral conductor associated with different circuits is in an enclosure, grounded circuit conductors of each circuit shall be identified or grouped to correspond with the ungrounded circuit conductor(s) by wire markers, cable ties, or similar means in at least one location within the enclosure.

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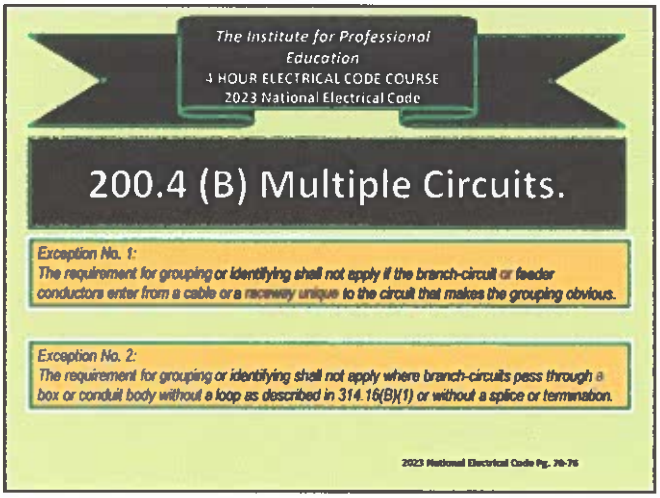
The Institute for Professional Education
4 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code
200.4 (B) Multiple Circuits.
Exception No. 1:
The requirement for grouping or identifying shall not apply if the branch-circuit or feeder conductors enter from a cable or a raceway unique to the circuit that makes the grouping obvious.
Exception No. 2:
The requirement for grouping or identifying shall not apply where branch-circuits pass through a box or conduit body without a loop as described in 314.16(B)(1) or without a splice or termination.
2023 National Electrical Code Pg. 70-76

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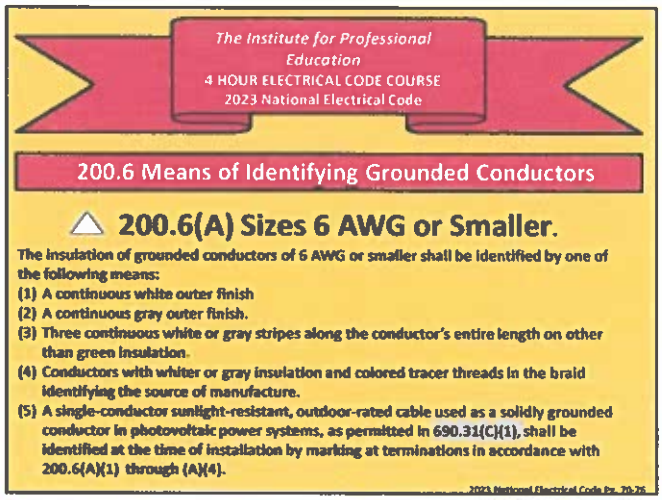
The Institute for Professional Education
4 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code
200.6 Means of Identifying Grounded Conductors
200.6(A) Sizes 6 AWG or Smaller.
The insulation of grounded conductors of 6 AWG or smaller shall be identified by one of the following means:
(1) A continuous white outer finish
(2) A continuous gray outer finish.
(3) Three continuous white or gray stripes along the conductor's entire length on other than green insulation.
(4) Conductors with whiter or gray insulation and colored tracer threads in the braid identifying the source of manufacture.
(5) A single-conductor sunlight-resistant, outdoor-rated cable used as a solidly grounded conductor in photovoltaic power systems, as permitted in 690.31(C)(1), shall be identified at the time of installation by marking at terminations in accordance with 200.6(A)(1) through (A)(4).
2023 National Electrical Code Pg. 70-76

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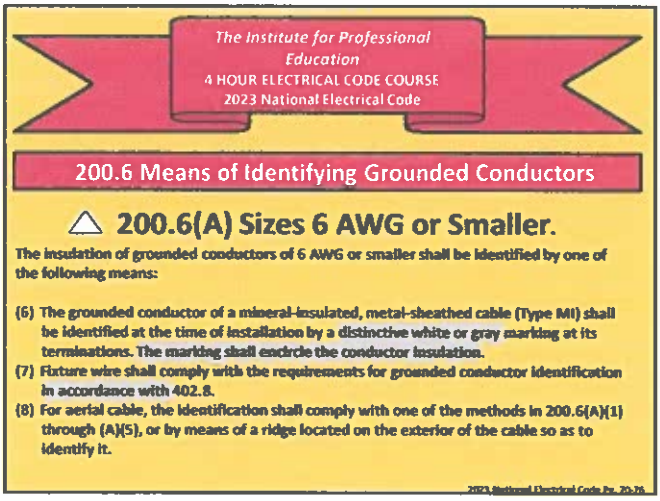
The Institute for Professional Education
4 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code
200.6 Means of Identifying Grounded Conductors
200.6(A) Sizes 6 AWG or Smaller.
The insulation of grounded conductors of 6 AWG or smaller shall be identified by one of the following means:
(6) The grounded conductor of a mineral-insulated, metal-sheathed cable (Type MI) shall be identified at the time of installation by a distinctive white or gray marking at its terminations. The marking shall encircle the conductor insulation.
(7) Fixture wire shall comply with the requirements for grounded conductor identification in accordance with 402.8.
(8) For aerial cable, the identification shall comply with one of the methods in 200.6(A)(1) through (A)(5), or by means of a ridge located on the exterior of the cable so as to identify it.
2023 National Electrical Code Pg. 70-76

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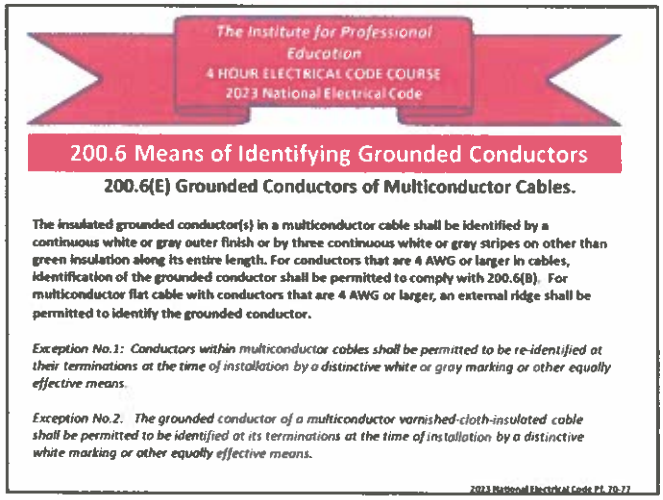
The Institute for Professional Education
4 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code
200.6 Means of Identifying Grounded Conductors
200.6(E) Grounded Conductors of Multiconductor Cables.
The insulated grounded conductor(s) in a multiconductor cable shall be identified by a continuous white or gray outer finish or by three continuous white or gray stripes on other than green insulation along its entire length. For conductors that are 4 AWG or larger in cables, identification of the grounded conductor shall be permitted to comply with 200.6(B). For multiconductor flat cable with conductors that are 4 AWG or larger, an external ridge shall be permitted to identify the grounded conductor.
Exception No.1: Conductors within multiconductor cables shall be permitted to be re-identified at their terminations at the time of installation by a distinctive white or gray marking or other equally effective means.
Exception No.2. The grounded conductor of a multiconductor varnished-cloth-insulated cable shall be permitted to be identified at its terminations at the time of installation by a distinctive white marking or other equally effective means.
2023 National Electrical Code Pg. 70-77

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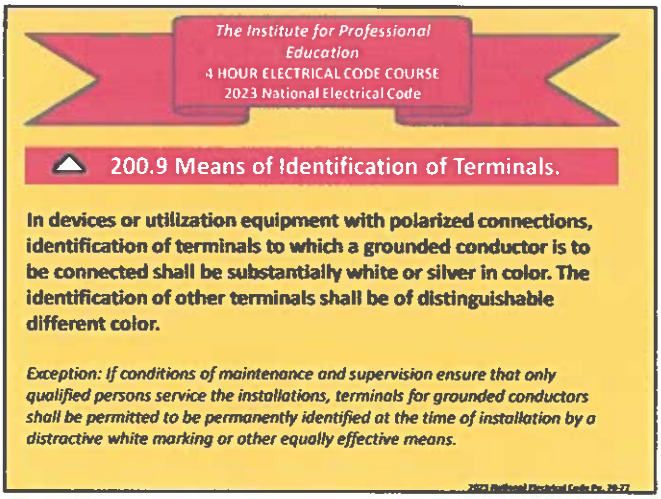
The Institute for Professional Education
4 HOUR ELECTRICAL CODE COURSE
2023 National Electrical Code
200.9 Means of Identification of Terminals.
In devices or utilization equipment with polarized connections, identification of terminals to which a grounded conductor is to be connected shall be substantially white or silver in color. The identification of other terminals shall be of distinguishable different color.
Exception: If conditions of maintenance and supervision ensure that only qualified persons service the installations, terminals for grounded conductors shall be permitted to be permanently identified at the time of installation by a distractive white marking or other equally effective means.

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Institute for Professional Education
WWW. Ohiocodeclass.org/
Instructor: Paul Fussner
Phone 1-216-299-9367
2023 National Electrical Code

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File Attachments for Item:

ER-7 2023 NEC Install Standards (Wink Electric)

All certifications (5 hours)

Staff Notes: There are no slides. Format includes traditional lecture, class discussion, sample illustrations, handouts, and use of code book.

ESIAC Recommendation:

Committee Recommendation:

Ohio | Department of Commerce

Mike DeWine, Governor
Jon Husted, Lt. Governor

Sheryl Maxfield, Director

Board of Building Standards

Application for Continuing Education Course Approval

Provider Information:

Name: Clifford Winkel

Organization: Wink Electric

Address: 5640 Broad Bvd North Ridgeville, Ohio 44039

E-mail: winkelectric@hotmail.com Telephone: 440 346 4125

Website: winkelectric.net

Conference Sponsor (if applicable)_____ Conference Email:_____

Check here if Course Renewal:_____ Prior course number _____ *(i.e. BBS2018-429)*

Renewals will only be granted for identical content and certifications, within the current code cycle.
Attach a copy of prior course approval letter for confirmation. No further information is required.

New Course Information:

Course title: 2023 NEC INSTALL STANDARDS

Course instructor: Clifford Winkel

Course description: 5 hour course to cover the top 2023 NEC code installations pertaining to every day scenarios. Attendees input and questions are encouraged and included in material covered. Topics covers will include pool installations, wire derating, EV installations, and more.

Instructional hours per session: 5 Number of Sessions: 1

Course Date(s) and Location: BTB Event Center 34437 Center Ridge North Ridgeville, Ohio 44039 2/17/24
NET Electric 12925 Pearl Rd Strongsville, Ohio 44136 3/16/24

Special Content:

Code Administration: ☐
Existing Buildings: ☐
Electrical Instruction: ☑
Plumbing Instruction: ☐

Conference Course: _____
Conference Name: _____
Conference location: _____

Course to be offered online? ☐ **On Demand** ☐ **Webinar** ☐

Course Website: _____

Detail online course participation confirmation method *(i.e. test, quizlets, participant activity confirmation)*:
Course syllabus with interactive discussion.

Course applicable for the following certifications

Residential Certifications Only: ☐
Administrative Course, All Certifications: ☐

Commercial Certifications: ☑

Application materials included:

☑ Course Outline or Course Learning Objectives
☐ Presentation Materials/Slides (not required for roundtable courses)
☐ Assessment Materials (for online courses)
☑ Presenter Bio

Please submit application and materials in .pdf format to: michael.lane@com.ohio.gov or BBS@com.ohio.gov

Clifford Winkel
5640 Broad Blvd.
North Ridgeville, Ohio 44039
440-346-4125
winkelectric@hotmail.com

BIO

Hello, my name is Cliff Winkel and I am an electrical contractor operating out of North Ridgeville, Ohio. I have been an electrician since 1990 beginning with simple house remodels and rewiring working for various companies. In 1997 I started working for an outfit out of Cleveland, Ohio which dealt with commercial, residential, and industrial applications. In 2000 I applied, tested, passed, and received my Ohio Electrical Contractor's License (#23838) and started my own business, Winkelectric. In 2004 I applied, tested, passed and received my Ohio Electrical Safety Inspector's License (#1862). In 2005 I applied for, and received my Approved Training Agency License (#517). I also am licensed as a fire alarm contractor and am entry level NABCEP certified in photovoltaic installations. I also currently have a NICET level III fire alarm certification. In 2005, 2009 – 2023 I taught OCLIB electrical continuing education classes for electrical contractors (focused on 2005 2008 2011 and 2014/2017/2020/2023 code changes and grounding). From 2000 to current I am continuing work as an electrical contractor. Some of the projects I have been involved in projects including residential buildings, commercial shopping centers, cellular tower land sites, and industrial high voltage maintenance and testing work. I have been registered and operated in numerous municipalities throughout Ohio.

Clifford Winkel

Wink Electric
11/21/23

Wink Electric Class Syllabus
2023 NEC INSTALL STANDARDS
5 hour continuing education class

Saturday 2/17/24 8A-1P, Saturday 3/16/24 8A-1P
Tuesday 8/20/24 8A-1P
Saturday 11/23/24 1P-6P
Instructor: Clifford Winkel

February location: BTB Event Center 34437 Center Ridge Rd North Ridgeville, Ohio 44039
March location: Net Electric 12925 Pearl Rd Strongsville, Ohio 44136
August Location Wink Electric Inc – 34400 Lorain Rd, North Ridgeville, Ohio 44039
November location: City of Elyria – 1194 Gulf Rd Elyria, Ohio 44035

Office Hours:

Please feel free to call our office at any time if any need arises. Our office hours are Monday through Friday 8am – 4pm. For any immediate issues, you can contact me vie cell phone at 440-346-4125

Course Objectives:

- Review National Electrical Code installations pertaining to the 2023 NEC.
- Apply covered 2023 NEC codes to circumstances in the field with discussion of practical use and actual examples of 2023 NEC applications.
- Use the ability to relate to the changes with the class from an instructor who also works in the field.
- As detailed below, there are certain changes we will be discussing. I have gotten feedback from many class members and have come up with 5 hours of code applications which affect installers daily. With 5 hour classes, I believe the amount of retention will be higher opposed to a 10 hour class.

Teaching Approach and Methods:

Portions of this course will be taught in the traditional lecture note taking format. However, a large part of the class will involve class discussions, sample illustrations, handouts, and hands on code book participation. All class members will be asked to bring their 2023 NEC book. Every hour there will be a ten minute period for open discussion. At the end of the class every applicant will fill out their individual attendance form and it will be signed then, with identification verification.

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Schedule of Topics and time schedule

8AM-9AM

Code	Discussion
General	Discuss any of the following codes pertaining to 2023 NEC.

Wink Electric Class Syllabus
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FIRST ENERGY STANDARDS – Discuss First Energy's instruction manual and cover differences between First Energy standards and NEC standards. Electronic copies of First Energy's field installation manual will be available for class members.

CLEVELAND PUBLIC POWER STANDARDS – Discuss Cleveland Public Power's requirements and their differences between NEC standards.

ARTICLE 210.11 – Branch circuits required. Discuss the necessary branch circuits required.

ARTICLE 210.12 exception – Discuss requirements to install AFCI and how to apply this exception. This discussion will include different methods of protection. Panel relocations will also be discussed.

ARTICLE 220.5(C) – Floor area. Discuss the way in which floor area is calculated for load calculations.

ARTICLE 220.41– Dwelling units minimum unit load. Discuss family dwelling unit loads to use for calculations.

ARTICLE 220.42(A) – Lighting load for non dwelling occupancies. Discuss non dwelling unit loads to use for calculations. Refer to table 220.42(A).

ARTICLE 220.47 – Receptacle loads other than dwelling units. Discuss receptacles load requirements. Refer to Table 220.45 or table 220.47

ARTICLE 220.57 – Electric Vehicle Supply Equipment. Discuss new section pertaining to load calculations for EVSE.

9AM-10AM

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ARTICLE 230.67 – Surge suppression. Discuss the increased areas in which SPDs are required.

ARTICLE 230.67(A) – SPDs. Discuss change in language from dwelling units to list specific occupancies

ARTICLE 230.85 – Emergency disconnects. Discuss requirements for disconnect installations on one and two family dwellings. Discuss different options to obtain code compliance.

ARTICLE 240.4 – Protection of conductors. Discuss this section and its relation to conductor sizing for special applications and their unique characteristics. Table reference 240.4(G).

ARTICLE 240.6 – Standard ampere ratings. Discuss applications of using table 240.6(A) and its use for sizing OCPD.

ARTICLE 250.52 – Grounding electrodes. Discuss proper installation of grounding electrodes and methods.

ARTICLE 250.52(A)(3) – Concrete encased electrode. Discuss installation of concrete encased electrodes and their installation on new installations and existing installations.

ARTICLE 250.64 (B) – Securing and protection against physical damage. Discuss methods to provide protection to appropriate sized conductors. Reference recent changes in PVC protection of conductors.

ARTICLE 250.66 – Size of AC grounding electrode conductor. Discuss table and proper way to size GEC conductors.

10AM-11AM

Wink Electric Class Syllabus
2023 NEC INSTALL STANDARDS
5 hour continuing education class

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Instructor: Clifford Winkel

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ARTICLE 250.122– Size of equipment grounding conductors. Discuss table and proper way to size EGC conductors.

ARTICLE 300.5 (D) – Protection from damage. Discuss deletion of "direct buried" language.

ARTICLE 310.15 (B) (1) (2) – Ambient temperature correction factors. Discuss how to de-rate conductors based on ambient temperature and in rooftop conditions.

ARTICLE 310.15 (C)(1) – Adjustment factors. Discuss how to de-rate conductors based on more than 3 current carrying conductors.

ARTICLE 310.16 – Ampacities of insulated conductors in raceway, cable, or earth (directly buried). Discuss table and proper way to size conductors.

ARTICLE 430.22/Table 430.250 – Single motor. Discuss the rule of 125% of the table full load current. Refer to table 430.250 for reference.

ARTICLE 430.22(E) – Duty cycle service. Discuss nameplate current rating percentage table and the continuous duty note at the bottom.

ARTICLE 430.120 – General. Discuss part X of article 430 relating to VFDs. Discuss differences between drives and motors and the 125% adjustments for drives. Reference 110.3(B) for VFD installation.

ARTICLE 440.4 (A)(B) – Marking on hermetic refrigerant motor compressors and equipment. Discuss marking of HVAC equipment and the information included to size HVAC conductors properly. Refer to article 240.4 reference.

ARTICLE 440.6(A) (B) – Ampacity and rating. Discuss tables to be used to properly size conductors feeding HVAC equipment.

11AM-12PM

Wink Electric Class Syllabus
2023 NEC INSTALL STANDARDS
5 hour continuing education class

Saturday 2/17/24 8A-1P, Saturday 3/16/24 8A-1P
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Saturday 11/23/24 1P-6P
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ARTICLE 440.12 (A)(1) – Ampere rating. Discuss adjustment for ampere rating in relation to sizing conductors feeding HVAC equipment

ARTICLE 445.13 – Ampacity of conductors. Discuss proper method of sizing conductors for generator installations.

ARTICLE 445.18 – Disconnecting means. Discuss disconnect requirements for generator installations.

ARTICLE 625.54 – Ground fault circuit interrupter protection for personnel. Discuss EV charging receptacle GFCI requirements.

ARTICLE 625.44 – Equipment connection. Discuss connection methods for EV chargers 60 amps and less.

ARTICLE 625.43 – Disconnecting means. Discuss connection methods of EV chargers 60 amps and more.

12PM-1PM

ARTICLE 680 – Swimming pools etc. Discuss reorganization to try to elevate usability of article 680.

ARTICLE 680.5 – GFCI and SPGFCI protection. Discuss revision requirements for these devices in article 680 areas.

ARTICLE 680.9 (A) – Power. Discuss revision clarifying open overhead wiring in raceways.

ARTICLE 680.10 – Electric pool water heaters. Discuss revision including electric pool water installations.

Wink Electric Class Syllabus
2023 NEC INSTALL STANDARDS
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ARTICLE 680.21 (D) – Pool pump motor replacement. Discuss revision requiring GFCI for pumps replacement and reconditioned.

ARTICLE 680.12 – Equipment rooms. Discuss revision requiring drainage.

ARTICLE 680.23 (B)(2)(a) – Forming shell. Discuss revision requiring listing for rigid in certain pool areas.

ARTICLE 680.32 – GFCI and special purpose SPGFCI protection. Discuss revision regarding when to install these devices.

ARTICLE 680.41 (A) – Emergency switch for spas and hot tubs. Discuss revision excluding the need to these installations at single family dwellings.

ARTICLE 680.44 – GFCI and SPGFCI protection. Discuss revision regarding these devices installed in these areas.

ARTICLE 680.54 (C) – Equipotential bonding of splash pads. Discuss new section addressing bonding requirements in these areas.

File Attachments for Item:

ER-8 2023 NEC Updates (Wink Electric)

All certifications (5 hours)

Staff Notes: There are no slides for this course. Format includes traditional lecture, class discussion, sample illustrations, handouts, and using the code book.

ESIAC Recommendation:

Committee Recommendation:

Ohio | Department of Commerce

Mike DeWine, Governor
Jon Husted, Lt. Governor

Sheryl Maxfield, Director

Board of Building Standards

Application for Continuing Education Course Approval

Provider Information:

Name: Clifford Winkel

Organization: Wink Electric

Address: 5640 Broad Bvd North Ridgeville, Ohio 44039

E-mail: winkelectric@hotmail.com Telephone: 440 346 4125

Website: winkelectric.net

Conference Sponsor (if applicable)_____ Conference Email:_____

Check here if Course Renewal:_____Prior course number _____ *(i.e. BBS2018-429)*

Renewals will only be granted for identical content and certifications, within the current code cycle.
Attach a copy of prior course approval letter for confirmation. No further information is required.

New Course Information:

Course title: 2023 NEC updates

Course instructor: Clifford Winkel

Course description: 5 hour course to cover the top 2023 NEC code changes pertaining to everyday installations. Attendees input and questions are encouraged and included in material covered.

Instructional hours per session: 5 Number of Sessions: 1

Course Date(s) and Location: BTB Event Center 34437 Center Ridge North Ridgeville, Ohio 44039 2/10/24
NET Electric 12925 Pearl Rd Strongsville, Ohio 44136 3/9/24

Special Content:

Code Administration: ☐
Existing Buildings: ☐
Electrical Instruction: ☑
Plumbing Instruction: ☐

Conference Course: _____
Conference Name: _____
Conference location: _____

Course to be offered online? ☐ **On Demand** ☐ **Webinar** ☐

Course Website: _____

Detail online course participation confirmation method *(i.e. test, quizlets, participant activity confirmation)*:
Course syllabus with interactive discussion.

Course applicable for the following certifications

Residential Certifications Only: ☐
Administrative Course, All Certifications: ☐

Commercial Certifications: ☑

Application materials included:

☑ Course Outline or Course Learning Objectives
☐ Presentation Materials/Slides (not required for roundtable courses)
☐ Assessment Materials (for online courses)
☑ Presenter Bio

Please submit application and materials in .pdf format to: michael.lane@com.ohio.gov or BBS@com.ohio.gov

Clifford Winkel
5640 Broad Blvd.
North Ridgeville, Ohio 44039
440-346-4125
winkelectric@hotmail.com

BIO

Hello, my name is Cliff Winkel and I am an electrical contractor operating out of North Ridgeville, Ohio. I have been an electrician since 1990 beginning with simple house remodels and rewiring working for various companies. In 1997 I started working for an outfit out of Cleveland, Ohio which dealt with commercial, residential, and industrial applications. In 2000 I applied, tested, passed, and received my Ohio Electrical Contractor's License (#23838) and started my own business, Winkelectric. In 2004 I applied, tested, passed and received my Ohio Electrical Safety Inspector's License (#1862). In 2005 I applied for, and received my Approved Training Agency License (#517). I also am licensed as a fire alarm contractor and am entry level NABCEP certified in photovoltaic installations. I also currently have a NICET level III fire alarm certification. In 2005, 2009 – 2023 I taught OCLIB electrical continuing education classes for electrical contractors (focused on 2005 2008 2011 and 2014/2017/2020/2023 code changes and grounding). From 2000 to current I am continuing work as an electrical contractor. Some of the projects I have been involved in projects including residential buildings, commercial shopping centers, cellular tower land sites, and industrial high voltage maintenance and testing work. I have been registered and operated in numerous municipalities throughout Ohio.

Clifford Winkel

Wink Electric
11/21/23

Wink Electric Class Syllabus
2023 NEC Code Updates
5 hour continuing education class

Saturday 2/10/24 8A-1P, Saturday 3/9/24 8A-1P
Tuesday 8/13/24 8A-1P
Saturday 11/23/24 7A-12P
Instructor: Clifford Winkel

February location: BTB Event Center 34437 Center Ridge Rd North Ridgeville, Ohio 44039
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August Location Wink Electric Inc – 34400 Lorain Rd, North Ridgeville, Ohio 44039
November location: City of Elyria – 1194 Gulf Rd Elyria, Ohio 44035

Office Hours:

Please feel free to call our office at any time if any need arises. Our office hours are Monday through Friday 8am – 4pm. For any immediate issues, you can contact me vie cell phone at 440-346-4125

Course Objectives:

- Review National Electrical Code updates to the 2023 NEC.
- Apply covered 2023 NEC codes to circumstances in the field with discussion of practical use and actual examples of 2023 NEC applications.
- Use the ability to relate to the changes with the class from an instructor who also works in the field.
- As detailed below, there are certain changes we will be discussing. I have combined the changes to attempt to achieve the "top 5 hours" of updates. With 5 hour classes, I believe the amount of retention will be higher opposed to a 10 hour class.

Teaching Approach and Methods:

Portions of this course will be taught in the traditional lecture note taking format. However, a large part of the class will involve class discussions, sample illustrations, handouts, and hands on code book participation. All class members will be asked to bring their 2023 NEC book. Every hour there will be a ten-minute period for open discussion. At the end of the class every applicant will fill out their individual attendance form and it will be signed then, with identification verification.

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Schedule of Topics and time schedule

8AM-9AM

Code	Discussion
General	Discuss any of the following codes pertaining to 2023 NEC code updates. Confirm with class that this will go into effect once 2023 NEC is adopted

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ARTICLE 100 DEFINITIONS – Discuss all definitions now being found in article 100 of the NEC. Definitions shall not contain requirements or recommendations. If a definition only applies to one article, the article number will appear in parentheses after the definition.

90.5 (C) Mandatory Rules, Permissive Rules – Subdivision (C) was revised to state that unless a standard referenced in the NEC contains a date, that reference is to be considered the latest edition of the standard.

ARTICLE 100 Counter (Countertop) – Discuss new definition pertaining to countertop installations.

ARTICLE Servicing – Discuss new definition pertaining to maintenance and repair activities.

ARTICLE 100 Work Surface – Discuss new definition establishing the difference between work surface and countertop.

ARTICLE 110.3(A) – Examination, identification, installation, use, and listing (Product certification) of equipment – Discuss new number 8 now including cybersecurity as something that needs considered and evaluated.

ARTICLE 110.3(B) – Examination, identification, installation, use, and listing (Product certification) of equipment – Discuss new informational note discussing the use of QR codes to gather information.

ARTICLE 110.17 – Servicing and maintenance of equipment. Discuss revised code to limit service and maintenance of equipment to qualified persons.

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ARTICLE 110.20 – Reconditioned equipment. Discuss new language defining what is considered acceptable to being reconditioned.

ARTICLE 110.21(A)(2) – Reconditioned equipment. Discuss language that clarifies that the original listing mark is to be removed or made permanently illegible.

ARTICLE 110.26 – Spaces about electrical equipment. Discuss language pertaining to doors impeding access from electrical equipment areas.

ARTICLE 110.26 (A)(6) – Grade, floor, or working platform. Discuss new language pertaining to keeping areas clear of objects

ARTICLE 110.34(A) – Working space and guarding. Discuss revisions regarding the conditions of the work space about equipment.

ARTICLE 210.2 – Reconditioned equipment. Discuss relocation from 210.15 to 210.2 as it applies to branch circuitry.

ARTICLE 210.8(A)(6) – Dwelling units kitchens. Discuss expansion of GFCI protection in kitchens (cord and plug).

ARTICLE 210.8(A) – Dwelling units bathrooms. Discuss revision of GFCI protection regarding exhaust fans.

ARTICLE 210.8(A)(8) – GFCI Protection for personnel. – Discuss weight supporting attachment fitting and GFCI protection of said fitting.

9AM-10AM

ARTICLE 210.8(B)(4) – Other than dwelling units. Discuss addition of buffet style locations requiring GFCI protection.

ARTICLE 210.8(B)(7) – Other than dwelling units sinks. Discuss addition of cord and plug connected equipment to code language.

ARTICLE 210.8(B)(13) – Other than dwelling units aquariums. Discuss addition of new item 13 discussing aquariums and bait wells.

ARTICLE 210.8(D) – Specific appliances. Discuss additional language pertaining to specific appliances listed in 218.8(D).

ARTICLE 210.8(F) – Outdoor outlets. Discuss revision regarding replacements of existing receptacles and their GFCI requirements.

ARTICLE 210.11(C)(4) – Branch circuits required. Discuss revision regarding the use of 15 amp circuits feeding garage areas.

ARTICLE 210.11(C)(4) – Branch circuits required. Discuss new exception 4 allowing 20 amp garage bay circuits to feed other items.

ARTICLE 210.12(D)(3) – Other occupancies. Discuss new language adding sleeping areas to other occupancy types.

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ARTICLE 210.17 – Guest rooms and suites. Discuss revision adding requirements for assisted living buildings and their receptacle layouts.

ARTICLE 210.23 – Permissible loads. Discuss 10 amp branch circuitry language added to the 2023 NEC. Wire sizing for this refer to 240.4.

ARTICLE 210.52(C) – Dwelling units islands/peninsulas. Discuss revisions regarding placement of receptacles in islands/peninsula areas.

ARTICLE 210.52(G) – Basements, garages, accessory buildings. Discuss clarification of the security receptacle not meeting the requirements of 210.52(G).

ARTICLE 215.18, 225.42, 230.67 – SPD. Discuss the expansion of SPD requirements in the 2023 NEC.

ARTICLE 220.57 – Electric Vehicle Supply Equipment. Discuss new section pertaining to load calculations for EVSE.

ARTICLE 220.110 – Receptacle loads. Discuss new tables pertaining to receptacle loads in patient care spaces.

ARTICLE 225.41/224.42 – Emergency disconnects. Discuss new language requiring emergency disconnects for one and two family dwelling units being served by feeders.

ARTICLE 230.67(A) – SPDs. Discuss change in language from dwelling units to list specific occupancies.

10AM-11AM

ARTICLE 230.71(B) EXCEPTION – Discuss exception grandfathering older installations installed in accordance with older versions of the NEC.

ARTICLE 230.85 – Emergency disconnects. Discuss new sub divisions regarding the use of emergency disconnects.

ARTICLE 240.6(D) – Remotely accessible adjustable trip circuit breakers. Discuss revision to allow remote access to adjustable trip circuit breakers.

ARTICLE 240.24 (E) – Not located in bathrooms. Discuss revision clarifying over current devices not being acceptable in bathroom areas.

ARTICLE 242.2 – Reconditioned equipment. Discuss new language stating SPDs cannot be reconditioned.

ARTICLE 242.9 – Indicating. Discuss requirement for indicating lights for SPDs.

ARTICLE 250.24 – Grounding of AC systems. Discuss revision to clarify requirements of parallel installations.

ARTICLE 250.24 (D)(2) – Grounding of AC systems. Discuss revision clarifying parallel service conductor installations

ARTICLE 250.50, 250.52(A)(3)(1), 250.52 (B)(2) – Grounding electrode system. Discuss change of language regarding concrete encased electrodes.

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ARTICLE 250.64(G) – Enclosures with vent openings. Discuss new requirements not allowing vented areas to be used to install GEC.

ARTICLE 250.70 – Methods of grounding and bonding. Discuss revision to grounding electrode installation methods.

ARTICLE 250.118(A) – Types of EGC. Discuss new item (6)(F) that was added along with the special rules associated with it.

ARTICLE 250.130 – EGC connections. Discuss revision adding snap switches.

ARTICLE 250.140 – Frames of ranges and dryers. Discuss revision trying to streamline understanding of this section.

ARTICLE 250.148– Continuity of EGC. Discuss revision adding subdivision (A) clarifying connections of EGC in boxes.

ARTICLE 300.4 (G) – Fittings. Discuss revision dealing with bushing being installed before installation.

TABLE 300.5 – Minimum cover requirements. Discuss revision adding EMT to the table.

ARTICLE 300.5 (D) – Protection from damage. Discuss deletion of "direct buried" language.

ARTICLE 300.11 (C) – Raceways used as means of support. Discuss revision adding class 3 circuits as a conductors allowed to be supported in this fashion.

11AM-12PM

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ARTICLE 300.14 – Length of free conductors at openings. Discuss revision allowing splicing of short conductors.

ARTICLE 300.17 – Number and size of conductors in raceways. Discuss revision in language safeguarding conductors during and after installation.

12PM-1PM

ARTICLE 312.10 – Screws and other fasteners. Discuss new section dealing with field installed screws.

ARTICLE 314.5 – Screws and other fasteners. Discuss new section dealing with screws and other fasteners entering enclosures.

ARTICLE 320.23 (A) – Cables run across framing members. Discuss revision of language to framing members opposed to joists.

ARTICLE 352.44 (B) – Expansion fittings. Discuss new requirements for expansion joints. Refer to article 352.10 (K)

ARTICLE 404.14 (D) – Snap switch terminations. Discuss new language dealing with 14 awg wire and snap switches.

ARTICLE 404.16 – Reconditioned equipment. Discuss new language prohibiting reconditioning of switches.

ARTICLE 404.30 – Switch enclosures. Discuss new **requirements** for doors with switch mechanisms.

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ARTICLE 406.30 (D) – Receptacle terminations. Discuss new language regarding the limitations of 15 amp branch circuits.

ARTICLE 406.9 (C) – Bathtub and shower space. Discuss revision regarding limitations of receptacles around these areas.

ARTICLE 406.12 – TR receptacles. Discuss revision in language attempting to streamline language regarding areas where TR receptacles are required.

ARTICLE 408.4 – Descriptions required. Discuss revision regarding circuit directories.

ARTICLE 408.9 – Replacement panelboards. Discuss revision in requirements for replacement panelboards.

ARTICLE 408.38 – Enclosure. Discuss revision regarding listing of equipment with available arc fault current greater than 10k.

ARTICLE 408.43 – Panelboard orientation. Discuss revision prohibiting panelboards being installed in a face gown position.

ARTICLE 410.2 – Reconditioned equipment. Discuss revision adding LED drivers and lamps to items that are prohibited from recondition.

ARTICLE 410.10 (F) – Luminaires installed in or under roof decking. Discuss revision requiring 1 ½" space under roof decking.

ARTICLE 410.71 – Disconnecting means for luminaires. Discuss relocation from 410.71 to this section. Formerly 410.130 (G)

ARTICLE 422 – Appliances. Discuss deletion of sections 422.3, 422.4, 422.15, 422.23, 422.46, 422.50.

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ARTICLE 422.16 (B)(2) – Built in dishwashers and compactors. Discuss revision to provisions regarding pass through cords in these installations.

ARTICLE 426.28 – Ground fault protection. Discuss revision recognizing manufacturer's requirements on snow melting equipment.

ARTICLE 430.2 – Reconditioned motors. Discuss new section regarding guidance on reconditioning motors.

ARTICLE 440.8 – Single machine and location. Discuss revision to 440.8 prohibiting mini split installation in certain areas.

ARTICLE 440.14 – Location. Discuss revision regarding workspace clearance for HVAC equipment.

ARTICLE 505.9 (C) CHAPTER 9 TABLE 13 – Equipment suitable for hazardous locations. Discuss new table 13 in Chapter 9 and deletion of table 505.9 (C)(2)(4).

ARTICLE 517 – Health care facilities. Discuss revision in definitions of Category 1-4 spaces.

ARTICLE 517.6 – Patient care related equipment. Discuss new language confirming reconditioning requirements in other areas of the code do not apply to patient care equipment.

ARTICLE 517.13 – EGC in patient care spaces. Discuss revision in language regarding installations in these areas.

ARTICLE 517.22 – Demand factors. Discuss new section regarding demand factors in heath care facilities.

12PM-1PM

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ARTICLE 518.4 – Wiring methods. Discuss revision in language including POE cabling.

ARTICLE 518.5 – Supply. Discuss revision reorganizing assembly occupancies.

ARTICLE 547.26 – Physical protection. Discuss new section regarding nonmetallic cables.

ARTICLE 547.44 – Equipotential planes and bonding. Discuss new section clarifying indoor and outdoor locations of these areas.

ARTICLE 550.32 – Service equipment. Discuss revision for disconnect location.

ARTICLE 555.14 – Equipotential planes and bonding. Discuss new section regarding installing equipotential planes in marinas and boatyards.

ARTICLE 555.15 – Replacement of equipment. Discuss new section requiring replacement devices to be installed to the new requirements of the NEC.

ARTICLE 555.35 (E) – Leakage current measurement device. Discuss new language requiring these devices to be listed by 1/1/26.

ARTICLE 555.36 (C) – Emergency electrical disconnect. Discuss new requirements mandating the emergency disconnect be located within sight of a marina power outlet.

ARTICLE 600.5 (A) – Exception. Discuss new exception relocation of timeclock language.

ARTICLE 620.12 (A) – Traveling cables. Discuss new addition of class 2 cables to this section.

ARTICLE 620.22 (A) – Car light receptacles. Discuss revision to specify permissible loads on the car light circuit.

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ARTICLE 625.6 – Listed. Discuss revision determining which EV systems are to be listed.

ARTICLE 625.44 (A) – Portable equipment. Discuss revision adding 60 amp receptacles to this section.

ARTICLE 630.8 – GFCI for welders. Discuss new section laying out when to install these.

ARTICLE 700.2, 701.2, 702.2, AND 708.2 – Reconditioned equipment. Discuss reconditioning of transfer switches being prohibited.

CHAPTER 9 TABLE 13 – Equipment suitable for hazardous locations. Discuss new table located in chapter 9.

ANNEX A – Discuss new table A.1(b).

File Attachments for Item:

ER-9 Electrical Safety Based on the 2023 NEC and NFPA 70E (Matthews Electrical Services)

All certifications (4 hours)

Staff Notes:

ESIAC Recommendation:

Committee Recommendation:

APPLICATION FOR CONTINUING EDUCATION APPROVAL
COURSE CONDITIONS AND GUIDELINES

The Ohio Board of Building Standards is committed to the ongoing education and professional development of board-certified personnel through the delivery of high-quality, accurate and engaging professional continuing education content. To this end, the Board reviews and approves Continuing Education Courses for building department personnel.

Board approval is granted for course instruction on current codes and standards, including the OBC, OMC, OPC, and RCO, and any other content areas directly related to the responsibilities of the certification for which credit is being requested.

Promotion: Any person or organization promoting an approved course is required to make full and accurate disclosure regarding course title, course approval number, number of credit hours, categories for which the BBS has approved the class, and fees in promotion materials and advertising. ***The Board does not grant retroactive approval. It is recommended that courses be submitted for approval well in advance of any scheduling of classes and advertising***. Advertising may not falsely state BBS approval before approval is granted. Course providers may state that BBS approval is pending.

Application Submission: All Applications and associated materials shall be submitted by email in .pdf format. Instructions for completing the application are attached.

Certificate of Completion: Course providers shall provide participants a certificate of completion containing the following information:

- Name of participant
- Title of approved courses
- BBS approval #
- BBS approved certifications
- Date of the continuing education program
- Number of approved credit hours awarded, and
- Signature of authorized sponsor or instructor.

Any person or organization administering an approved course shall return a completed BBS Course Attendance form by email.

Participants: Participants must attend the complete course as presented by the instructor to receive credit hours approved by the Board. The organization or instructor of online courses shall plan and execute methods to verify the individual's attendance and completion of the course. No partial credit will be given to any participant who failed to complete the entire course as approved.

Board approval: All courses are approved for the calendar year in which application is made. Courses may be renewed so long as the referenced code is in effect, and the CEUs, certification and content remain unchanged. When the referenced code is updated, courses must be updated, and new approvals obtained.

Facility/training area: BBS Course may be delivered in person or online, or both, at the sponsor's option.
Course facilities shall include the following:

In Person Classes:
Sufficient seating capacity
ADA accessible facilities
Appropriate Audio/Visual devices for delivery
Writing surfaces for participants

Online Classes:
Web-accessible
ADA accessible delivery
Tech support available
Live and recorded courses permitted

In-person facilities shall comfortably and safely seat at least the number of attendees present in the room and shall be climate controlled, non-smoking, and sound controlled so that outside noise will not interfere with the training.

Ohio | Department of Commerce

Mike DeWine, Governor
Jon Husted, Lt. Governor

Sheryl Maxfield, Director

Board of Building Standards

Application for Continuing Education Course Approval

Provider Information:

Name: HENRY PETER MATTHEWS

Organization: MATTHEWS ELECTRICAL SERVICES

Address: 1203 MCKINLEY PLACE

E-mail: hpmatthews@att.net Telephone: 419-575-3488

Website: www.matthewselectrical.net

Conference Sponsor (if applicable) _____ Conference Email: _____

Check here if Course Renewal: ☐ Prior course number _____ (*i.e. BBS2018-429*)

Renewals will only be granted for identical content and certifications, within the current code cycle.
Attach a copy of prior course approval letter for confirmation. No further information is required.

New Course Information:

Course title: Electrical Safety Based on the NEC and NFPA 70E

Course instructor: Henry Matthews

Course description: The course will cover major electrical safety topics from the 2023 NEC and the latest version of NFPA 70B. This course will cover topics such as clearance around electrical equipment, GFCI, AFCI and tamper resistant receptacles. It will also cover grounding and bonding principles. This course will also cover the two main causes of electrical injuries and fatalities - shock and arc flash - and how to protect yourself and others from these risks.

Instructional hours per session: 4 Number of Sessions: _____

Course Date(s) and Location: TBD (1st Quarter of 2024)

Special Content:

Code Administration: ☐
Existing Buildings: ☑
Electrical Instruction: ☑
Plumbing Instruction: ☐

Conference Course: _____
Conference Name: _____
Conference location: _____

Course to be offered online? ☑ **On Demand** ☐ **Webinar** ☑

Course Website: www.matthewselectrical.net

Detail online course participation confirmation method *(i.e. test, quizlets, participant activity confirmation)*:
Participation will be verified by Zoom attendance tracking, live roll call, polls and surveys.

Course applicable for the following certifications

Residential Certifications Only: ☑ Commercial Certifications: ☑
Administrative Course, All Certifications: ☐

Application materials included:

☑ Course Outline or Course Learning Objectives
☑ Presentation Materials/Slides (not required for roundtable courses)
☑ Assessment Materials (for online courses)
☑ Presenter Bio

Please submit application and materials in .pdf format to: michael.lane@com.ohio.gov or BBS@com.ohio.gov

Instructions for new Continuing Education Approval form

Provider Information

1. Please include all contact information.
2. If course is not part of a conference, leave conference sponsor and email blank.

Course Renewal

1. Indicate if the course is being submitted for renewal. Include prior approval letter and write in prior course number.
2. Certification approval for courses has now changed: all existing courses being renewed will be approved within the new classification system.
    a. Courses previously approved for only residential certifications will be approved for all residential certifications.
    b. Courses previously approved for at least on commercial certification will now be approved for all commercial certifications and all residential certifications.
    c. Courses on required instruction topics, Ohio Ethics, Code Administration and Existing Buildings, will be noted as Administrative Courses and be approved for all certifications.
3. Courses being renewed should skip the New Course information section and are not required to submit outline, agenda, slides or other instructional materials for review. Skip to Special Content, and mark any item that applies to the course.

New Course Information

1. Enter course title, name of instructor, and a brief description of the course content. Learning objectives may be substituted for course description, if desired.
2. Number of instructional hours per session is the length of instructional time.
3. Number of sessions: can be 1 or the number of sessions planned.
4. Course date(s) and location: not necessary at this time, enter if known.

Special Content

1. Indicate if the course will meet instructional time in Code Administration or Existing Buildings.
2. Indicate if the course is a plumbing or electrical course, for ESIAC review and trainee course tracking.
3. If the course is associated with a conference, indicate the conference name and location, as this will allow BBS to coordinate approvals with the conference provider.
4. If the course will be offered online, specify whether it will be on demand or offered as a virtual webinar, or both. Include website where the course will be provided.

Course applicable for the following certifications

This section represents a major change from previous BBS course approval forms.

1. If the course is only for residential certifications, check 'Residential Certifications Only'. The course, if approved, will be approved for all residential certifications.
2. If the course is appropriate for any commercial certifications, check Commercial Certifications. The course, if approved, will be approved for all commercial certification **AND** all residential certifications.
3. If the course is intended to meet required instruction in Code Administration (Chapter 1) or Existing Buildings (commercial or residential) check 'Administrative Course, All Certifications'.

Application Materials Included

This is a checklist for the course submitter's use, to be sure all materials necessary for review are included with the application. All materials should be submitted in .pdf format, along with the application, via email to Michael.Lane@com.ohio.gov or BBS@com.ohio.gov

Electrical Safety
Based on the 2023 NEC and NFPA 70E
OCILB Course number: 4871419
OBBS Course number:

MATTHEWS ELECTRICAL SERVICES

Please Join Webinar as a Panelist!

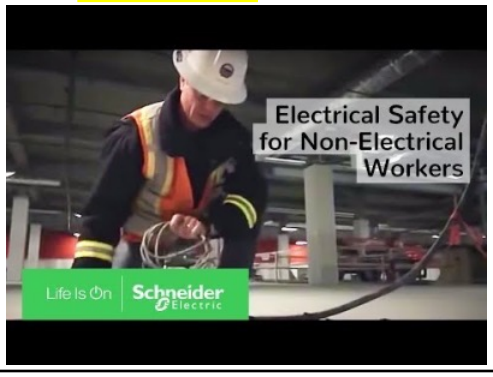
Allows host to verify your attendance and allows you to see and interact with other attendees
You will not have to present material!

Mute your microphones!
Sit back and relax until webinar starts!

Text me at cell no. 419-575-3488 for any problems

Thank You!

Please enjoy this video as we wait for the webinar to start!



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Electrical Safety
Based on the 2023 NEC and NFPA 70E
OCILB Course number: 4871419

MATTHEWS ELECTRICAL SERVICES

Ohio Training Agency #48714

Henry Matthews, PE, CPE, CESCP
hpmatthews66@att.net
hpmatthews@matthewselectrical.net

2

Electrical Safety Applicability

- Electrical Safety Applies to Everyone!
- The requirements of the NEC apply to those involved in the safe and compliant installation of electrical equipment and systems
- The requirements of NFPA 70E are in place for all installations except residential and utilities
- HOWEVER! The guidelines in NFPA 70E are good safe practices for **ALL** installations!

3

Webinar Rules

Be	Attendee must be present the entire time (except breaks)
Be	Webinar may be recorded • Proof of attendance and participant identity
Keep	Keep webcam active* • Instructor will periodically check for presence of all attendees • During presentation, participant view will be blocked
Mute	Mute microphone at all times • Prevents distraction during webinar • Instructor may activate participant microphone if verbal response is needed

6

4

Webinar Rules (Continued)

5-minute breaks every hour

- Return promptly after breaks
- The instructor will check attendance after each break

Emergencies

Contingency Plans: Ohio Weather

Unexpected interruption

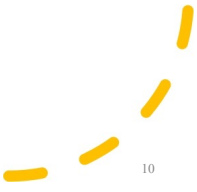
- Re-joining webinar
- Problems:
  - send me a text message: 419-575-3488
  - Or email: hpmatthews66@att.net

7

5

How to Use This Webinar

- Just Ask!
- Unmute yourself and ask or speak!



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6

Webinar Completion

- Certificate of completion will be sent via email to all attendees
- 4 hours of Ohio OCILB Code and/or OBBS credits will be submitted to the state board within 48 hours of class
- Feedback is encouraged to improve future webinars!
- Send other inquires, feedback and questions to: hpmatthews@matthewselectrical.net
- 419-701-7707
- 419-575-3488 (cell)

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7

CERTIFICATE OF COMPLETION

THIS CERTIFIES THAT

JOE STUDENT

OCILB License no: 12345 Electrical, HVAC, Plumbing

HAS SUCCESSFULLY COMPLETED THE TRAINING REQUIREMENTS FOR

ELECTRICAL SAFETY BASED ON THE NEC AND NFPA 70E

OCILB COURSE NUMBER: 4871419

March 26, 2022
DATE

MATTHEWS ELECTRICAL SERVICES
Agency #48714

HENRY P. MATTHEWS PE, CESCP
INSTRUCTOR

8

WELCOME!

- Goals
  - Promote learning
  - Make session engaging
    - Discussion
    - Videos
    - Case Studies
    - Polls
  - Make 4 hours as productive as possible!

9

Your Tour Guide: Henry Matthews

- Advanced Senior Engineer (Current): Oil and Gas Company (17 yrs)
- Plant Engineering Manager: Cooper Standard Automotive (13 yrs)
- Electrical Designer: Toledo Engineering Company (4 yrs)
- BS Electrical Engineering – Penn State University
- MBA – Bowling Green State University
- Registered Professional Engineer – OH, IN, KY, WI, MI, IL,WV
- Certified Professional Engineer – CPE
- Certified Electrical Safety Compliance Professional (CESCP) by NFPA
- Licensed Electrical Contractor – OH
- Registered Training Agency – OCILB OH #48714
- Registered Training Agency – Ohio Board of Building Standards (BBS)
- Senior Member of IEEE
- Member of NFPA – Builders and Architects division
- Member of International Association of Electrical Inspectors (IAEI)
- Member of Association of Facility Engineers (AFE)
- Member of Society of Maintenance and Reliability Professionals (SMRP)
- Co-chair API RP 545 – Lightning Protection for Above Ground Storage Tanks
- Over 30 years in the electrical design, construction, safety and standards industry

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11

Objectives

- To provide basic information on electrical safety for all persons working on or around electrical equipment.
- This information is to protect the worker and bystanders near the location(s) where work is being performed.
- Provide information in simple terms to facilitate understanding and comprehension.

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Other Resources

- NFPA: www.nfpa.org
- OSHA: www.osha.gov
- IEEE (Electrical Safety Workshop): http://www.ewh.ieee.org/cmte/ias-esw/
- IAEI: www.iaei.org
- Mike Holt Enterpises: www.MikeHolt.com
- NEMA: www.nema.org
- UL: www.ul.com
- NECA: www.necanet.org
- Brainfiller.com: www.brainfiller.com
- E-Hazard: https://www.e-hazard.com/
- Electrical Safety Foundation International (ESFi): https://www.esfi.org/
- Fluke Corporation: www.Fluke.com
- Westex: www.westex.com
- Schneider Electric: www.schneiderelectric.com
- Eaton Corporation: www.eaton.com
- Red Vector Training: www.redvector.com
- Schweitzer Engineering Labs: www.selinc.com

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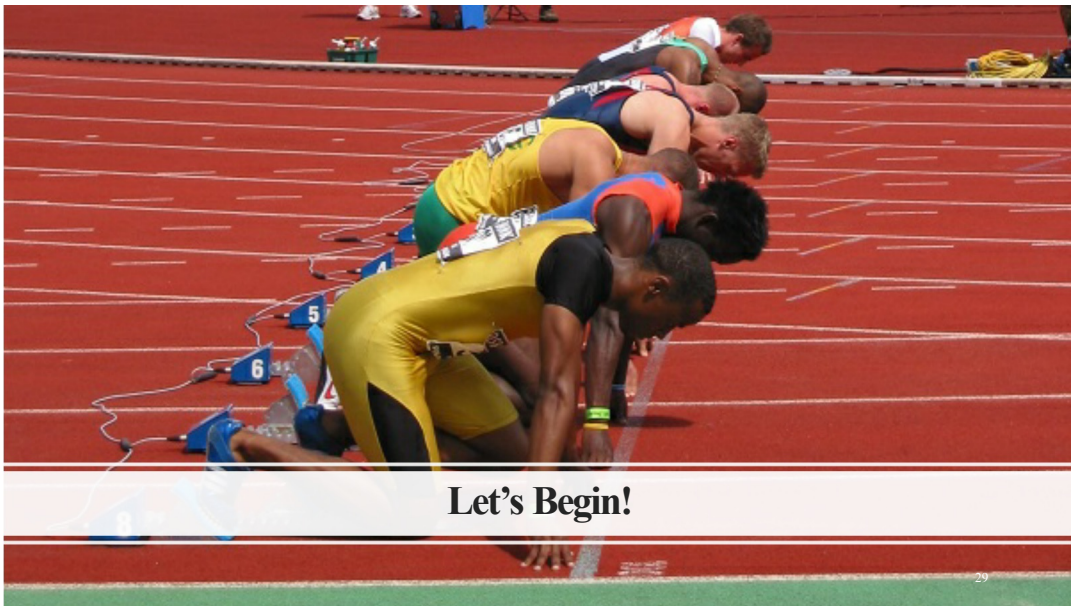

14

health

NEWS CONDITIONS A - Z NUTRITION WELLNESS ABOUT US

HEALTH CONDITIONS A-Z > SKIN CONDITIONS

A Survivor Shares What It's Like To Be Electrocuted

Despite sustaining serious burns, Samantha Richards lived to tell a harrowing story.

By Samantha Richards as told to Julia Naftulin • Updated on September 30, 2022

Medically reviewed by Susan Bard, MD

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electrocute /ɪˈlɛktrəˌkjuːt/ *verb*

electrocutes; electrocuted; electrocuting

Britannica Dictionary definition of ELECTROCUTE

[+ object]

: to kill (a person or animal) by electric shock — usually used as *(be/get) electrocuted*

- He stepped on the power line and *was* nearly *electrocuted*.

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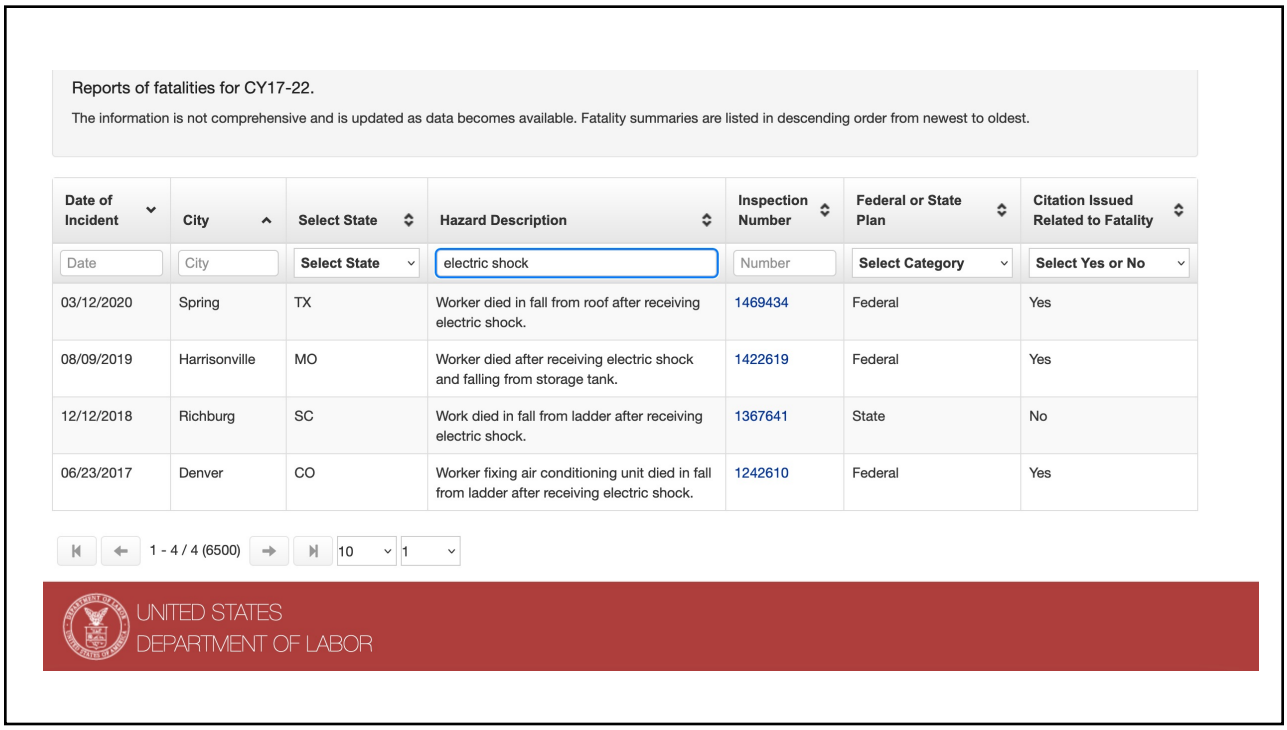

Reports of fatalities for CY17-22.

The information is not comprehensive and is updated as data becomes available. Fatality summaries are listed in descending order from newest to oldest.

Date of Incident	City	Select State	Hazard Description	Inspection Number	Federal or State Plan	Citation Issued Related to Fatality
Date	City	Select State	electric shock	Number	Select Category	Select Yes or No
03/12/2020	Spring	TX	Worker died in fall from roof after receiving electric shock.	1469434	Federal	Yes
08/09/2019	Harrisonville	MO	Worker died after receiving electric shock and falling from storage tank.	1422619	Federal	Yes
12/12/2018	Richburg	SC	Work died in fall from ladder after receiving electric shock.	1367641	State	No
06/23/2017	Denver	CO	Worker fixing air conditioning unit died in fall from ladder after receiving electric shock.	1242610	Federal	Yes

1 - 4 / 4 (6500) 10 1

UNITED STATES DEPARTMENT OF LABOR

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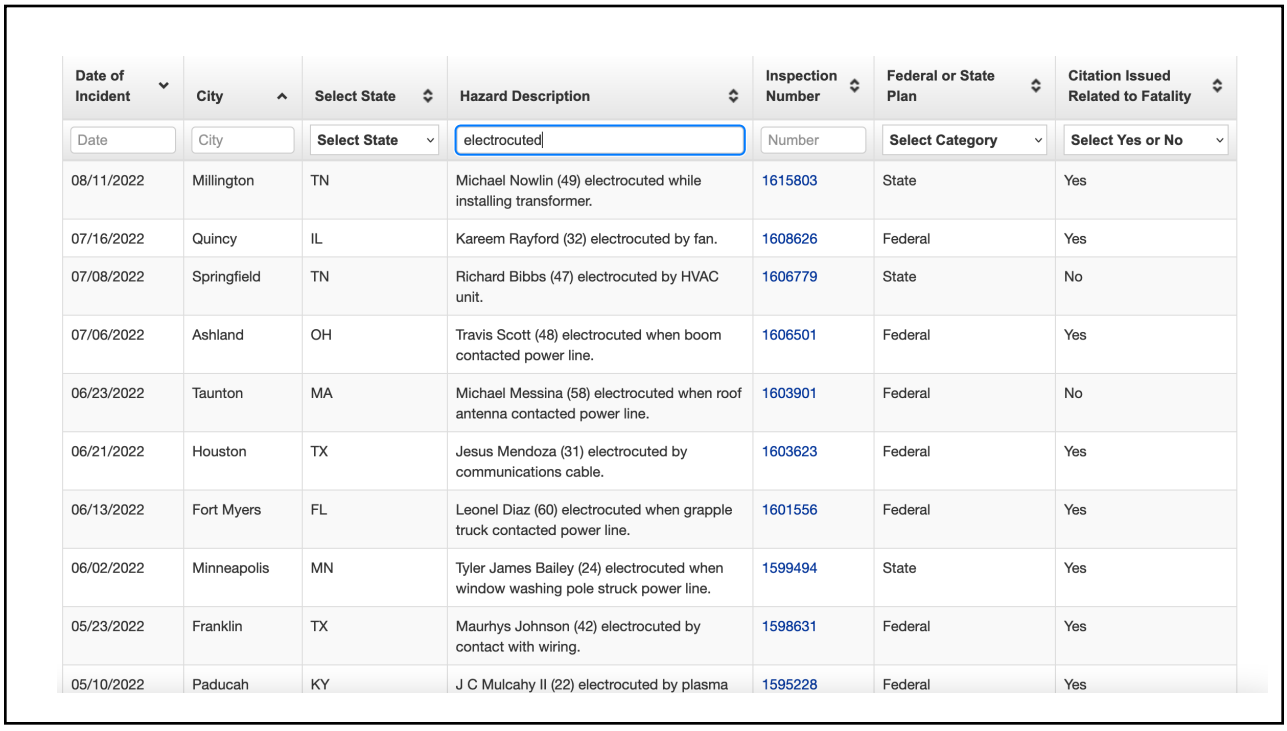

Date of Incident	City	Select State	Hazard Description	Inspection Number	Federal or State Plan	Citation Issued Related to Fatality
Date	City	Select State	electrocuted	Number	Select Category	Select Yes or No
08/11/2022	Millington	TN	Michael Nowlin (49) electrocuted while installing transformer.	1615803	State	Yes
07/16/2022	Quincy	IL	Kareem Rayford (32) electrocuted by fan.	1608626	Federal	Yes
07/08/2022	Springfield	TN	Richard Bibbs (47) electrocuted by HVAC unit.	1606779	State	No
07/06/2022	Ashland	OH	Travis Scott (48) electrocuted when boom contacted power line.	1606501	Federal	Yes
06/23/2022	Taunton	MA	Michael Messina (58) electrocuted when roof antenna contacted power line.	1603901	Federal	No
06/21/2022	Houston	TX	Jesus Mendoza (31) electrocuted by communications cable.	1603623	Federal	Yes
06/13/2022	Fort Myers	FL	Leonel Diaz (60) electrocuted when grapple truck contacted power line.	1601556	Federal	Yes
06/02/2022	Minneapolis	MN	Tyler James Bailey (24) electrocuted when window washing pole struck power line.	1599494	State	Yes
05/23/2022	Franklin	TX	Maurhys Johnson (42) electrocuted by contact with wiring.	1598631	Federal	Yes
05/10/2022	Paducah	KY	J C Mulcahy II (22) electrocuted by plasma	1595228	Federal	Yes

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On the Horizon… Thousands of EV, Solar PV, Energy Storage Installations

https://www.youtube.com/watch?v=Cwj4lSMfH68&t=1s

Electrical Safety will be more important than ever!!!

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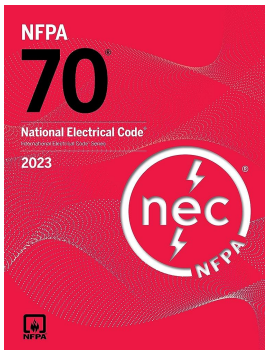
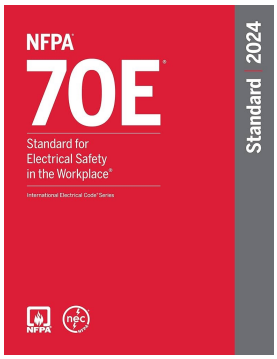
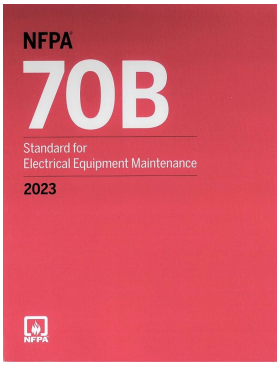


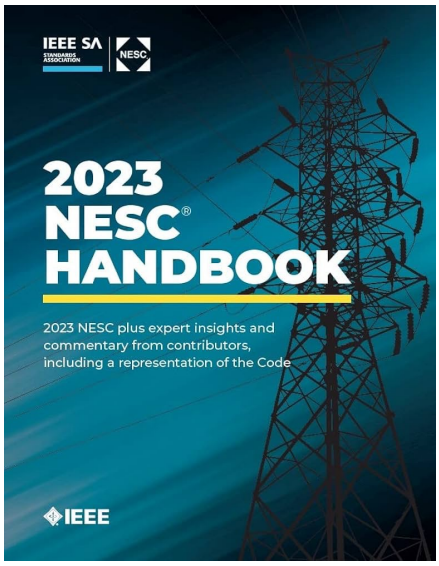




The NEC "Suite"

20

Not in Scope but Important!



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Why Do We Need Electrical Safety Training?

22

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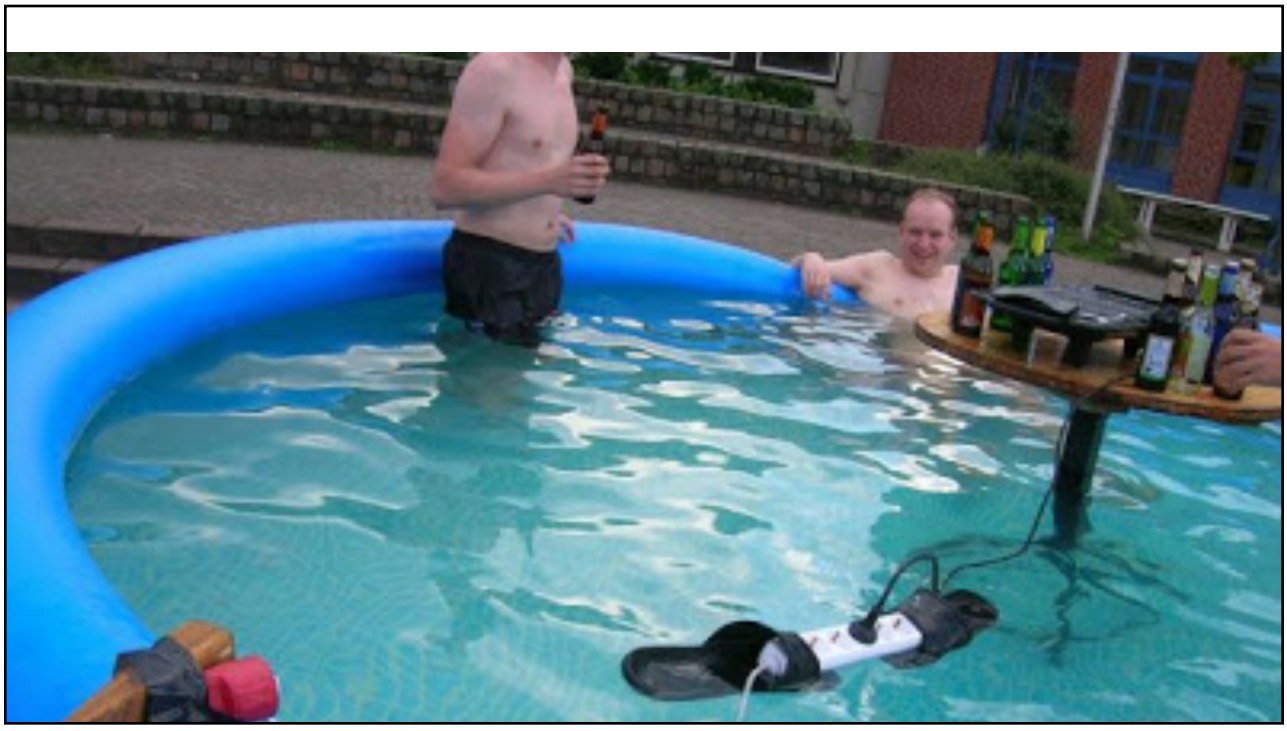

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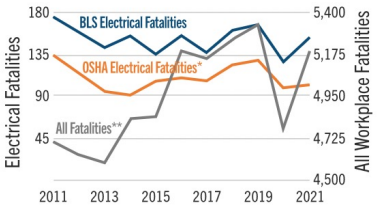
Electrical Fatalities in the Workplace 2011–2021

Contact with or exposure to **electricity** continues to be one of the **leading causes of workplace fatalities and injuries** in the United States. Between 2011 and 2021, there was a total of **1,201 workplace fatalities** involving electricity reported by the Occupational Safety and Health Administration (OSHA) and **1,653 electrical fatalities** reported by the Bureau of Labor Statistics. During this period, 69% of all electrically related fatalities happened in **non-electrically related occupations**.

Workplace Electrical Fatalities: Bureau of Labor Statistics and OSHA



118 occupations were involved in electrical fatalities

31% of fatalities were in electrical occupations

69% of fatalities were in non-electrical occupations

1.2% average decrease in non-electrical occupations electrical fatalities

0.89% average decrease in electrical occupations electrical fatalities

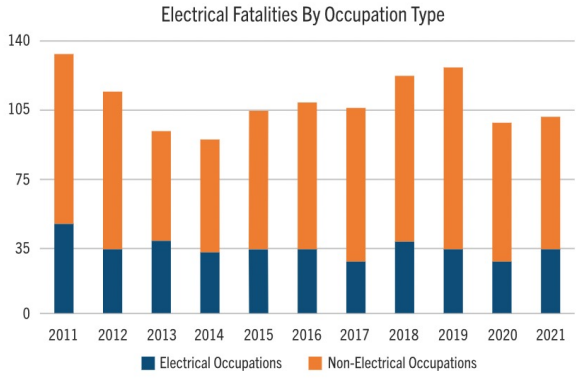
*OSHA reports only account for completed accident reports

**Total workplace fatalities as reported by the BLS

25

Top 10 Occupations Involved in Electrical Fatalities

Electricians **15.15%**
Laborers, except construction **10.07%**
Construction laborers **8.99%**
Electrical power installers and repairers **8.49%**
Tree trimming occupations **5.33%**
Electricians' apprentices **3.25%**
Heating, air conditioning, and refrig. mechanics **2.83%**
Painters, construction and maintenance **2.75%**
Roofers **2.16%**
Truck drivers, heavy **1.92%**



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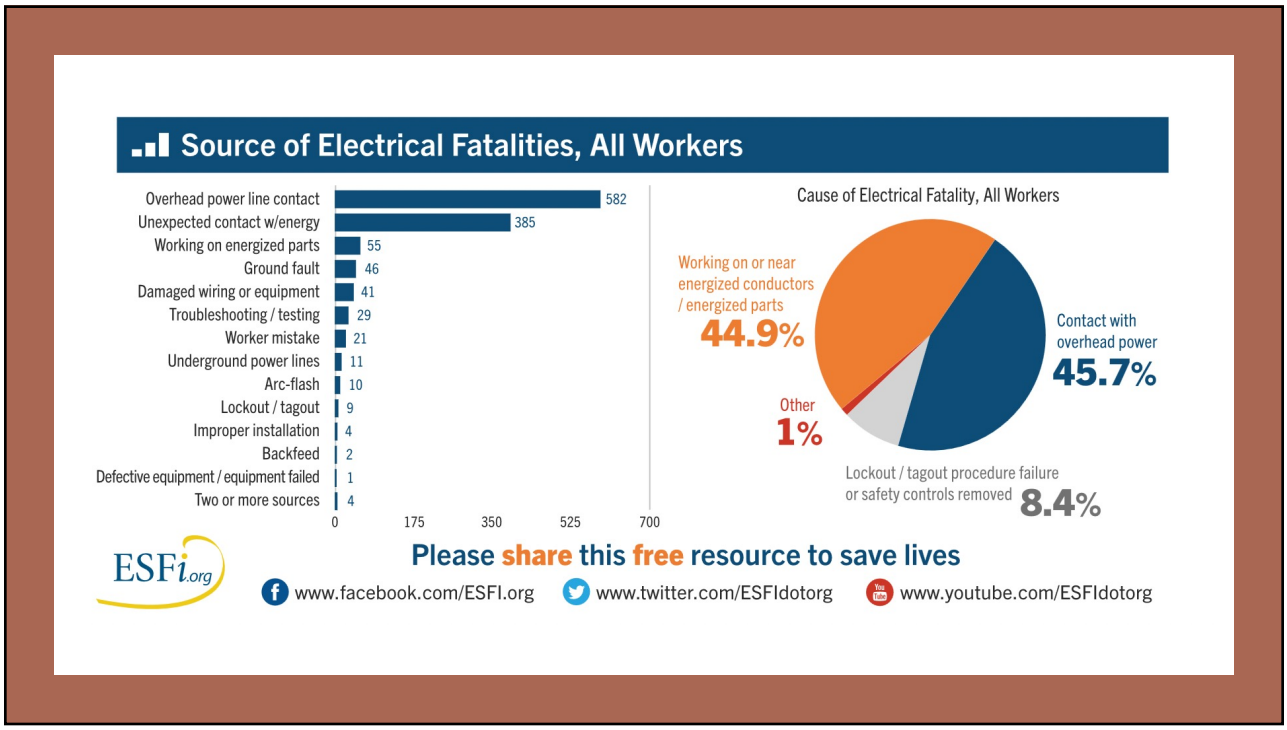

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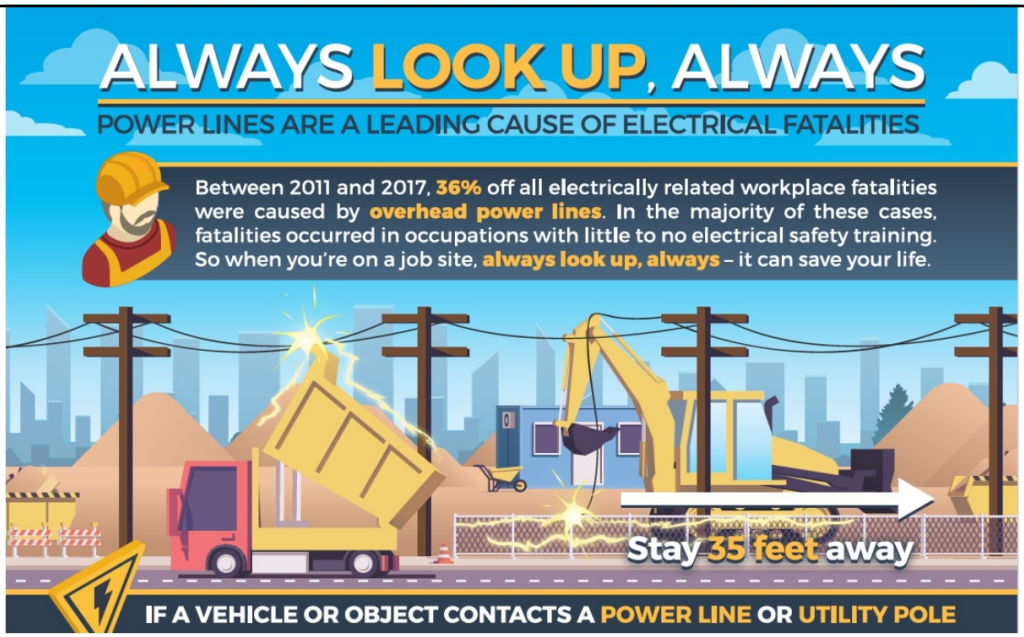
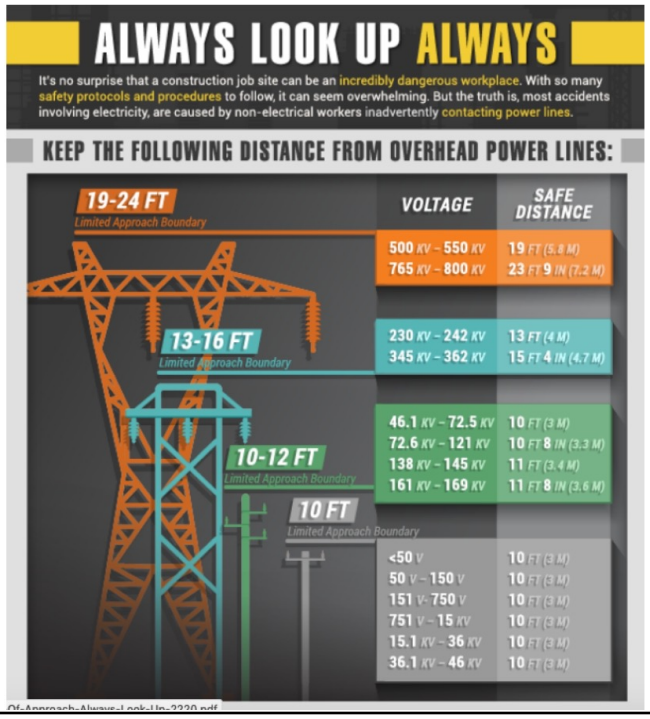


https://www.youtube.com/watch?v=sliTxeKrgCs

28



29

Electrical Survivor Story

30

Electricity Safety Basics

Electrical current wants to go back to its source!

- Not necessarily ground
- It may use the ground to get back to the source

It will take any and all available paths to get back to the source – including people

- Most of the current will travel on the "path of least resistance (impedance)
- Provides safe shortcut for current to return to source

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Electrical Hazards

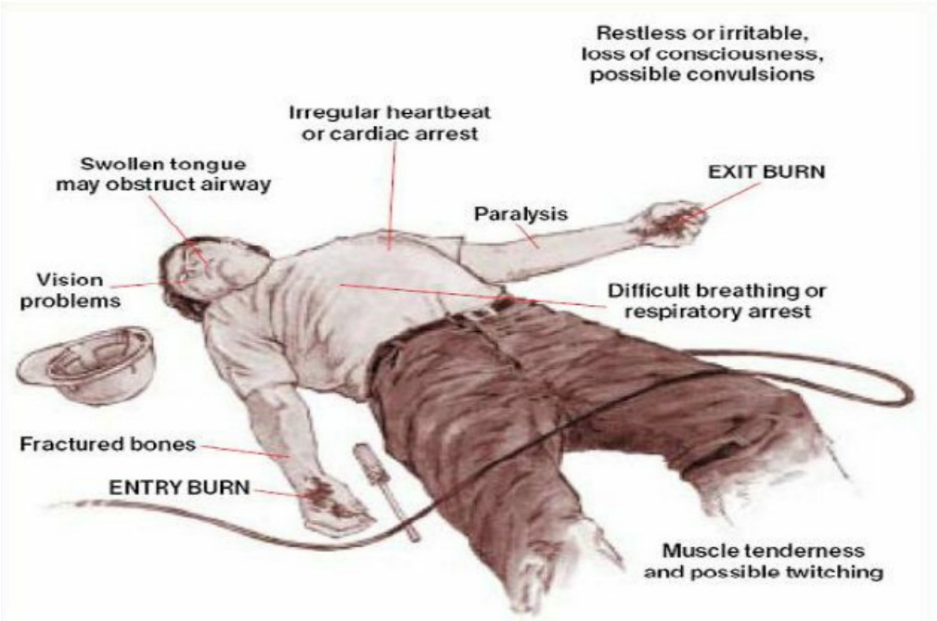
SHOCK

ARC FLASH

More than 90% of electrical fatalities among US workers are due to electrical shock. - IAEI

32

Electrical Injuries and Impacts



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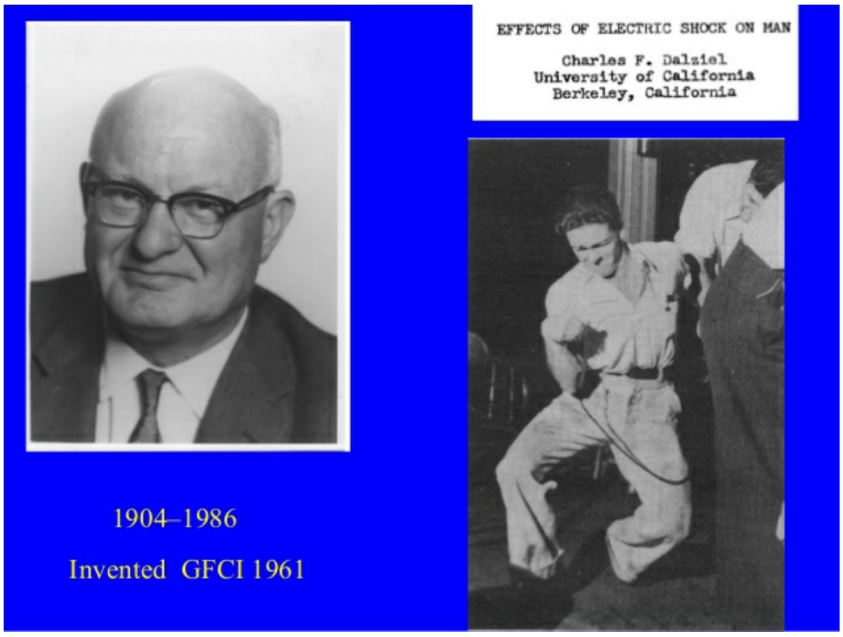

https://www.youtube.com/watch?v=AtLkesjZBXk

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Current vs Impact on the Human Body

Current in miliamps (ma)	Probable Effect on the Human Body
1 ma (.001 amp)	Perception level. Slight tingling sensation. Still dangerous under certain conditions.
5 ma (.005 amp)	Slight shock felt; not painful but disturbing. Avergage individual can let go. However, strong involuntary reactions to shocks in this range may lead to injuries.
6 ma – 16 ma (.006 - .016) amps	Painful shock, begin to lose muscular control. Commonly referred to as the freezing current or "let-go" range.
17 ma – 99 ma (0.017 -.099) amps	Extreme Pain, respiratory arrest, severe muscular contractions. Individual cannot let go. Death is possible.
100 ma – 2000 ma (.1 - 2 amps)	Ventricular fibrillation (uneven, uncoordinated pumping of the heart.) Muscular contraction and nerve damage begins to occur. Death is likely.
greater than 2000 ma (2 amps)	Cardiac arrest, internal organ damage, and severe burns. Death is probable

Note: GFCIs are set just below the "let-go" range (6ma)

https://www.youtube.com/watch?v=WfTWhRipM8s

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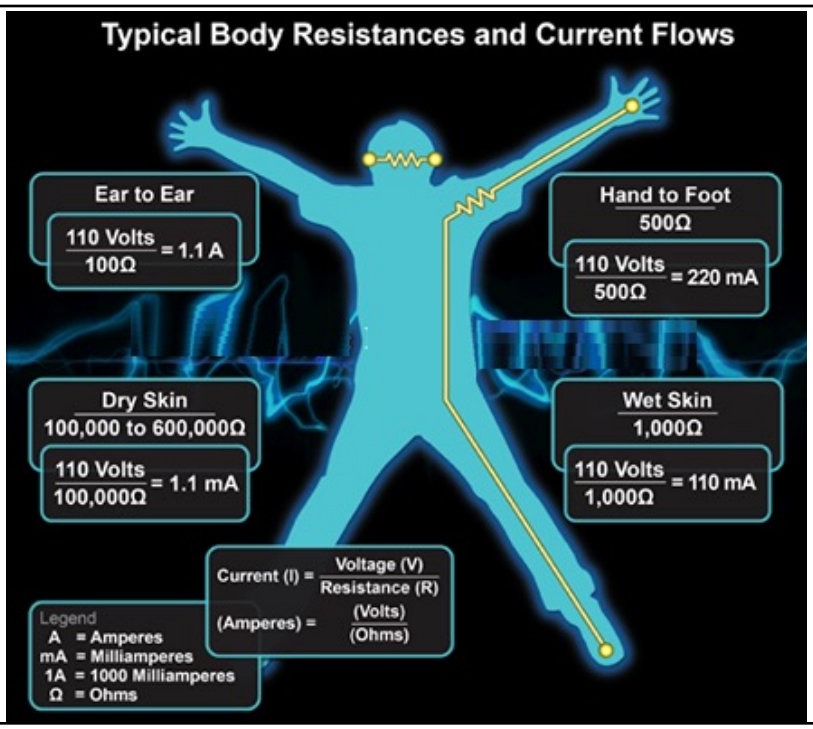

Severity of Shock Depends On:

- **Magnitude of the current**
- **Path through the body**
- **Duration of the current**

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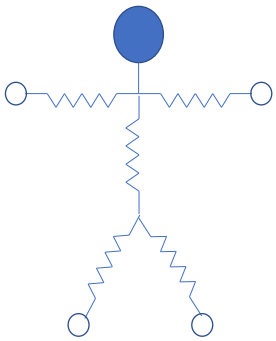
Body Resistance Chart

Paths Electricity Can Take Through Body

The lower the resistance, the more current flows

Body Part	Resistance (ohms)
Dry, intact skin (no cuts or scabs)	100,000 – 600,000
Wet skin	1000
Within the body	400
Ear to ear	100

V=IxR
I=V/R



Dry skin: I = V/R
I = 120 volts /100,000 ohms
I = 0.0012A = 1.2 mA
perception level, tingle

Wet skin: I = V/R
I = 120 volts/1000 ohms
I = 0.12 A = 120 mA
Ventricular fibrillation
Death is likely!

- Differences in men and women
- Salty and sweaty skin lowers resistance

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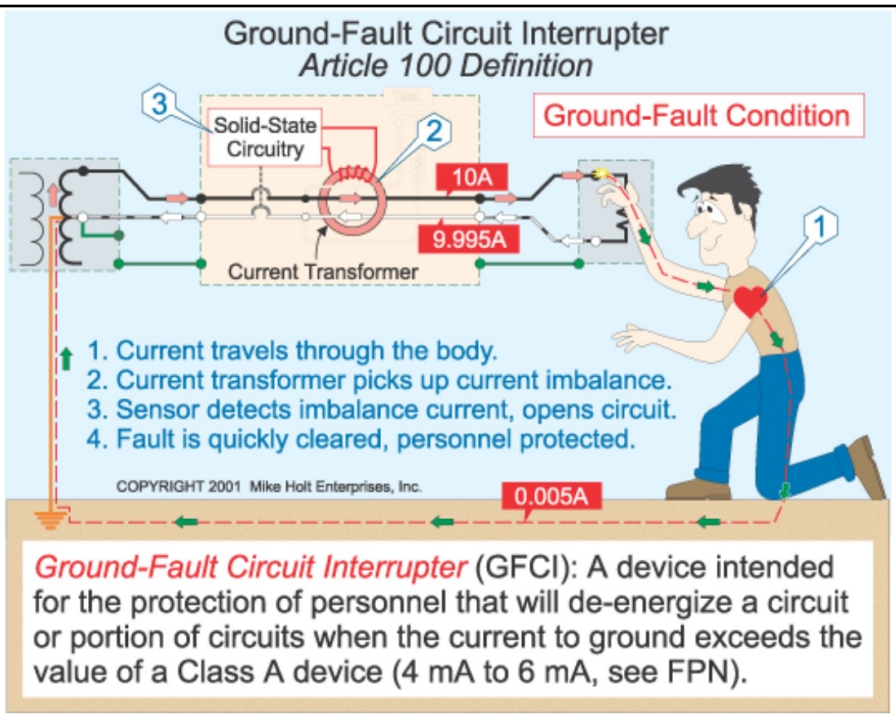

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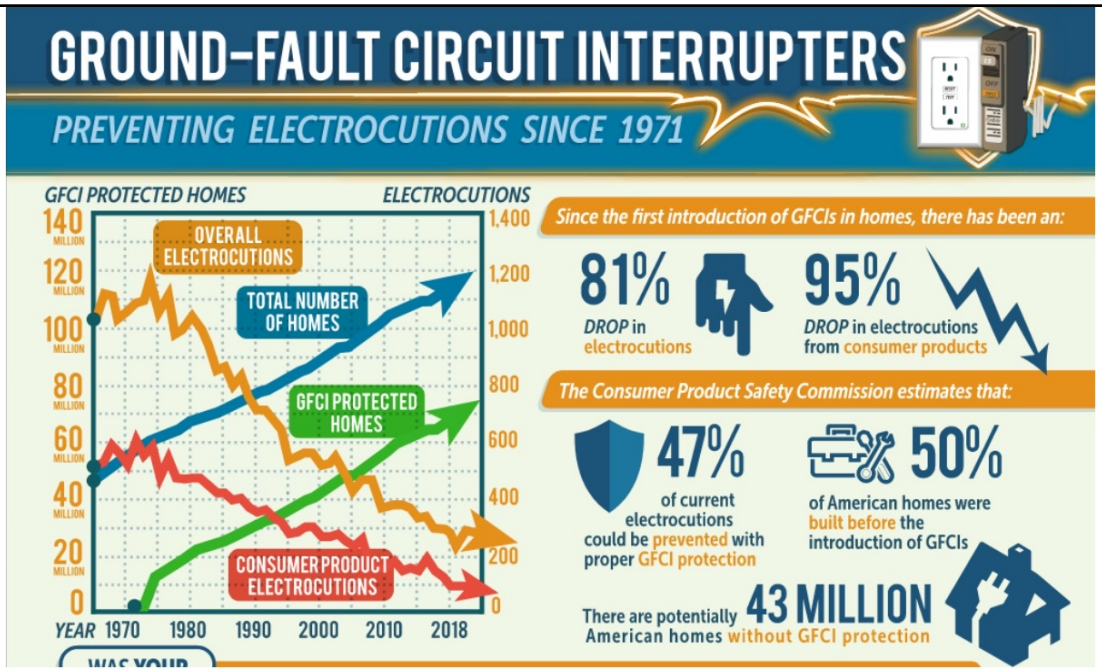

www.efsi.org

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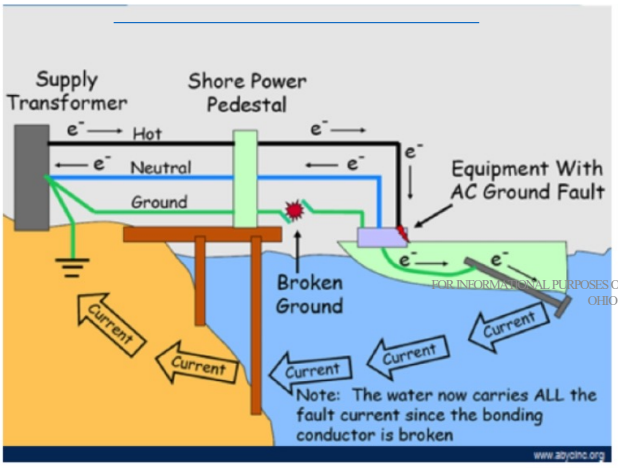
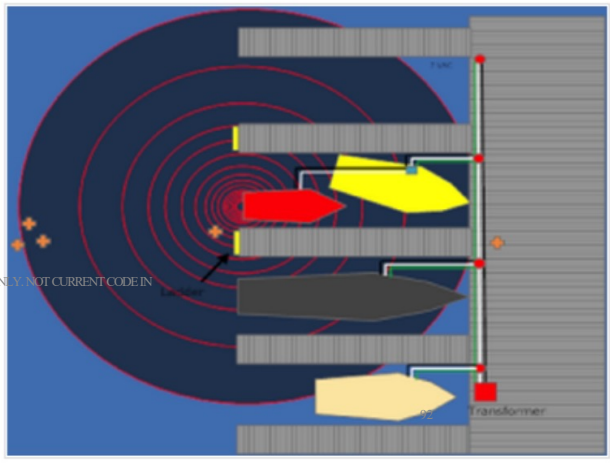
Electric Shock Drowning

https://www.youtube.com/watch?v=Cwi4lSMfH68&t=1s



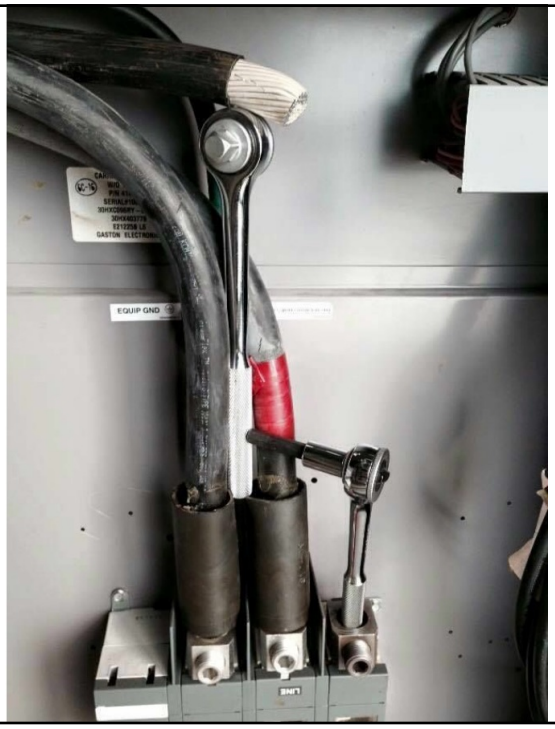


FOR INFORMATIONAL PURPOSES ONLY. NOT CURRENT CODE IN OHIO

40

More Safety Hazards

Let's just process this one for a while…



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How Many Amps is a Pop can Rated?

What is the clearing time?

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Grounding and Bonding!

Article 250

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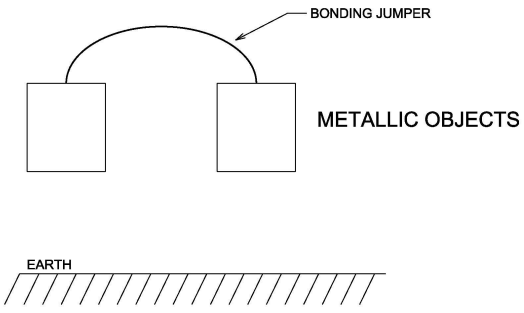
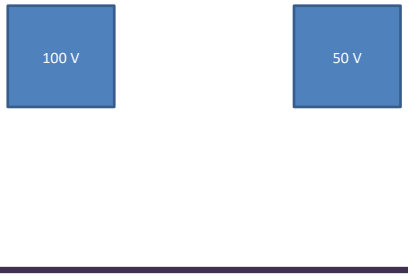
BONDING



- Both objects are at same voltage (equi-potential), but not necessarily 0 volts
- No current flow between bonded objects

44

Bonding Example (Before)



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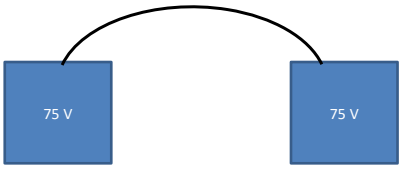
Bonding Example (After)



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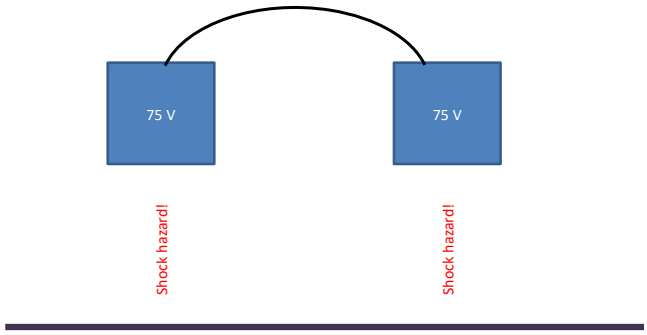
Bonding Example (After)



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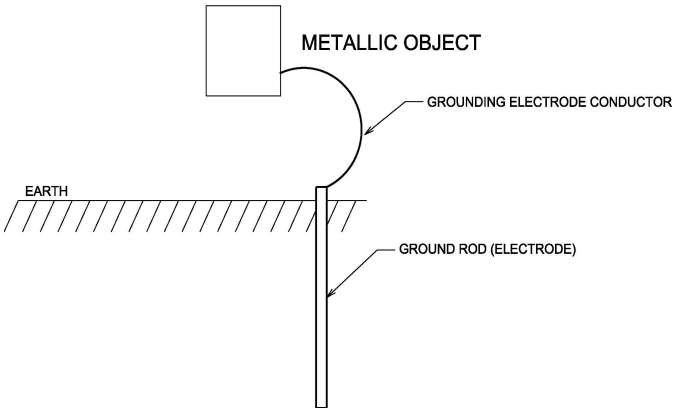
GROUNDING



Object is now at 0 volts (ground reference)

48

Grounding Example (Before)

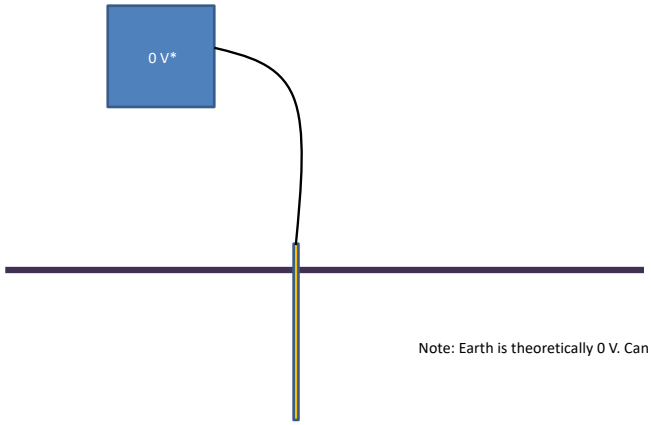
49

Grounding Example (Before)

Shock hazard!

50

Grounding Example (After)



Note: Earth is theoretically 0 V. Can have voltage gradients

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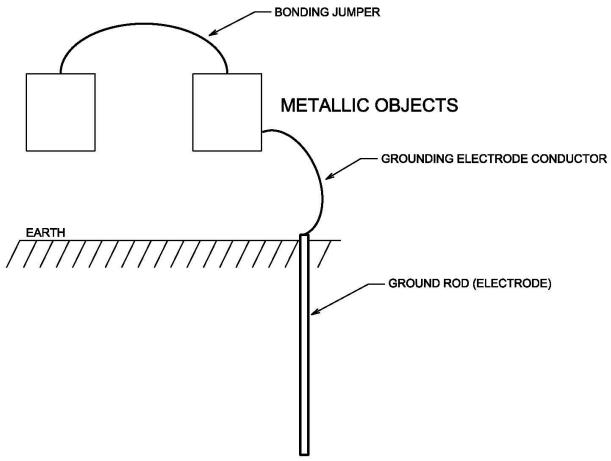
BONDING AND GROUNDING



Both objects are now at 0 volts

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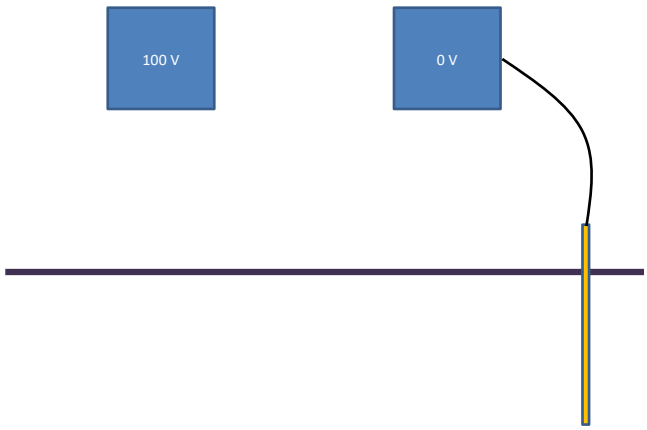
Grounding and Bonding Example (Before)



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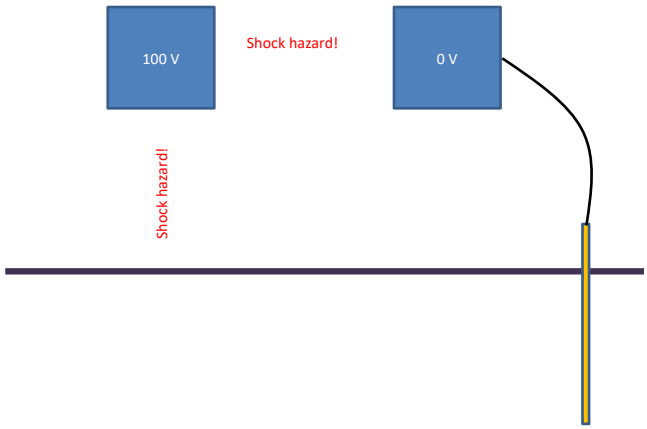
Grounding and Bonding Example (Before)



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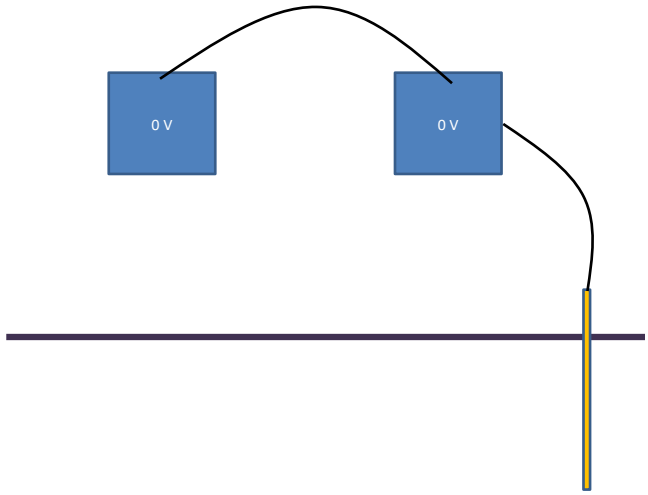
Grounding and Bonding Example (After)



55

Grounding and Bonding: Establish an Effective Ground Fault Path

Pros: It saves lives

Cons:

- High fault current levels possible
- Relies on proper and quick operation of fuses, circuit breakers and relays
  - Properly maintained!
- Conductive surfaces temporarily energized

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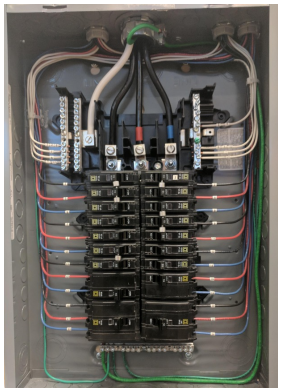
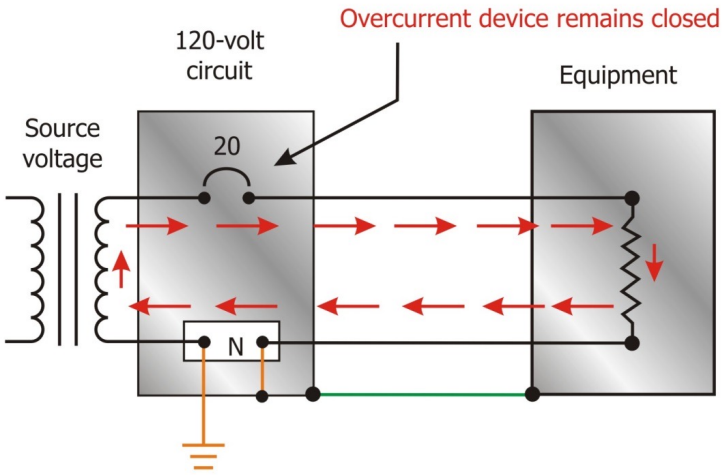
Purpose

- Low impedance (resistance) return fault current back to the source
- Fault (abnormal) current will use all metal to get back to source
  - Equipment grounding conductor (green wire)
  - Metallic conduit
  - Fittings
  - Enclosures
- Important to keep all connections tight to prevent
  - Arcing, sparking
  - High resistance connections
- High current intended to trip circuit breaker quickly



57

Normal Current in the Circuit



I = E ÷ R = 120 volts ÷ 80 ohms = 1.5 amps

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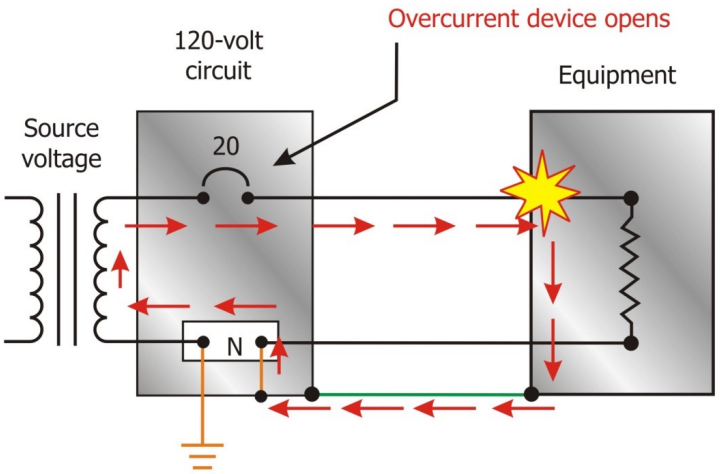
Ground-Fault Current in the Circuit



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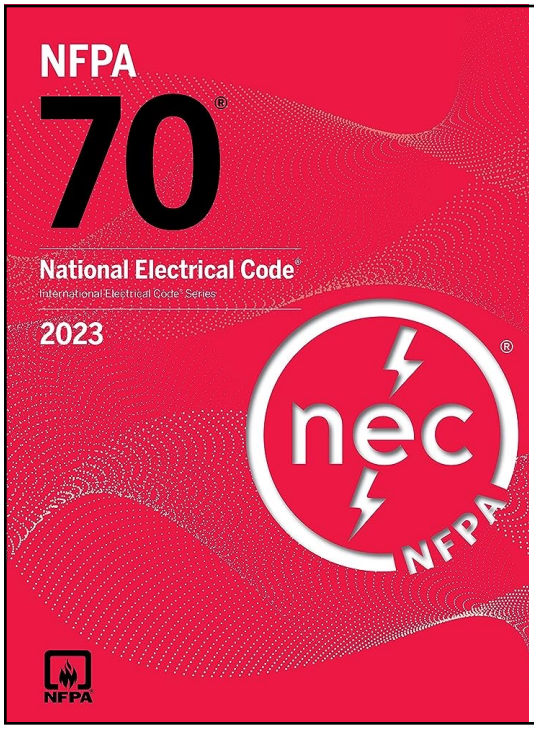
I = E ÷ R = 120 volts ÷ .5 ohms = 240 amps

Note: Unless ungrounded conductors are totally severed (broken), a certain amount of load current in the normal circuit will be present (under ground-fault conditions)

59



NEC Electrical Safety Requirements

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NEC Safety Highlights

- Definitions
- Labeling requirements
- Safe Working Spaces, Clearances
- GFCI requirements
- Grounding and Bonding

61

NEC 110.3 Examination, Identification, Installation, Use and Listing (Product Certification) of Equipment)

- Opinion: Similar to OSHA's General Duty Clause

- NEC 110.3(B) Installation and Use
  - Equipment that is listed, labeled, or both shall be installed and used in accordance with any instructions included in the listing or labeling.

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OSHA® Occupational Safety and Health Administration

OSHA General Duty Clause 5(a)(1):

(a) Each employer --

(1) shall furnish to each of his employees employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees;

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LISTING: Nationally Recognized Testing Laboratories (NRTL)
(List Maintained by OSHA)

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Working Space

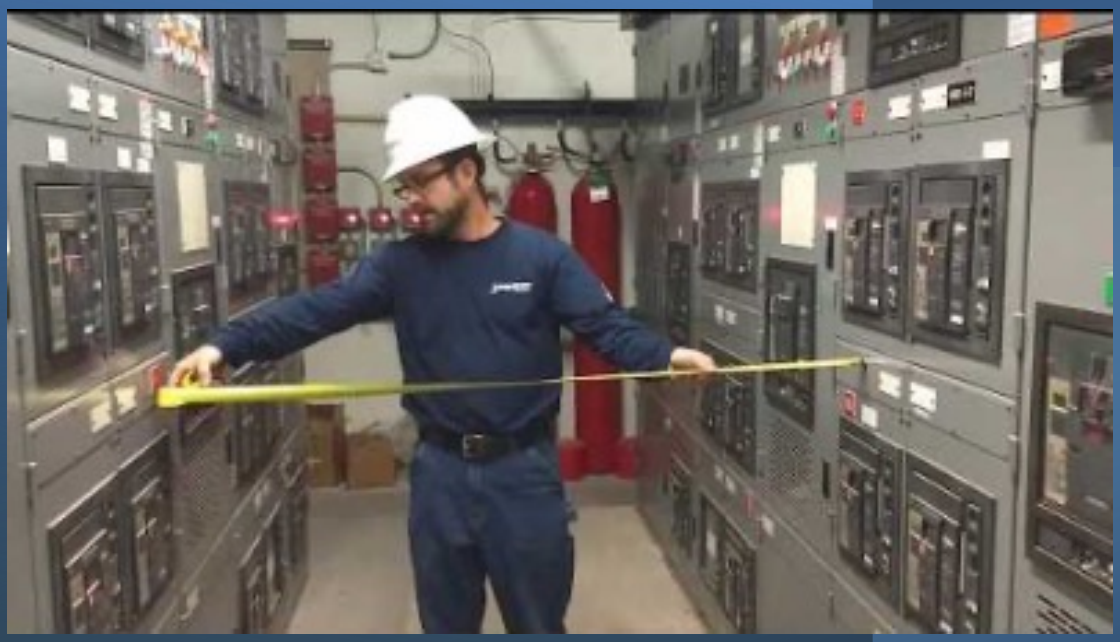
- Adequate working space shall be allocated around electrical equipment to provide for maintenance and safe operation

Nominal Voltage	Condition 1	Condition 2	Condition 3
0-150	3 ft	3 ft	3 ft
151-600	3 ft	3 ft – 6 in.	4 ft
601-1000	3 ft	4 ft	5 ft

Note: not related to Shock tables in NFPA 70E

https://www.youtube.com/watch?v=pEYuUd_USA

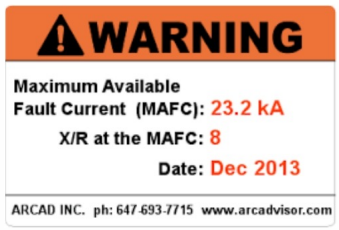
65



66

Labeling (hazard communication)

- Frequent target of inspectors!
- 2nd leading OSHA citations
-



67

Contrast

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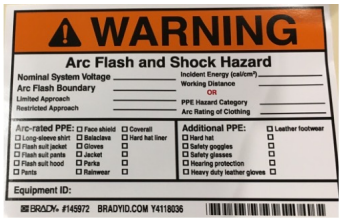
Equipment Labeling

- Equipment requiring examination, servicing, adjustment or maintenance while energized shall be marked with a label
- Label shall have:
  1. Nominal system voltage
  2. Arc flash boundary
  3. At least one of the following:
     - Incident energy and corresponding working distance or PPE category – but not both
     - Minimum arc rating of clothing
     - Site-specific PPE



69

210.8 (A) GFCIs for Dwelling Units	
210.8(A)(1)	Bathrooms
210.8(A)(2)	Garages and also accessory buildings that have a floor located at or below grade level not intended as habitable rooms and limited to storage areas, work areas, and areas of similar use
210.8(A)(3)	Outdoors
210.8(A)(4)	Crawlspaces
210.8A)(5)	Basements
210.8(A)(6)	Kitchens
210.8A)(7)	Areas with sinks and permanent provisions for food preparation, beverage preparation, or cooking
210.8(A)(8)	Sinks — where receptacles are installed within 1.8 m (6 ft) from the top inside edge of the bowl of the sink
210.8(A)(9)	Boathouses
210.8(A)(10)	Bathtubs or shower stalls — where receptacles are installed within 1.8 m (6 ft) of the outside edge of the bathtub or shower stall
210.8(A)(11)	Laundry areas
210.8(A)(12)	Indoor Damp and Wet locations

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Appliances

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Cases That Drove Change

52-year old plumber killed while installing dishwasher, came in contact with energized range

10-year old girl killed behind energized appliance

Oklahoma child retrieving pet behind clothes dryer

10-year old boy playing hide and seek

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210.8 (B) Other Than Dwelling Units	
210.9(B)(1)	Bathrooms
210.9(B)(2)	Kitchens
210.9(B)(3)	Areas with sinks and permanent provisions for food preparation, beverage preparation, or cooking
210.9(B)(4)	Buffet serving areas with permanent provisions for food serving, beverage serving, or cooking
210.9(B)(5)	Rooftops
210.9(B)(6)	Outdoors
210.9(B)(7)	Sinks where receptacles or cord-and-plug-connected fixed or stationary appliances are installed within 1.8 m (6 ft) from the top inside edge of the bowl of the sink
210.9(B)(8)	Indoor Damp and Wet locations
210.9(B)(9)	Locker rooms with associated showering facilities
210.9(B)(10)	Garages, accessory buildings, service bays, and similar areas other than vehicle exhibition halls and showrooms
210.9(B)(11)	Crawl Spaces
210.9(B)(12)	Unfinished Areas of basements
210.9(B)(13)	Aquariums, bait wells, and similar open aquatic vessels or containers, such as tanks or bowls, where receptacles are installed within 1.8 m (6 ft.) from the top inside edge or rim or from the conductive support framing of the vessel or container
210.9(B)(14)	Laundry Areas
210.9(B)(15)	Bathtubs and shower stalls where receptacles are installed within 1.8 m (6 ft) of the outside edge of the bathtub or shower stall

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GFCI Requirements Common to Both Dwelling and Non-Dwelling Units	Articles
Crawl Space lighting outlets	210.8(C)
Specific Appliances	210.8(D)
Equipment Requiring Servicing	210.8(E) and 210.63
Outdoor Outlets △	210.8(F)
Sumps Pumps △	422.5(A)(6)
Dishwashers	422.5(A)(7)
Docks, marinas, boatyards etc. △	Article 555
Swimming Pools, Spas, hot tubs, baptismal pools, splash ponds, etc. △	Article 680

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Chapter 5 GFCI Requirements

Requirement	Article
Commercial Garages	511.12
Agricultural Buildings ⚠	547.5(G)
Mobile Homes, Manufactured Homes, Mobile Homes ⚠	550.13(B)

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Chapter 6 GFCI Requirements

Requirement	Reference
Elevator Pits, Hoistways, Dumbwaiters etc. ⚠	620.6
Electric Vehicle Charging Equipment ⚠	625.54
Storable and Portable Immersion Pools	680.35
Permanently Installed Immersion Pools	680.45
Fountains including Splash Pads ⚠	680.50
Pool motors ⚠	680.21(C)
Pool pump motor replacements	680.21(D)
Pool equipment room	680.22(A)(5)
Permanently Installed Non-submersible pumps	680.59
Natural and Artificially Made Bodies of Water ⚠	682.15

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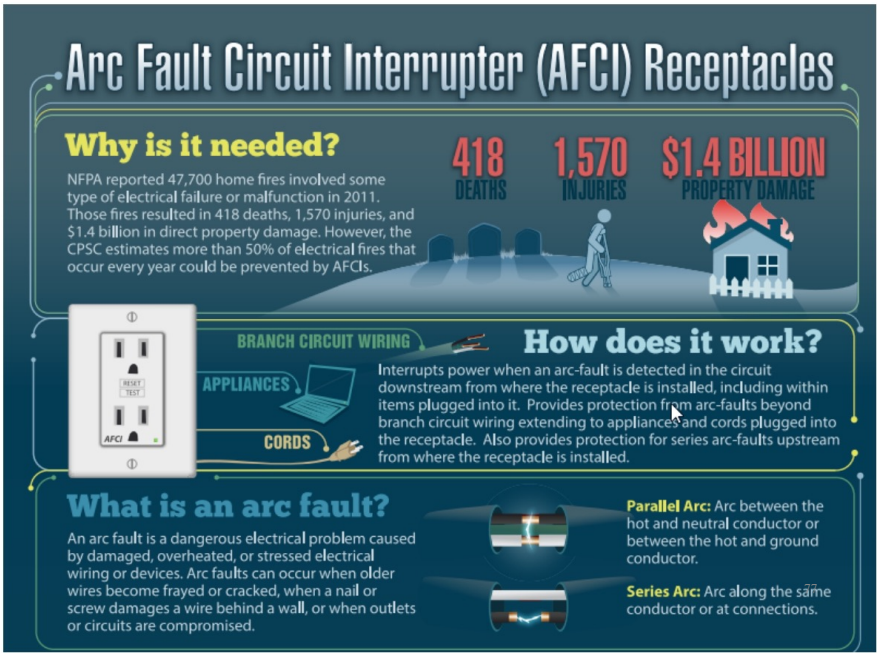
https://www.youtube.com/watch?v=C-SBly_2bPQ

www.ESFi.org



77

AFCI Requirements

Area	AFCI	AFCI Code reference
Kitchen	X	210.12(A)
Dining Room	X	210.12(A)
Bedroom	X	210.12(A)
Closets	X	210.12(A)
Living Room	X	210.12(A)
Family Room	X	210.12(A)
Parlor	X	210.12(A)
Libraries	X	210.12(A)
Hallway	X	210.12(A)
Laundry Room	X	210.12(A)
Den	X	210.12(A)
Sunroom	X	210.12(A)
Recreation Room	X	210.12(A)
Dormitory units	X	210.12(B)
Dormitory bathrooms	X	210.12(B)
Patient Sleeping Rooms in Nursing Homes and Limited-Care Facilities	X	210.12(C)
Hotel Guest rooms and suites	X	210.12(D)

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Tamper Resistant Receptacles	Reference
Dwelling units including	406.12(1)
Attached and detached garages and accessory buildings to dwelling units	406.12(1)
Common areas of multifamily dwellings	406.12(1)
Guest rooms and guest suites of hotels, motels, and their common area	406.12(2)
Child care facilities	406.12(3)
Preschools and Education facilities	406.12(4)
Business office, corridors, waiting rooms and the like in clinics, medical and dental offices, and outpatient facilities	406.12(5)
Subset of assemblies occupancies described in 518.2 to include places of awaiting transportation, gyms, skating rinks and auditoriums	406.12(6)
Dormitory Units	406.12(7)
Assisted Living Facilities	406.12(8)

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Purpose

To provide a practical safe working environment for workers and observers from the hazards of electricity

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Scope

- Industrial, Commercial, Government etc.
- Practices recommended for residential, but not mentioneds pecifically in NFPA 70E
- Not covered: utilities outside of buildings, marine, communications industry

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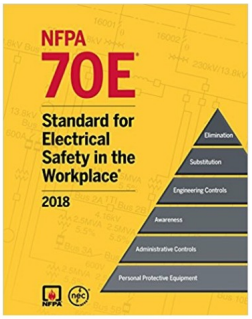
The OSHA Connection

- OSHA is the "Shall"
- NFPA 70E is the "How"



OSHA
Occupational Safety and Health Administration

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NFPA 70E Highlights

- Hierarchy of Risk Controls
- Safe Work Practices
- Qualified vs Unqualified Persons
- Establishing an Electrically Safe Work Condition
- PPE selection (Table vs Incident Energy Method)
- Lockout Tagout and Energy Isolation
- Shock and Arc Flash Protection Boundaries
- ”Normal Operating Conditions” (controversial)
- Energized Work and Energized Work Permit
- Communication
- Emergency Procedures
- Training and documentation to prove it

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Key Concepts

Don’t work on equipment live!

Turn off equipment 50V and before working on it

Conduct Hazard Risk Assessment

The role of the Qualified Person

Energy Isolation/Lockout Tagout

Wear proper PPE

Understand the arc flash label

Communication!

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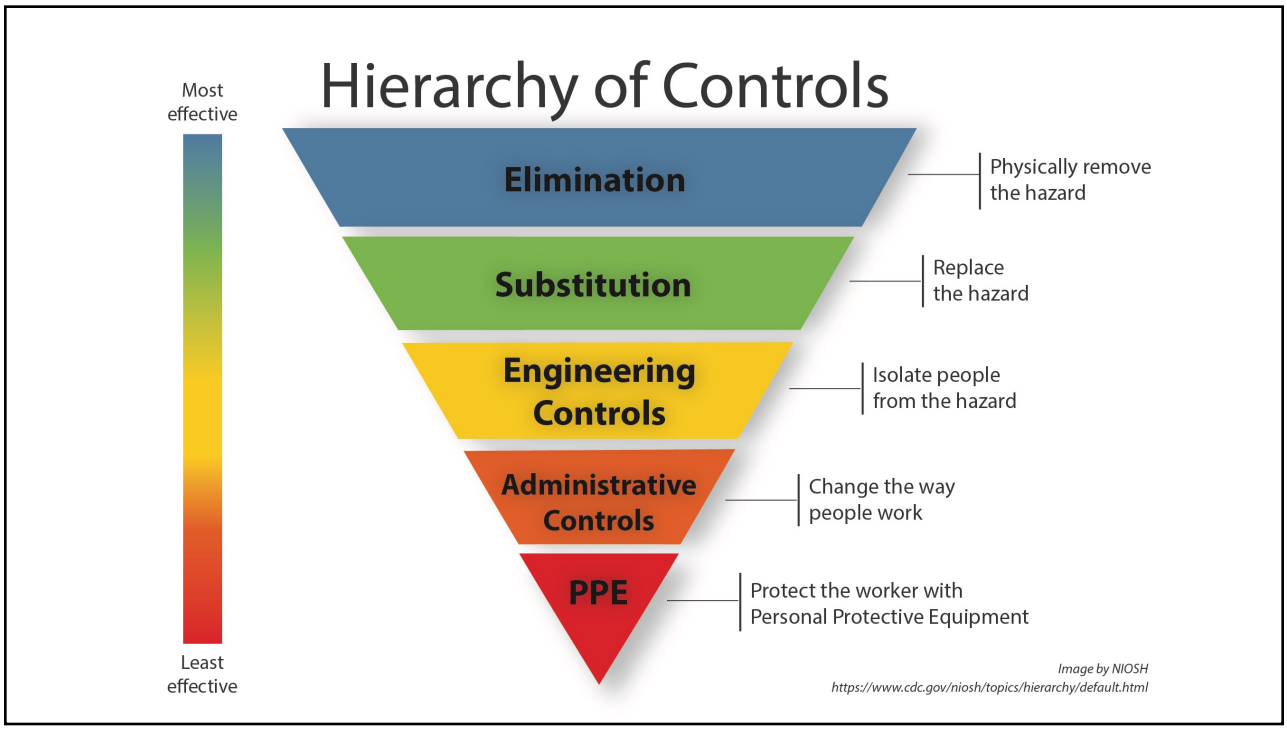

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Examples

- **Elimination -** Turn it off!
- **Substitution –** 24 VDC for 120 VDC
- **Engineering Controls** – arc resistant gear, coordination
- **Awareness –** training, labels
- **Administrative Controls –** standards, policies, codes
- **PPE** – last line of defense

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CONGRATULATIONS!

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Next Steps

- A Certificate of Completion will be emailed to those who successfully completed course
- 4 hours of Code Class Hours will be reported to the OCILB for Code Continuing Education Credits
- Contact instructor at hpmatthews@matthewselectrical.net for any questions or comments
- Make sure you completely sign out of webinar after the next slide!

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File Attachments for Item:

ER-10 NEC 2023 Load Calculations (Electrical League of Ohio)

All certifications (4 hours)

Staff Notes:

ESIAC Recommendation:

Committee Recommendation:

Application for Continuing Education Course Approval

Provider Information

Name *	Organization	Email *	Phone Number *
Terri	Hanna	terrihanna-wiehn@sbcglobal.	(440) 333-5040

Address *	City *	State *	Zip Code *
20575 Center Ridge Road	Rocky River	Ohio	44116

Website	Conference Sponsor (if applicable)	Conference Email
www.electricalleague.com		

☐ Check here if Course Renewal

Prior course number(s)' (i.e. BBS2018-429)

Renewals will only be granted for identical content and hours, within the current code cycle. Attach a copy of prior course approval letter for confirmation. No further information is required

New Course Information

Course title

NEC Load Calculations

Course instructor

Timothy G. Pool, PE, RCDD, ESI 7011

Course description

Executive Summary of course: Completing electrical load calculations are sometimes the most misunderstood concept in the National Electrical Code. Increases in the number of Electric Vehicles in the market make calculating loads in dwelling units and commercial buildings critical. This class course will cover the basics of calculating load on existing and new structures including dwelling units and commercial buildings on branch circuits, feeders, and services.
Article 220 – Branch Circuit, Feeder, and Service Load Calculations Class Time
• Article 215.5 Diagrams of Feeders 10 min
• Article 220.5 Calculations 30 min
• Article 220.11(A) Motor-Operated and Combination Loads 20 min
• Article 220.11(C) Electric Cooking Appliances 10 min
• Article 220.14(B) Electric Dryers 10 min
• Article 220.14(I) Receptacle Outlets 20 min
• Article 220.16 Loads for Additions to Existing Installations 20 min
• Article 220.40 Feeder and Service Load Calculations 20 min
• Article 220.42(B) Energy Code. 20 min
• Article 220.45 General Lighting 10 min
• Article 220.50 Motors and Air-Conditioning Equipment 20 min
• Article 220.51 Fixed Electric Space Heating. 10 min
• Article 220.54 Electric Clothes Dryers 10 min
• Article 220.57 Electric Vehicle Supply Equipment 15 min
(EVSE) Load

• Article 220.70 Energy Management Systems (EMSs). 15 min
Total 4 hours

Instructional hours per session	Number of Sessions	Course Date	Course Location
4	1	2023-11-15	12975 Corporate Drive, Parm

Special Content

- [x] Code Administration
- [x] Existing Buildings
- [x] Electrical Instruction
- [ ] Plumbing Instruction

Conference Course	Conference Name	Conference location

Course to be offered online?

- [ ] Yes
- [x] No

- [ ] On Demand
- [ ] Webinar

Course Website

Detail online course participation confirmation method (i.e. test, quizlets, participant activity confirmation):

Course applicable for the following certifications *

- [x] Residential Certifications Only
- [x] Administrative Course, All Certifications
- [x] Commercial and Residential Certifications

Application materials included *

- [x] Course Outline or Course Learning Objectives
- [x] Presentation Materials/Slides (not required for roundtable courses)
- [ ] Assessment Materials (for online courses)
- [x] Presenter Bio
- [ ] Prior Course Approval Letter

Upload less than 100mb (Please attach PDF files only) *

File Name	Size
NEC Electrical Load Calculations - 4 HR April 2023.pdf	1.03 MB

Applicant Full Name *	Date of Submission
Theresa Hanna Wiehn	11/07/2023

Instructions for new Continuing Education Approval form

Provider Information

1. Please include all contact information.
2. If course is not part of a conference, leave conference sponsor and email blank.

Course Renewal

1. Indicate if the course is being submitted for renewal. Include prior approval letter and write in prior course number.
2. Certification approval for courses has now changed: all existing courses being renewed will be approved within the new classification system.
    a. Courses previously approved for only residential certifications will be approved for all residential certifications.
    b. Courses previously approved for at least one commercial certification will now be approved for all commercial certifications and all residential certifications.
    c. Courses on required instruction topics, Ohio Ethics, Code Administration and Existing Buildings, will be noted as Administrative Courses and be approved for all certifications.
3. Courses being renewed should skip the New Course information section and are not required to submit outline, agenda, slides or other instructional materials for review.

Skip to Special Content, and mark any item that applies to the course.

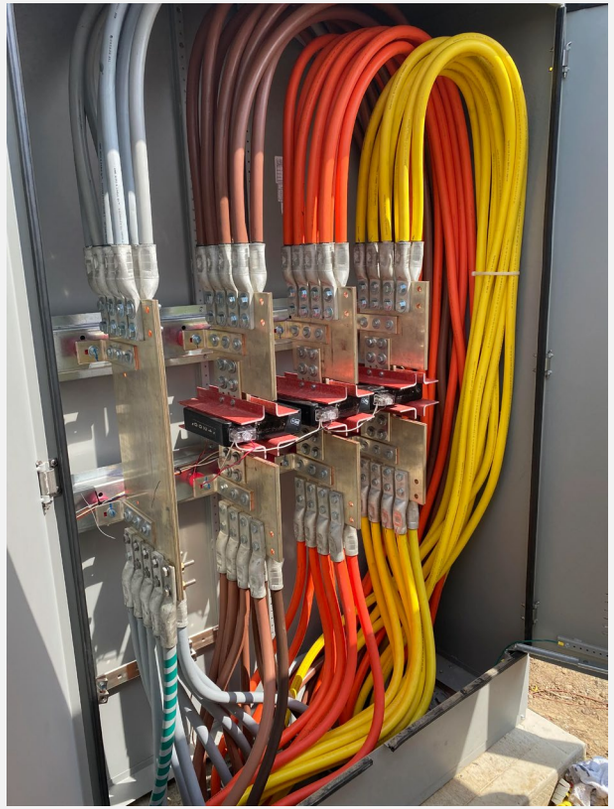
New Course Information

1. Enter course title, name of instructor, and a brief description of the course content.
Learning objectives may be substituted for course description, if desired.
2. Number of instructional hours per session is the length of instructional time.
3. Number of sessions: can be 1 or the number of sessions planned.
4. Course date(s) and location: not necessary at this time, enter if known.

Special Content

1. Indicate if the course will meet instructional time in Code Administration or Existing Buildings.
2. Indicate if the course is a plumbing or electrical course, for ESIAC review and trainee course tracking.
3. If the course is associated with a conference, indicate the conference name and location, as this will allow BBS to coordinate approvals with the conference provider.
4. If the course will be offered online, specify whether it will be on demand or offered as a virtual webinar, or both. Include website where the course will be provided.

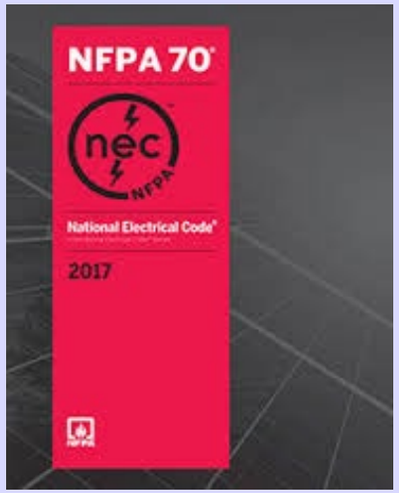
Electrical Load Calculations

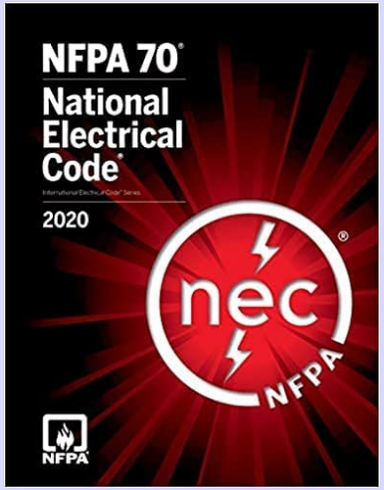


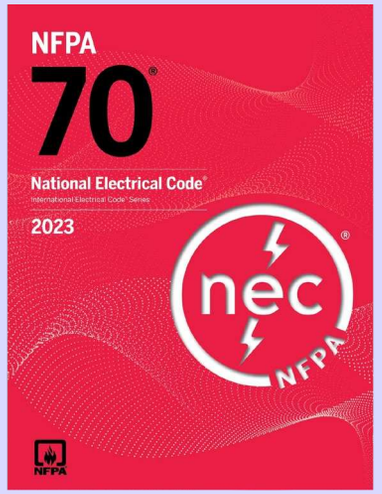
ELECTRICAL LEAGUE of Ohio

Presented by: Timothy Pool, P.E., RCDD, ESI

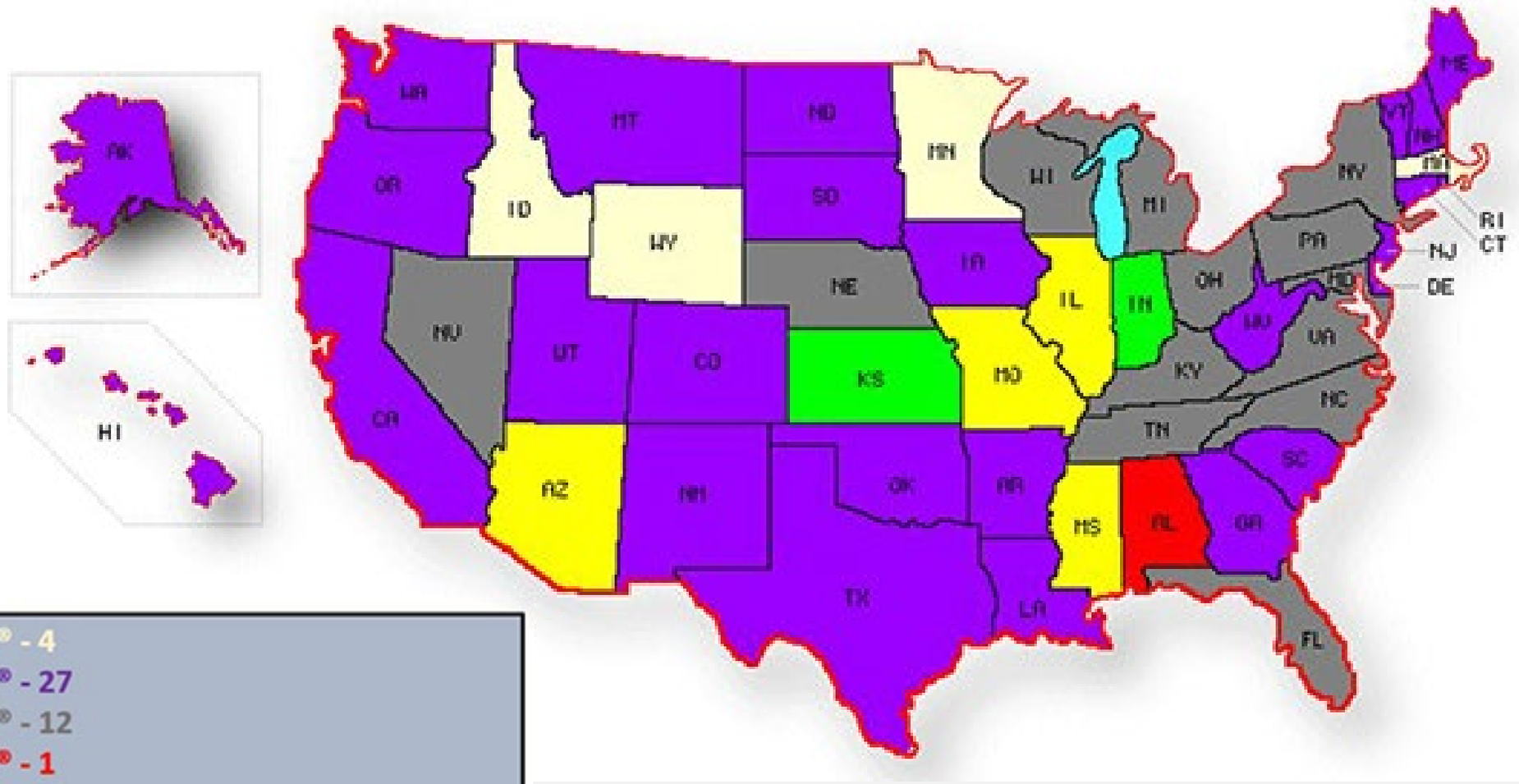
Intro and Code Update Status







NEC® in Effect
7/1/2023



2023 NEC® - 4
2020 NEC® - 27
2017 NEC® - 12
2014 NEC® - 1
2008 NEC® - 2
County/Municipality NEC® regulation only - 4

Source: diynetc.net (c)

NEC® Update Process In Progress
7/1/2023

2023 NEC® Update Process Underway - 12
2020 NEC® Update Process Underway - 3
Current Update Process Completed - 31
(See NEC® in Effect Map for Updated Edition)
County/Municipality NEC® regulation only - 4

Summary

The Ohio Board of Building Standards meeting on August 11, 2023, approved adoption of the 2023 NEC for Ohio effective **March 1, 2024**

Ohio will skip the 2020 NEC.

For now, permitting and inspections for all new construction on both commercial and residential remains on the 2017 NEC.

Class Outline

- General Introduction
- Residential Feeder and Service Calculations
- Branch Circuit Load Calculations
- Commercial Feeder and Service Calculations
- Adding to an existing service

A 10-minute break will be given every hour.

Questions are encouraged.

The presentation will be available from Terri after the class.

General Introduction to Article 220

Residential Load Summary Example

Parts 6 and 7 were relocated in the 2023 NEC to Article 220.

Article 220 is divided up into 5 parts that help you know what type of load calculation you are performing:

Part 1 – General

Part 2 – Branch Circuit Load Calculations

Part 3 – Feeder and Service Load Calculations

Part 4 – Optional Feeder and Service Load Calculations

Part 5 – Farm Load Calculations

N **Part 6 – Healthcare facilities**

N **Part 7 – Marinas, Boatyards, Floating Buildings and Commercial and Noncommercial Docking Facilities**

Article 220 - Part 1
General Info and Calculating Floor Area

ARTICLE 220 – PART 1

Table 220.3 Specific-Purpose Calculation References

Calculation	Article	Section (or Part)
Air-conditioning and refrigerating equipment, branch-circuit conductor sizing	440	Part IV
Capacitors	460	460.8
Fixed electric heating equipment for pipelines and vessels, branch-circuit sizing	427	427.4
Fixed electric space-heating equipment, branch-circuit sizing	424	424.3
Fixed outdoor electric deicing and snow-melting equipment, branch-circuit sizing	426	426.4
Fixed resistance and electrode industrial process heating equipment	425	425.4
Motors, feeder demand factor	430	430.26
Motors, multimotor and combination-load equipment	430	430.25
Motors, several motors or a motor(s) and other load(s)	430	430.24
Over 1000-volt ac and 1500-volt dc branch-circuit calculations	235	235.19
Over 1000-volt feeder calculations	215	215.2(B)
Phase converters, conductors	455	455.6
Storage-type water heaters	422	422.11

220.3 Other Articles for Specific-Purpose Calculations.

Table 220.3 shall provide references for specific-purpose calculation requirements not located in Chapters 5, 6, or 7 that amend or supplement the requirements of this article.

Multi-motor Air Conditioning equipment for example can be sized based on the MCA marked by the manufacturer on the equipment.

ARTICLE 220 – PART 1

220.5 Calculations.

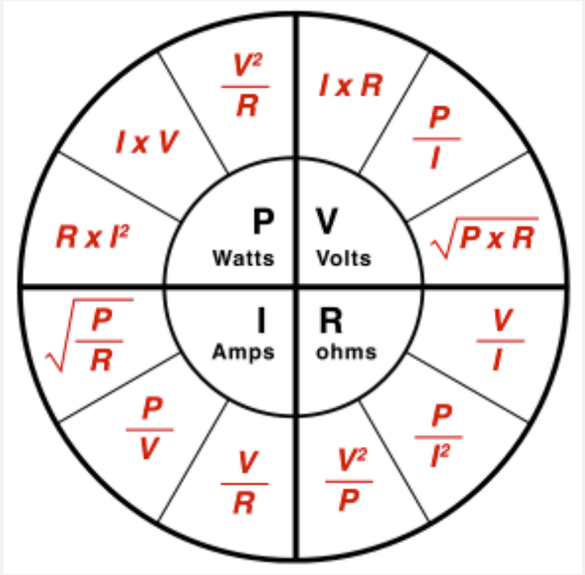
220.5(A) Voltages.

Unless other voltages are specified, for purposes of calculating branch-circuit and feeder loads, nominal system voltages of 120, 120/240, 208Y/120, 240, 347, 480Y/277, 480, 600Y/347, and 600 volts shall be used.

220.5(B) Fractions of an Ampere.

Calculations shall be permitted to be rounded to the nearest whole ampere, with decimal fractions smaller than 0.5 dropped.

ARTICLE 220 – PART 1



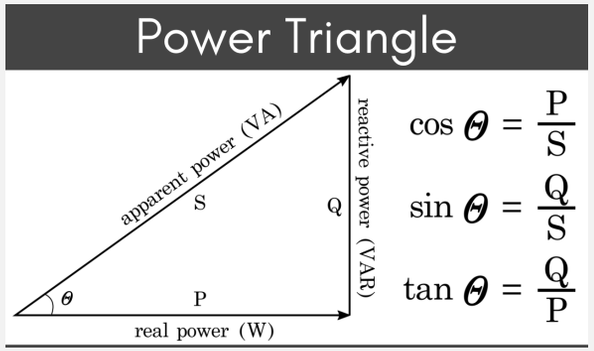
220.5 Calculations. Explanation

We always use KW or KVA for our loads rather than amps. The same amps load has a different KW load based on the system voltage and phase. For example, on a **120/208V, 3 phase, 4 wire panel:**

A 30-amp 208 volt, 1 phase load (2 pole) = 6.24 KW (30 × 208)

A 30-amp 208 volt, 3 phase load (3 pole) = 10.8 KW (30 × 208 × √3)

A 30-amp 120 volt, 1 phase load (1 pole) = 3.6 KW (30 × 120)



Adding the amps together we have 90 amps (30+30+30) (Incorrect)

Adding the KW together and then finding the amps from the system voltage = 57 amps (6240+10800+3600 / 208 / √3) (Correct)

ARTICLE 220 – PART 1

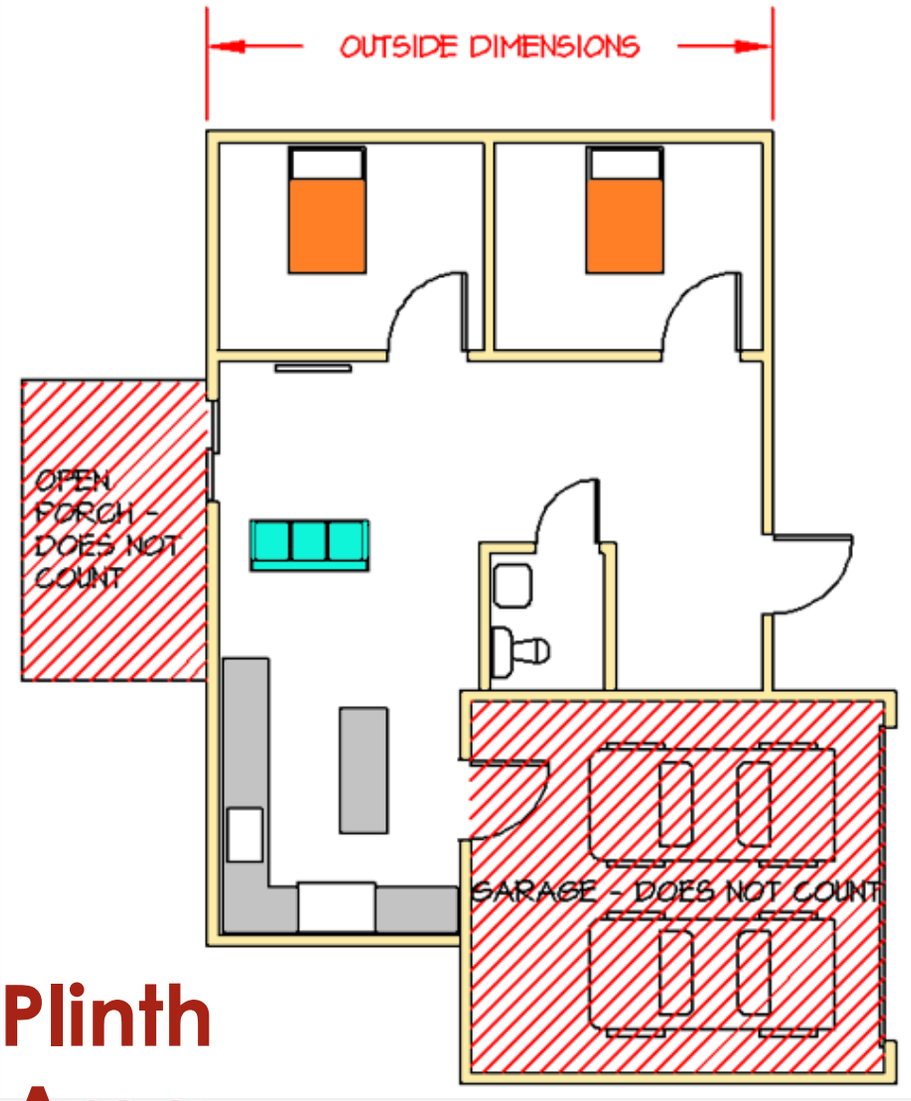
220.5 Calculations. Explanation

It is also incorrect to assume the total of the branch circuit calculated wattage is the same as the total wattage of the feeder or service. The total of the branch circuit wattage will be greater because there are no demand factors in the branch circuit calculations.

I have a panel in my house with 30, 20/1 circuit breakers so my total service load is calculated to be 30 x 16 amps = 480 amps. (Incorrect)

Each load on the branch circuit is calculated in accordance with Part 2 of Article 220 and the service or feeder total is calculated in accordance with Part 3 of Article 220 with appropriate demand factors. (Correct)

ARTICLE 220 – PART 1



Plinth Area

220.5 Calculations.

220.5(C) Floor Area.

The floor area for each floor shall be calculated from the outside dimensions of the building, dwelling unit, or other area involved. For dwelling units, the calculated floor area **shall not** include open porches or unfinished areas not adaptable for future use as a habitable room or occupiable space.

Note: Typical Architectural floor areas subtract the area occupied by walls.

Article 220 - Part 3
Feeder and Service Load Calculation

Article 220 – Part 3 Dwelling Units

Part III. Feeder and Service Load Calculations

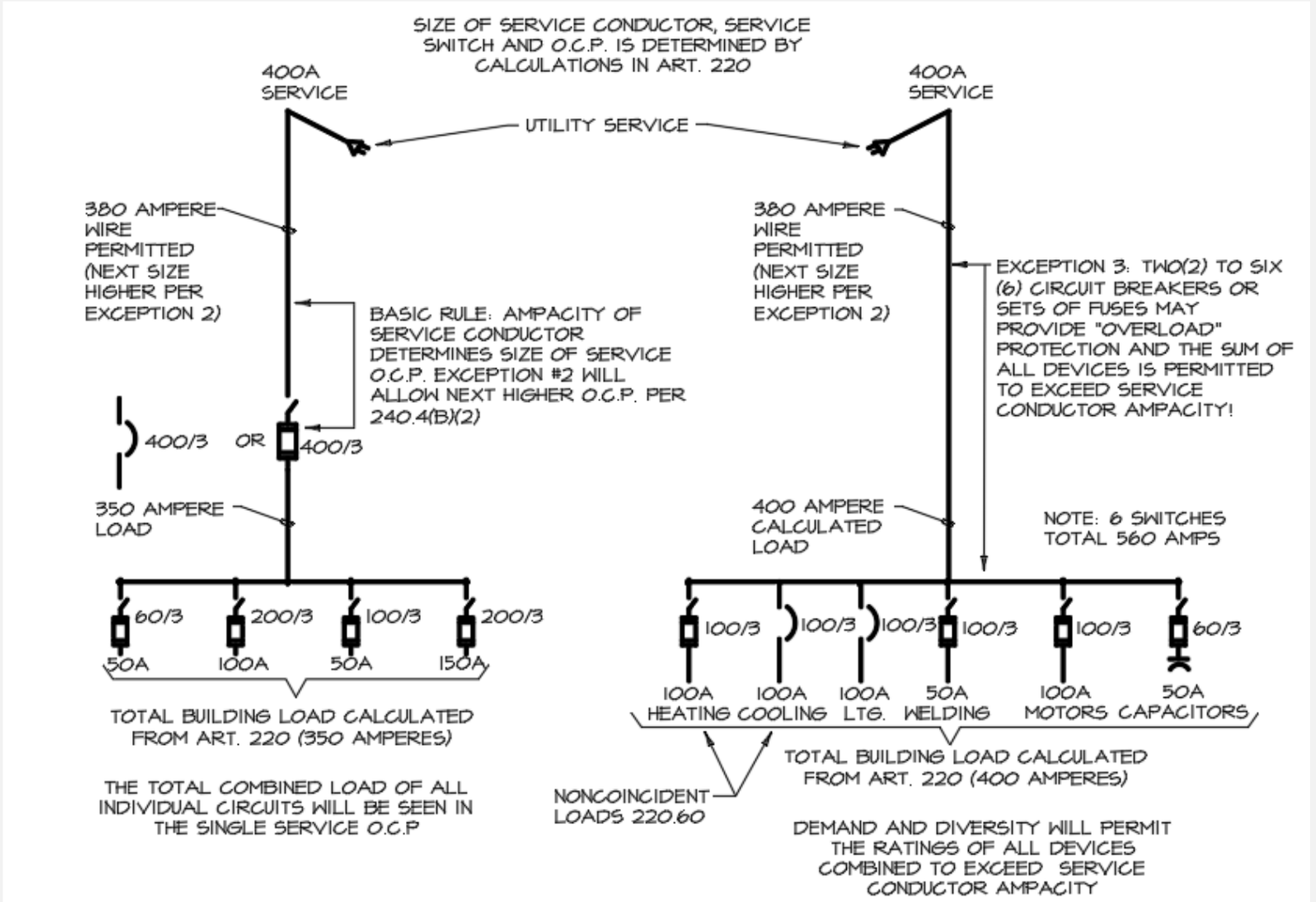
220.40 General.

The calculated load of a feeder or service shall not be less than the sum of the loads on the branch circuits supplied, as determined by Part II of this article, after any applicable demand factors permitted or required by Part III, IV, V, VI, or VII have been applied.

Informational Note No. 1: See Informative Annex D, Examples D1(a) through D10, for examples of feeder and service load calculations.

Informational Note No. 2: See 220.11(B) for the maximum load in amperes permitted for lighting units operating at less than 100 percent power factor.

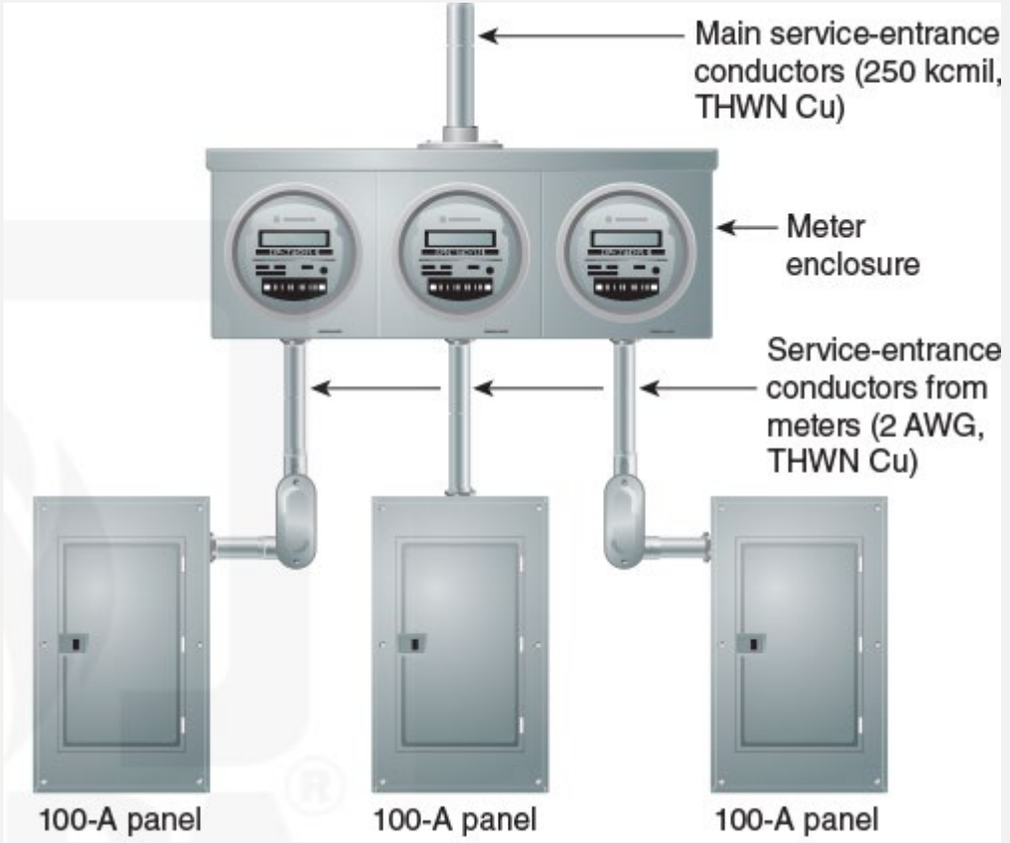
Article 220 – Part 3 Dwelling Units



ARTICLE 230.90 AND EXCEPTIONS
PROVIDE RULES FOR SERVICE OVERCURRENT PROTECTION

Example 1: The main service overcurrent device and conductor size may be smaller than the combined sum of the branch feeders because of the larger diversity on the service and smaller diversity on the feeders.

Article 220 – Part 3 Dwelling Units



Example 2: If each panelboard supplies a calculated load of 80 amperes. The main set of service conductors is sized to carry the total calculated load of 240 amperes (3 × 80 A). The service conductors from the meter enclosure to each panelboard (2 AWG Cu = 95 A per 60°C column of Table 310.16) are sized to supply a calculated load of 80 amperes and to meet the requirement of 230.90 relative to overcurrent (overload) protection of service conductors terminating in a single-service overcurrent protective device (OCPD). The main set of service conductors (250 kcmil THWN Cu = 255 A per 75°C column of Table 310.16) is not required to be sized to carry 300 amperes based on the combined rating of the panelboards. The individual service-entrance conductors to each panelboard (2 AWG THWN) meet the requirement of 230.90.

Article 220 – Part 3 Dwelling Units

Note: this includes apartments

220.41 Dwelling Units, Minimum Unit Load.

In one-family, two-family, and multifamily dwellings, the minimum unit load shall be not less than 33 volt-amperes/m^2 (3 volt-amperes/ft^2).

Unit loads include the following lighting and receptacle outlets, and no additional load calculations shall be required:

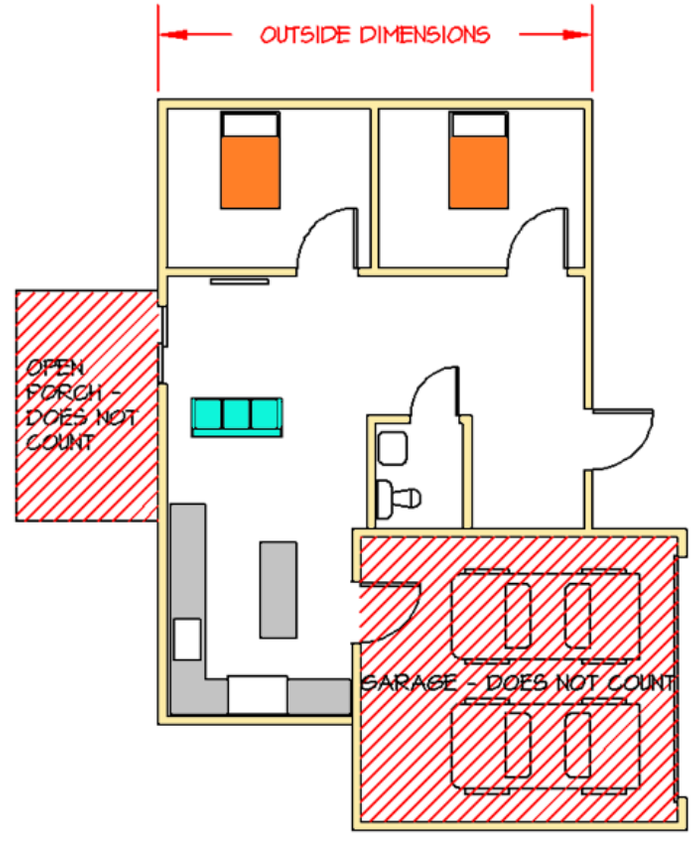
(1) All **general-use receptacle outlets** of 20-ampere rating or less, including receptacles connected to the circuits specified in 210.11(C)(3) and (C)(4)

(2) The receptacle outlets specified in 210.52(E) and (G) **(Outdoor/Garage)**

(3) The lighting outlets specified in 210.70 **(Kitchen/Attic/Garage/Outdoor)**

The minimum lighting load shall be determined using the minimum unit load and the floor area as determined in 220.5(C) for dwelling occupancies. Motors rated less than 1⁄8 hp and connected to a lighting circuit shall be considered part of the minimum lighting load. **(Bathroom Exhaust Fans)**

Residential Load Service Example



A single-family house has a 1,500 square feet of habitable space (outside wall dimensions), a 400 square foot garage, and a 150 square foot deck.

What is the total square foot area used to determine the load?

1,500 square feet

What is the calculated minimum lighting (and general use receptacle) Demand Load?

3 VA × 1,500 sq ft = 4,500 VA

Article 220 – Part 3 Dwelling Units

220.52 Small-Appliance and Laundry Loads — Dwelling Unit.

220.52(A) Small-Appliance Circuit Load.

In each dwelling unit, the load shall be calculated at 1500 volt-amperes for each 2-wire small-appliance branch circuit as covered by 210.11(C)(1) **(you need at least two).** Where the load is subdivided through two or more feeders, the calculated load for each shall include not less than 1500 volt-amperes for each 2-wire small-appliance branch circuit. **These loads shall be permitted to be included with the general lighting load and subjected to the demand factors provided in Table 220.45.**

Exception: The individual branch circuit permitted by 210.52(B)(1), Exception No. 2 (specific appliance like a refrigerator), shall be permitted to be excluded from the calculation required by 220.52.

Article 220 – Part 3 Dwelling Units

See 210.52(F) this is not required if laundry is not permitted

220.52(B) Laundry Circuit Load.

A load of not less than 1500 volt-amperes shall be included for each 2-wire laundry branch circuit installed as covered by 210.11(C)(2) **(you need at least one)**. **This load shall be permitted to be included with the general lighting load and shall be subjected to the demand factors provided in Table 220.45.**

Note: This does not include the electric dryer

Residential Load Service Example

We determined that the single-family house has 1,500 square feet of habitable space and the calculated demand load of the lighting and general receptacles is 4,500 VA.

What is the minimum load required to be added for the small appliances in the kitchen?

$2 \times 1{,}500\ VA = 3{,}000\ VA$

What is the minimum load required for the laundry circuit?

$1 \times 1{,}500 = 4{,}500\ VA$

Total $4{,}500\ VA + 3{,}000\ VA + 4{,}500\ VA = 12{,}000\ VA$

Article 220 – Part 3 Dwelling Units

220.45 General Lighting.

The demand factors specified in Table 220.45 shall apply to that portion of the total branch-circuit load calculated for general illumination. They shall not be applied in determining the number of branch circuits for general illumination.

Article 220 – Part 3 Dwelling Units

*The demand factors of this table shall not apply to the calculated load of feeders or services supplying areas in hotels and motels where the entire lighting is likely to be used at one time, as in ballrooms or dining rooms.

Table 220.45 Lighting Load Demand Factors

Type of Occupancy	Portion of Lighting Load to Which Demand Factor Applies (Volt-Amperes)	Demand Factor (%)
Dwelling units	First 3000 at	100
	From 3001 to 120,000 at	35
	Remainder over 120,000 at	25
Hotels and motels, including apartment houses without provision for cooking by tenants*	First 20,000 or less at	60
	From 20,001 to 100,000 at	50
	Remainder over 100,000 at	35
Warehouses (storage)	First 12,500 or less at	100
	Remainder over 12,500 at	50
All others	Total volt-amperes	100

Residential Load Service Example

If we continue our example, the 12,000 VA calculated total can be run through the lighting load demand factors of table 220.45.

First 3,000 VA at 100% = 3,000 VA

3001 to 120,000 VA at 35% = 9,000 VA x .35 = 3,150 VA

Total general lighting, receptacle, small appliance and laundry ckt. demand load = 6,150 VA

Article 220 – Part 3 Dwelling Units

Permitted Fastened in place appliances:

- Disposers
- Trash Compactors
- Dishwashers
- Water Heaters
- Attic Fans

220.53 Appliance Load — Dwelling Unit(s).

Applying a demand factor of **75 percent** to the nameplate rating load of four or more appliances rated 1⁄4 hp or greater, or 500 watts or greater, that are **fastened** in place, and that are served by the same feeder or service in a one-family, two-family, or multifamily dwelling shall be permitted. This demand factor shall **not** apply to the following:

(1) Household electric cooking equipment that is fastened in place

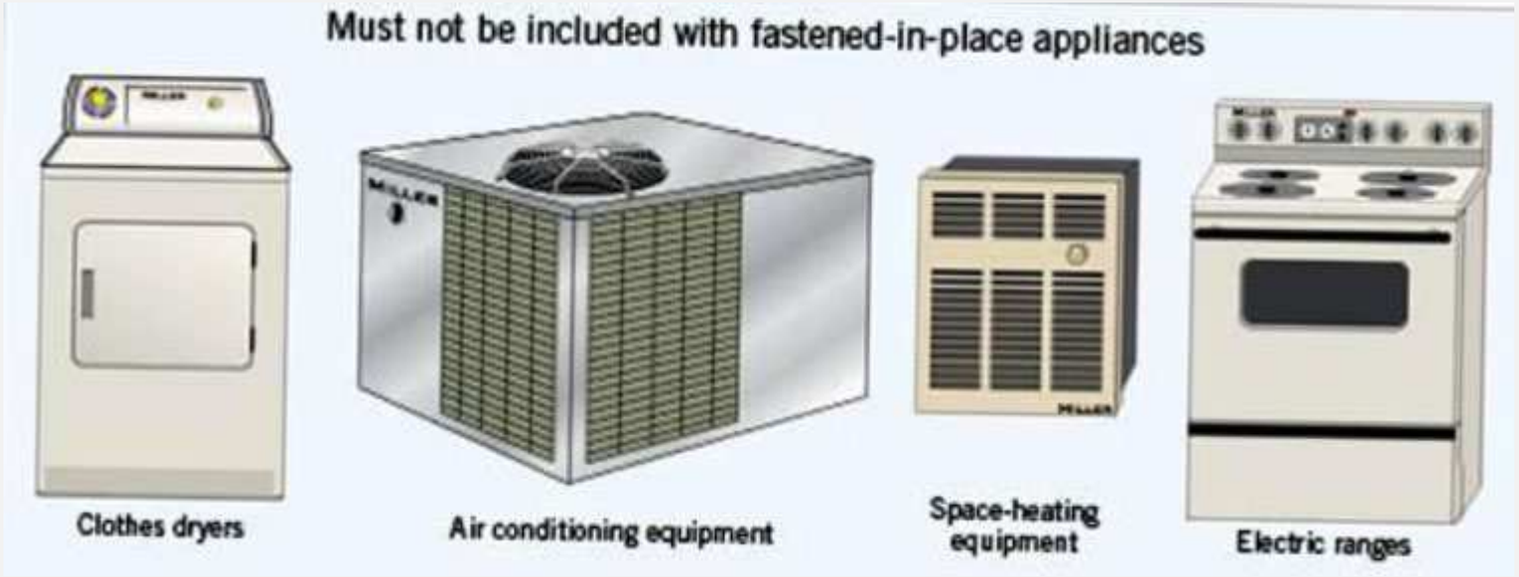
(2) Clothes dryers

(3) Space heating equipment

(4) Air-conditioning equipment

(5) Electric vehicle supply equipment (EVSE)

Article 220 – Part 3 Dwelling Units



Definitions:

- **Appliance, Fixed** is An appliance that is fastened or otherwise secured at a specific location.
- **Appliance, Portable** is An appliance that is actually moved or can easily be moved from one place to another in normal use.
- **Appliance, Stationary** is An appliance that is not easily moved from one place to another in normal use.

Residential Load Service Example

If we continue our example, we found the total demand load of the house to be 6,150 VA.

Next, we add in four (4) fastened in place appliance loads (nameplate info) over 500 watts (1/4 HP) and take 75% demand:

Built in Microwave:	**1250 VA**
Dishwasher:	**1500 VA**
Garbage Disposal:	**1800 VA**
Trash Compactor:	**900 VA**

Total = 5450 VA × 75% = 4,088 VA

Article 220 – Part 3 Dwelling Units

Table 220.54 Demand Factors for Household Electric Clothes Dryers

Number of Dryers	Demand Factor (%)
1–4	100
5	85
6	75
7	65
8	60
9	55
10	50
11	47
12–23	47% minus 1% for each dryer exceeding 11
24–42	35% minus 0.5% for each dryer exceeding 23
43 and over	25%

220.54 Electric Clothes Dryers — Dwelling Unit(s).

The load for household electric clothes dryers in a dwelling unit(s) shall be either 5000 watts (volt-amperes) or the nameplate rating, whichever is larger, for each dryer served. The use of the demand factors in Table 220.54 shall be **permitted**. Where two or more single-phase dryers are supplied by a 3-phase, 4-wire feeder or service, the total load shall be calculated on the basis of twice the maximum number connected between any two phases. Kilovolt-amperes (kVA) shall be considered equivalent to kilowatts (kW) for loads calculated in this section.

Article 220 – Part 3 Dwelling Units

220.55 Electric Cooking Appliances in Dwelling Units and Household Cooking Appliances Used in Instructional Programs.

The load for household electric ranges, wall-mounted ovens, counter-mounted cooking units, and other household cooking appliances individually rated in excess of 1 ¾ kW shall be permitted to be calculated in accordance with Table 220.55. Kilovolt-amperes (kVA) shall be considered equivalent to kilowatts (kW) for loads calculated under this section.

Where two or more single-phase ranges are supplied by a 3-phase, 4-wire feeder or service, the total load shall be calculated on the basis of twice the maximum number connected between any two phases.

Article 220 – Part 3 Dwelling Units

Table 220.55 Demand Factors and Loads for Household Electric Ranges, Wall-Mounted Ovens, Counter-Mounted Cooking Units, and Other Household Cooking Appliances over 1 3⁄4 kW Rating (Column C to be used in all cases except as otherwise permitted in Note 3.)

Number of Appliances	Demand Factor (%) (See Notes)		Column C Maximum Demand (kW) (See Notes) (Not over 12 kW Rating)
	Column A (Less than $3^1/_2$ kW Rating)	Column B ($3^1/_2$ kW through $8^3/_4$ kW Rating)	
1	80	80	8
2	75	65	11
3	70	55	14
4	66	50	17
5	62	45	20
6	59	43	21
7	56	40	22
8	53	36	23
9	51	35	24
10	49	34	25
11	47	32	26
12	45	32	27
13	43	32	28
14	41	32	29
15	40	32	30

Article 220 – Part 3 Dwelling Units

16	39	28	31
17	38	28	32
18	37	28	33
19	36	28	34
20	35	28	35
21	34	26	36
22	33	26	37
23	32	26	38
24	31	26	39
25	30	26	40
26–30	30	24	15 kW + 1 kW for each range
31–40	30	22	
41–50	30	20	25 kW + $^{3}/_{4}$ kW for each range
51–60	30	18	
61 and over	30	16	

Article 220 – Part 3 Dwelling Units

Notes:

1. Over 12 kW through 27 kW ranges all of same rating. For ranges individually rated more than 12 kW but not more than 27 kW, the maximum demand in Column C shall be increased 5 percent for each additional kilowatt of rating or major fraction thereof by which the rating of individual ranges exceeds 12 kW.

2. Over 8 3⁄4 kW through 27 kW ranges of unequal ratings. For ranges individually rated more than 8 3⁄4 kW and of different ratings, but none exceeding 27 kW, an average value of rating shall be calculated by adding together the ratings of all ranges to obtain the total connected load (using 12 kW for any range rated less than 12 kW) and dividing by the total number of ranges. Then the maximum demand in Column C shall be increased 5 percent for each kilowatt or major fraction thereof by which this average value exceeds 12 kW.

3. Over 1 3⁄4 kW through 8 3⁄4 kW. In lieu of the method provided in Column C, adding the nameplate ratings of all household cooking appliances rated more than 1 3⁄4 kW but not more than 8 3⁄4 kW and multiplying the sum by the demand factors specified in Column A or Column B for the given number of appliances shall be permitted. Where the rating of cooking appliances falls under both Column A and Column B, the demand factors for each column shall be applied to the appliances for that column, and the results added together.

Article 220 – Part 3 Dwelling Units

4. Calculating the branch-circuit load for one range in accordance with Table 220.55 shall be permitted.

5. The branch-circuit load for one wall-mounted oven or one counter-mounted cooking unit shall be the nameplate rating of the appliance.

6. The branch-circuit load for a counter-mounted cooking unit and not more than two wall-mounted ovens, all supplied from a single branch circuit and located in the same room, shall be calculated by adding the nameplate rating of the individual appliances and treating this total as equivalent to one range.

7. This table shall also apply to household cooking appliances rated over 13⁄4 kW and used in instructional programs.

Residential Load Service Example

Continuing our single-family residential load calculation, if we add one 5,000-watt dryer, and one 8,000-watt oven, the total load summary will be:

Lighting and General Use Rec: 6,150 VA

Fastened in Place Appliances: 4,088 VA

Dryer: 5,000 Watts x 100% = 5,000 Watts

Oven: 8,000 Watts x 80% (column B) = 6,400 Watts

Total = 21,638 VA or 90.16 amps at 240V, 1 phase on the phase conductors

What about other loads and air conditioning? …We need to go back to Part 2 - branch circuit load calculation to find out…

Article 220 - Part 2
Branch-Circuit Load Calculations

ARTICLE 220.14 Other Loads

What is an outlet?

220.14 Other Loads — All Occupancies.

Branch-circuit load calculations shall include calculation of a minimum load on each **outlet** as calculated in 220.14(A) through (K) and then summed to establish the load on the branch circuit.

In all occupancies, the minimum load for each outlet for general-use receptacles and outlets not used for general illumination shall not be less than that calculated in 220.14(A) through (K), with the loads shown being based on nominal branch-circuit voltages.

Exception: The loads of outlets serving switchboards and switching frames in telephone exchanges shall be waived from the calculations.

ARTICLE 220.14 Other Loads

220.14(A) Specific Appliances or Loads.

An outlet for a specific appliance or other load not covered in 220.14(B) through (K) shall be calculated based on the ampere rating of the appliance or load served.

No Demand Factor!

Max 16- amp on a 20-amp CB for a continuous load! (operating more than 3 hours)

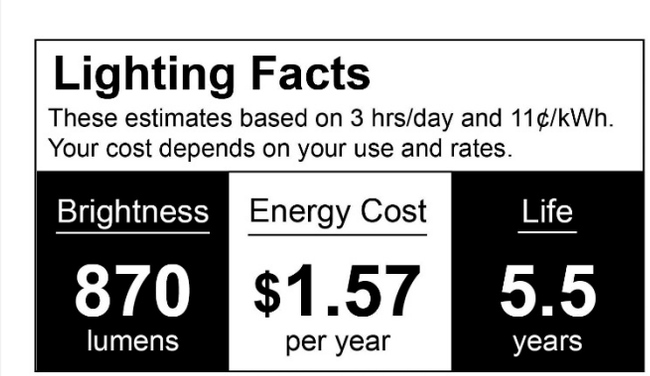
ARTICLE 220.14 Other Loads

220.14(B) Electric Dryers and Electric Cooking Appliances in Dwellings and Household Cooking Appliances Used in Instructional Programs.

Load calculations shall be permitted as specified in 220.54 for electric dryers and in 220.55 for electric ranges and other cooking appliances.

Same as Feeders and Services!

ARTICLE 220.14 Other Loads



220.14(C) Motor Outlets.

The conductor sizing requirements specified in 430.22, 430.24, and 440.6 **(MCA)** shall be used to determine the loads for motor outlets.

220.14(D) Luminaires.

An outlet supplying a luminaire(s) shall be calculated based on the maximum volt-ampere rating of the equipment and lamps for which the luminaire(s) is rated.

220.14(E) Heavy-Duty Lampholders.

Outlets for heavy-duty lampholders shall be calculated at a minimum of 600 volt-amperes.

ARTICLE 220.14 Other Loads

220.14(F) Sign and Outline Lighting.

Sign and outline lighting outlets shall be calculated at a minimum of 1200 volt-amperes for each required branch circuit specified in 600.5(A).

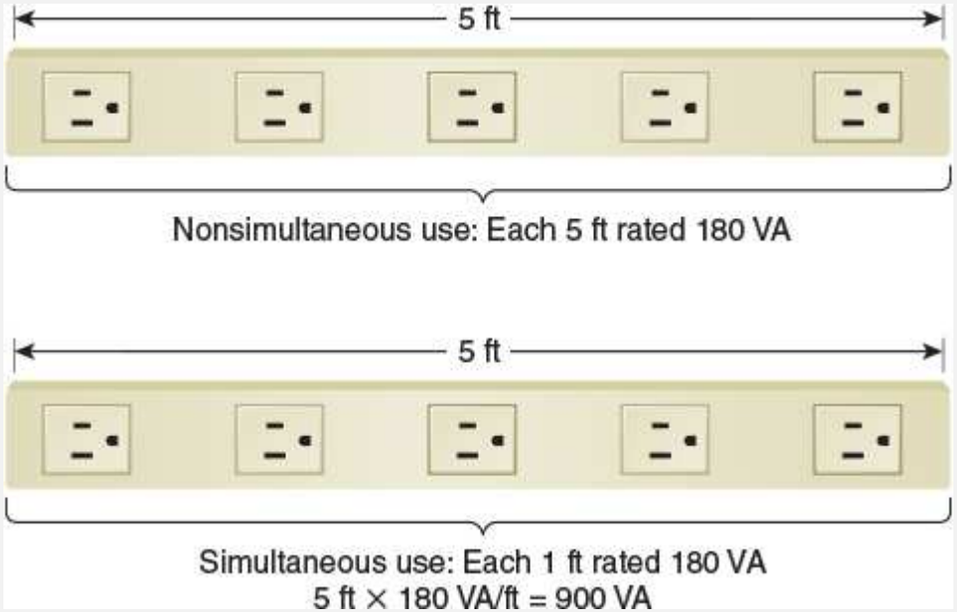
220.14(G) Show Windows.

Show windows shall be calculated in accordance with either of the following:

(1) The unit load per outlet as required in other provisions of this section

(2) At 200 volt-amperes per linear 300 mm (1 ft) of show window

ARTICLE 220.14 Other Loads

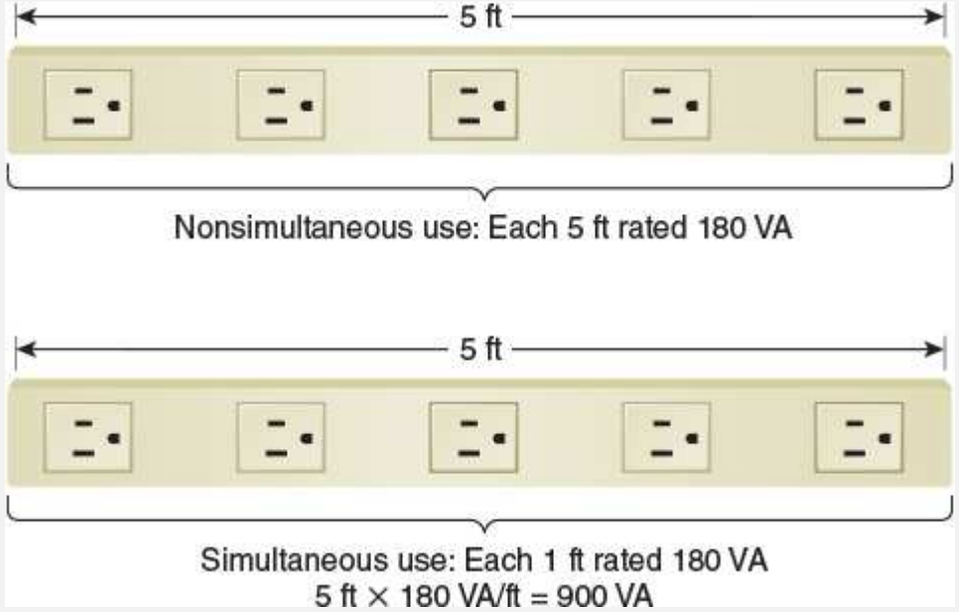


220.14(H) Fixed Multioutlet Assemblies.

Fixed multioutlet assemblies used in other than dwelling units or the guest rooms or guest suites of hotels or motels shall be calculated in accordance with the following:

(1) Where appliances are unlikely to be used simultaneously, each 1.5 m (5 ft) or fraction thereof of each separate and continuous length shall be considered as one outlet of not less than 180 volt-amperes.

ARTICLE 220.14 Other Loads

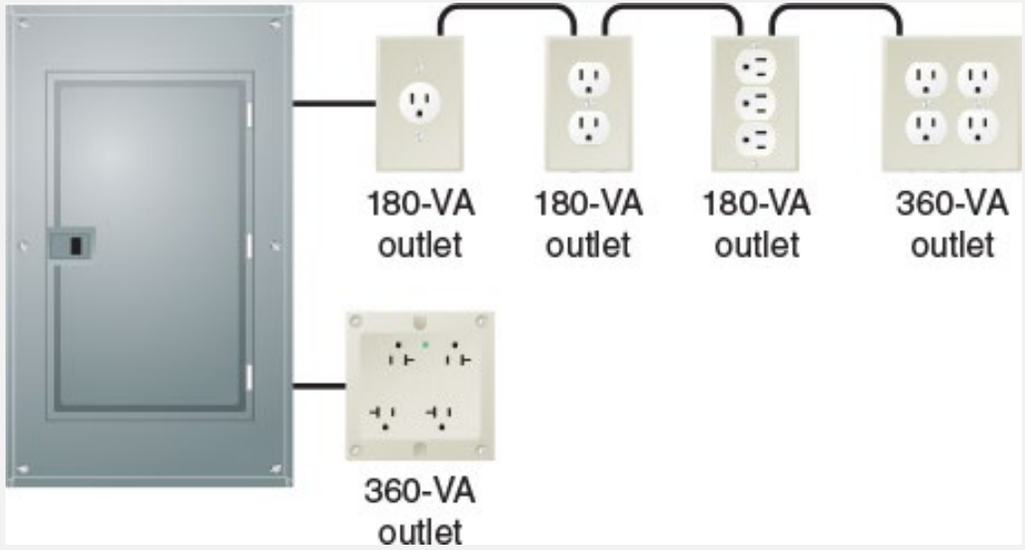


220.14(H) Fixed Multioutlet Assemblies.

(2) Where appliances are likely to be used simultaneously, each 300 mm (1 ft) or fraction thereof shall be considered as an outlet of not less than 180 volt-amperes.

For the purposes of this section, the calculation shall be permitted to be based on the portion that contains receptacles.

ARTICLE 220.14 Other Loads



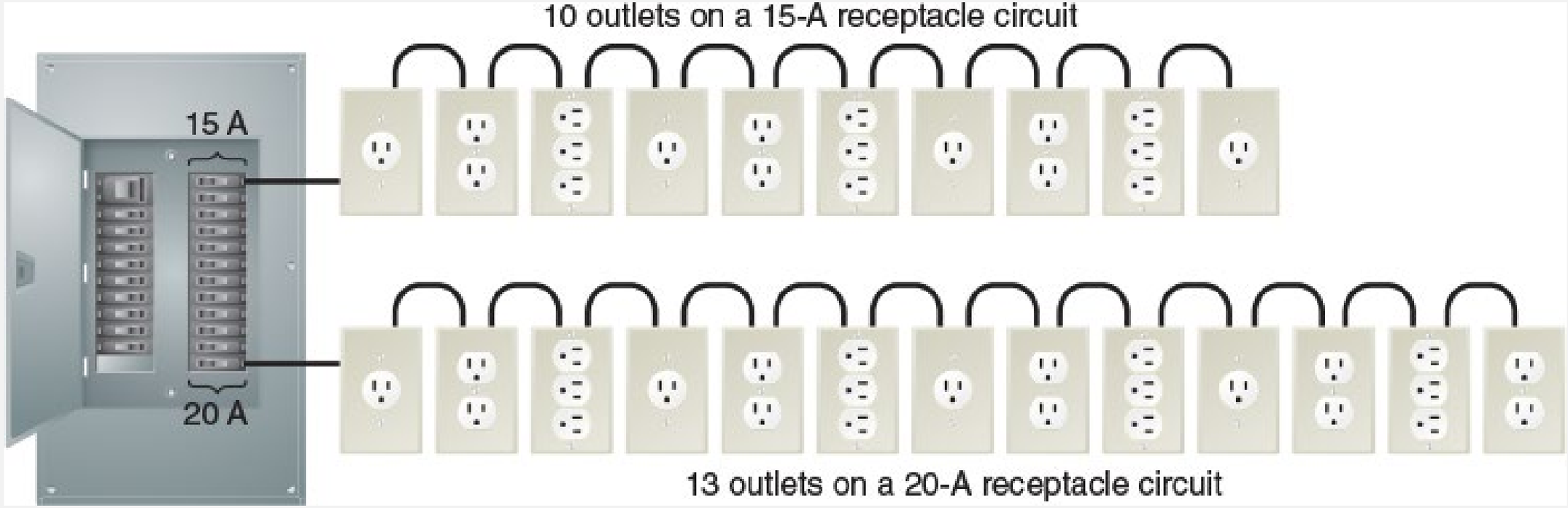
This would be a receptacle outlet used for a general purpose.

220.14(I) Receptacle Outlets.

Except as covered in 220.41 and 220.14(J), receptacle outlets shall be calculated at not less than **180 volt-amperes for each single or for each multiple receptacle on one yoke**. A single piece of equipment consisting of a multiple receptacle comprised of four or more receptacles shall be calculated at not less than 90 volt-amperes per receptacle. This provision shall not be applicable to the receptacle outlets specified in 210.11(C)(1) and (C)(2).

ARTICLE 220.14 Other Loads

Maximum number of receptacle outlets permitted on 15- and 20-ampere branch circuits.



ARTICLE 220.14 Other Loads

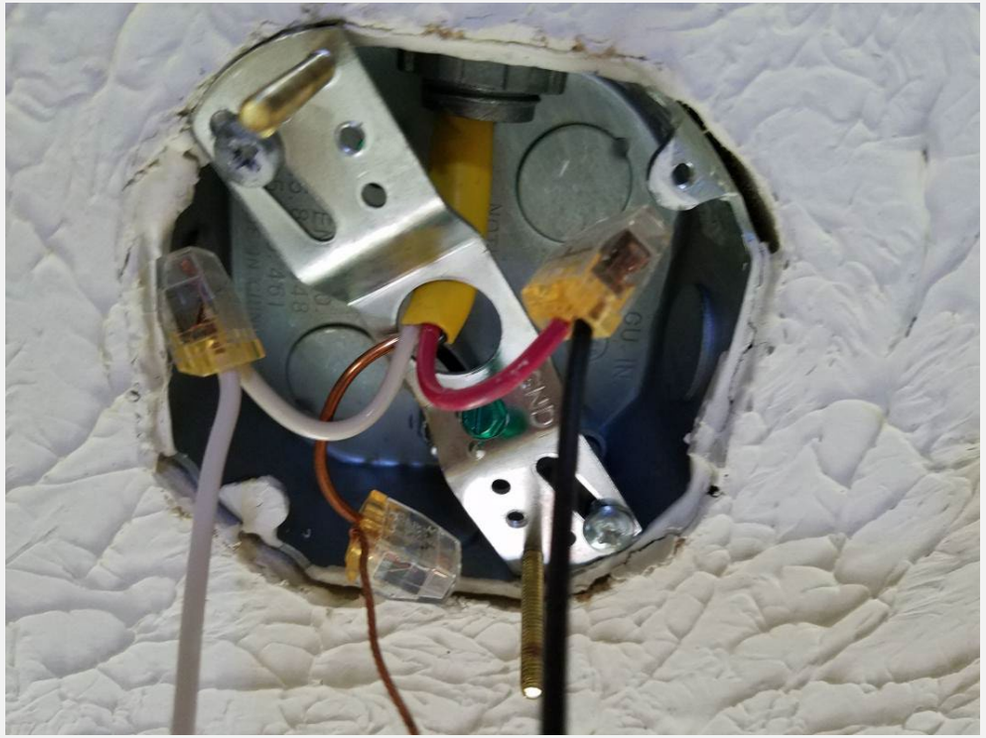
220.14(J) Receptacle Outlets in Office Buildings.

In office buildings, the receptacle loads shall be calculated to be the larger of the following:

(1) The calculated load from 220.14(I) **(180 volt-amperes per receptacle)**

(2) 11 volt-amperes/m^2 (1 volt-ampere/ft^2)

ARTICLE 220.14 Other Loads



220.14(K) Other Outlets.

Other outlets not covered in 220.14(A) through (J) shall be calculated based on 180 volt-amperes per outlet.

Residential Load Service Example

Finishing our residential load calculation, if we add one 12,000-watt air conditioning unit and one dryer, and one refrigerator appliance, the total final load summary will be:

Lighting and General Use Rec (Demand):	**6,150 VA**
Fastened in Place Appliances (70%):	**4,088 VA**
Dryer: 5,000 Watts x 100% =	**5,000 Watts**
Oven: 8,000 Watts x 80% (column B) =	**6,400 Watts**
Air Conditioning (100%):	**12,000 Watts**
Refrigerator (100%):	**1,400 Watts**

Total = 35,038 VA or 146 amps at 240V, 1 phase on the phase conductors

Part IV - Optional Dwelling Unit Load Calculations

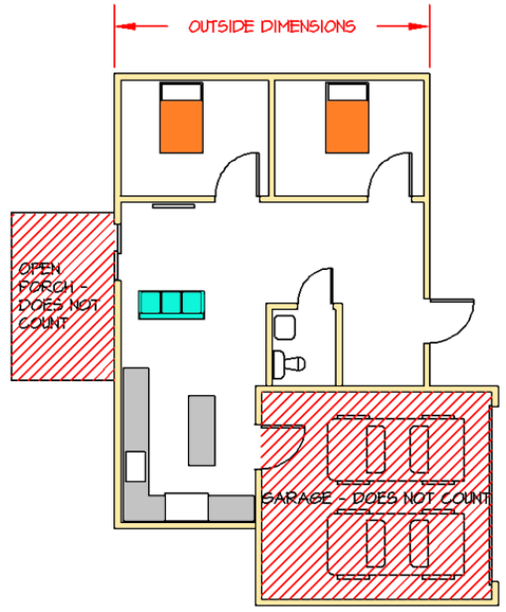
Article 220 – Part 4 Optional Calculation Dwelling Units

220.82 Dwelling Unit.

220.82(A) Feeder and Service Load.

This section applies to a dwelling unit having the total connected load served by a single 120/240-volt or 208Y/120-volt set of 3-wire service or feeder conductors with an ampacity of 100 or greater. It shall be permissible to calculate the feeder and service loads in accordance with this section **instead of the method specified in Part III of this article**. The calculated load shall be the result of adding the loads from 220.82(B) and (C). Feeder and service-entrance conductors whose calculated load is determined by this optional calculation shall be permitted to have the neutral load determined by 220.61.

Article 220.82(B) General Loads.



220.82(B) General Loads.

The general calculated load shall be not less than **100 percent of the first 10 kVA plus 40 percent of the remainder of the following loads (4 items)**:

(1) 33 volt-amperes/m^2 or 3 volt-amperes/ft^2 for general lighting and general-use receptacles. The floor area for each floor shall be calculated from the outside dimensions of the dwelling unit. The calculated floor area shall not include open porches, garages, or unused or unfinished spaces not adaptable for future use.

(2) 1500 volt-amperes for each 2-wire, 20-ampere small-appliance branch circuit and each laundry branch circuit covered in 210.11(C)(1) and (C)(2).

Article 220.82(B) General Loads.

220.82(B) General Loads.

(3) The nameplate rating of the following:

a. All appliances that are fastened in place, permanently connected, or located to be on a specific circuit

b. Ranges, wall-mounted ovens, counter-mounted cooking units

c. Clothes dryers that are not connected to the laundry branch circuit specified in 220.82(B)(2)

d. Water heaters

(4) The nameplate ampere or kVA rating of all permanently connected motors not included in 220.82(B)(3).

Article 220.82(C) Heat and AC Load

220.82(C) Heating and Air-Conditioning Load (6 items).

The largest of the following six selections (load in kVA) shall be included:

(1) 100 percent of the nameplate rating(s) of the air conditioning and cooling.

(2) 100 percent of the nameplate rating(s) of the heat pump when the heat pump is used without any supplemental electric heating.

(3) 100 percent of the nameplate rating(s) of the heat pump compressor and 65 percent of the supplemental electric heating for central electric space-heating systems. If the heat pump compressor is prevented from operating at the same time as the supplementary heat, it does not need to be added to the supplementary heat for the total central space heating load.

Article 220.82(C) Heat and AC Load

220.82(C) Heating and Air-Conditioning Load.

(4) 65 percent of the nameplate rating(s) of electric space heating if less than four separately controlled units.

(5) 40 percent of the nameplate rating(s) of electric space heating if four or more separately controlled units.

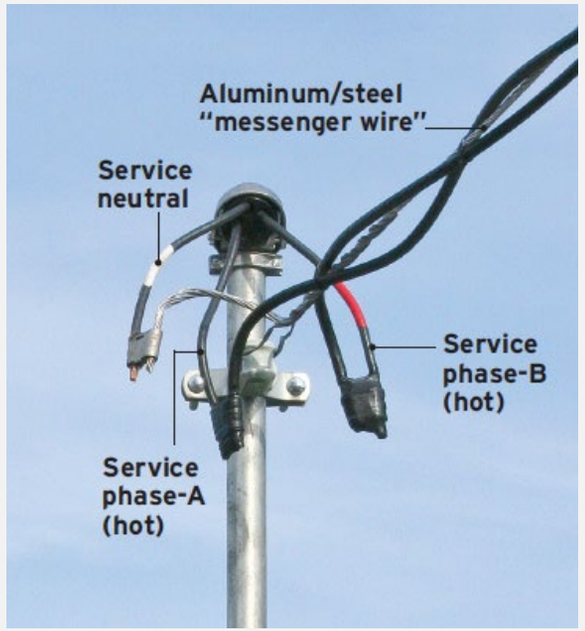
(6) 100 percent of the nameplate ratings of electric thermal storage and other heating systems where the usual load is expected to be continuous at the full nameplate value. Systems qualifying under this selection shall not be calculated under any other selection in 220.82(C).

Residential Load Service Optional Calculation

1500 ft^2 at 3 VA		4,500 VA
Two 20-A small-appliance circuits at 1500 VA each		3,000 VA
Fastened in Place Appliances Built in Microwave: 1250 VA Dishwasher: 1500 VA Garbage Disposal: 1800 VA Trash Compactor: 900 VA		5,450 VA
Laundry circuit		1,500 VA
Refrigerator		1,400 VA
Dryer		5,000 VA
Oven		6,400 VA
	Total general load	27,250 VA
First 10 kVA at 100%		10,000 VA
Remainder at 40% (17,250 VA × 0.4 × 1000)		6,900 VA
	Subtotal general load	16,900 VA
Air conditioning		12,000 VA
	Total	28,900 VA

Total =120 amps at 240V, 1 phase Approx the same!

ARTICLE 220.61 Neutral Load.



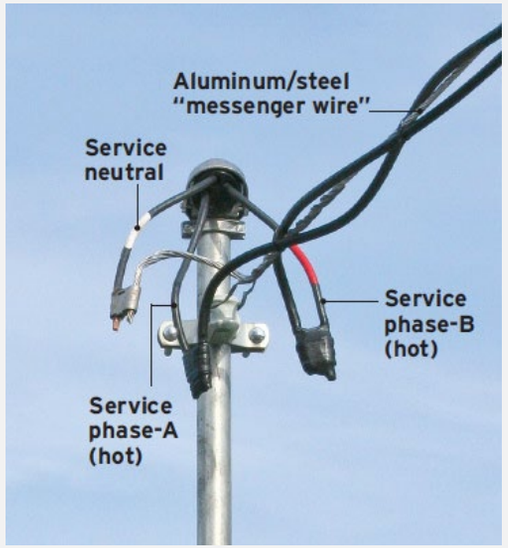
220.61 Feeder or Service Neutral Load.

220.61(A) Basic Calculation.

The feeder or service neutral load shall be the maximum unbalance of the load determined by this article. The maximum unbalanced load shall be the maximum net calculated load between the neutral conductor and any one ungrounded conductor.

Exception: For 3-wire, 2-phase or 5-wire, 2-phase systems, the maximum unbalanced load shall be the maximum net calculated load between the neutral conductor and any one ungrounded conductor multiplied by 140 percent.

ARTICLE 220.61(B) Reductions.



220.61 Feeder or Service Neutral Load. 220.61(B) Permitted Reductions.

A service or feeder supplying the following loads shall be permitted to have an additional demand factor of 70 percent applied to the amount in 220.61(B)(1) (household electric ranges, wall-mounted ovens, counter-mounted cooking units, and electric dryers) and a portion of the amount in 220.61(B)(2). (above 200 amps on a 200 amp or larger service).

220.61 (C) No neutral load reduction is permitted for services with 2 phase conductors of a 4-wire system or high harmonics.

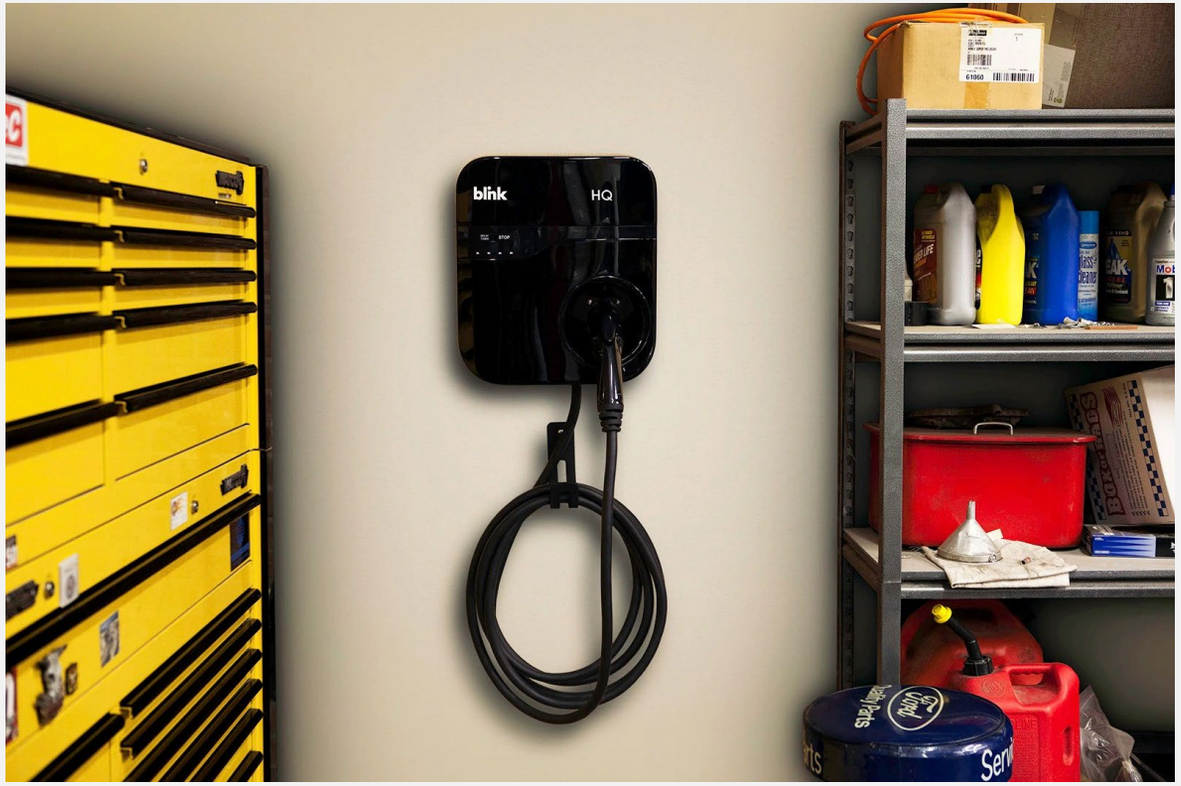
Residential Service Neutral Load Calc

Calculation for Neutral load on Feeders and Services

Net Load Lighting and Small-Appliance Load	6,150 VA
Range: 6400 VA at 70% *(per 220.61)*	4,480 VA
Dryer: 5000 VA at 70% *(per 220.61)*	3,500 VA
Total	14,130 VA

Calculated Load on Neutral will be 14,130 VA / 240 volts = 58.9 Amps

ARTICLE 220.57 Electric Vehicle



N 220.57 Electric Vehicle Supply Equipment (EVSE) Load.

The EVSE load shall be calculated at either 7200 watts (volt-amperes) or the nameplate rating of the equipment, whichever is larger.

Commercial Service Load Calculations

Article 220 – Part 3 Non-Dwelling Units

220.42 Lighting Load for Non-Dwelling Occupancies.

220.42(A) General.

A unit load of not less than that specified in Table 220.42(A) for non-dwelling occupancies and the floor area determined in 220.5(C) shall be used to calculate the minimum lighting load. Motors rated less than 1⁄8 HP and connected to a lighting circuit shall be considered general lighting load.

Informational Note: The unit values of Table 220.42(A) are based on minimum load conditions and 80 percent power factor and might not provide sufficient capacity for the installation contemplated.

Article 220 – Part 3 Non-Dwelling Units

Note: The load of the general receptacles is not included in this table.

Table 220.42(A) General Lighting Loads by Non-Dwelling Occupancy

Type of Occupancy	Unit Load	
	Volt-amperes/ m^2	Volt-amperes/ ft^2
Automotive facility	16	1.5
Convention center	15	1.4
Courthouse	15	1.4
Dormitory	16	1.5
Exercise center	15	1.4
Fire station	14	1.3
Gymnasium[1]	18	1.7
Health care clinic	17	1.6
Hospital	17	1.6
Hotel or motel, or apartment house without provisions for cooking by tenants[2]	18	1.7
Library	16	1.5

Article 220 – Part 3 Non-Dwelling Units

Manufacturing facility[3]	24	2.2
Motion picture theater	17	1.6
Museum	17	1.6
Office[4]	14	1.3
Parking garage[5]	3	0.3
Penitentiary	13	1.2
Performing arts theater	16	1.5
Police station	14	1.3
Post office	17	1.6
Religious facility	24	2.2
Restaurant[6]	16	1.5
Retail[7, 8]	20	1.9
School/university	16	1.5
Sports arena	16	1.5
Town hall	15	1.4
Transportation	13	1.2
Warehouse	13	1.2
Workshop	18	1.7

Article 220 – Part 3 Non-Dwelling Units

Note: The 125 percent multiplier for a continuous load as specified in 210.20(A) is included, therefore no additional multiplier shall be required when using the unit loads in this table for calculating the minimum lighting load for a specified occupancy.

Article 220 – Part 3 Non-Dwelling Units

1 Armories and auditoriums are considered gymnasium-type occupancies.

2 Lodge rooms are similar to hotels and motels.

3 Industrial commercial loft buildings are considered manufacturing-type occupancies.

4 Banks are office-type occupancies.

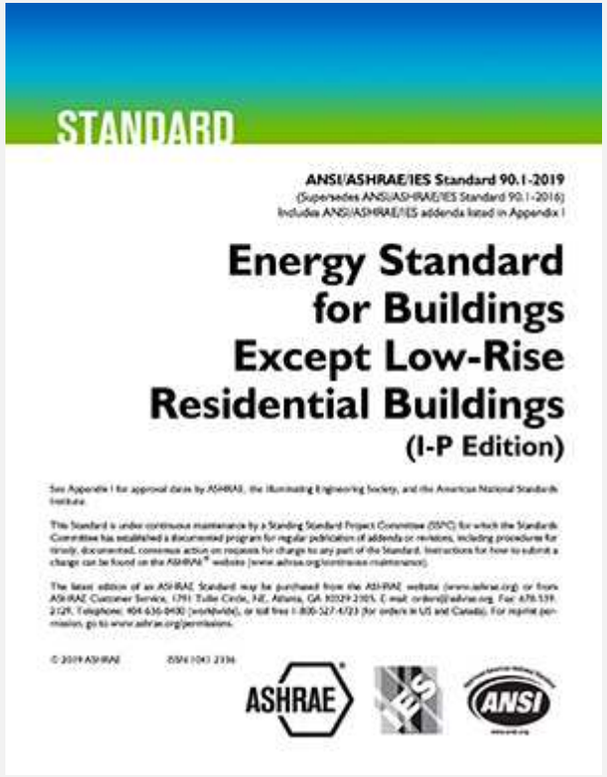
5 Commercial (storage) garages are considered parking garage occupancies.

6 Clubs are considered restaurant occupancies.

7 Barber shops and beauty parlors are considered retail occupancies.

8 Stores are considered retail occupancies.

Article 220 – Part 3 Non-Dwelling Units



220.42(B) Energy Code.

Where the building is designed and constructed to comply with an energy code adopted by the local authority, the lighting load shall be permitted to be calculated using the unit values specified in the energy code where the following conditions are met:

(1) A power monitoring system is installed that will provide continuous information regarding the total general lighting load of the building.

(2) The power monitoring system will be set with alarm values to alert the building owner or manager if the lighting load exceeds the values set by the energy code. Automatic means to take action to reduce the connected load shall be permitted.

(3) The demand factors specified in 220.45 are not applied to the general lighting load.

(4) The continuous load multiplier of 125 percent shall be applied.

Article 220 – Part 3 Non-Dwelling Units

Table 220.47 Demand Factors for Non-Dwelling Receptacle Loads	
Portion of Receptacle Load to Which Demand Factor Applies (Volt-Amperes)	Demand Factor (%)
First 10 kVA or less at	100
Remainder over 10 kVA at	50

220.43 Office Buildings.

In office buildings, the receptacle loads shall be calculated to be the larger of the following:

(1) The calculated load from 220.14(I) **(180 VA per receptacle)** after Table 220.47 demand factors have been applied

(2) 11 volt-amperes/m^2 or 1 volt-ampere/ft^2

How many general receptacles are required in a 10,000 square foot commercial office building?

ARTICLE 220.56 Kitchen Equipment

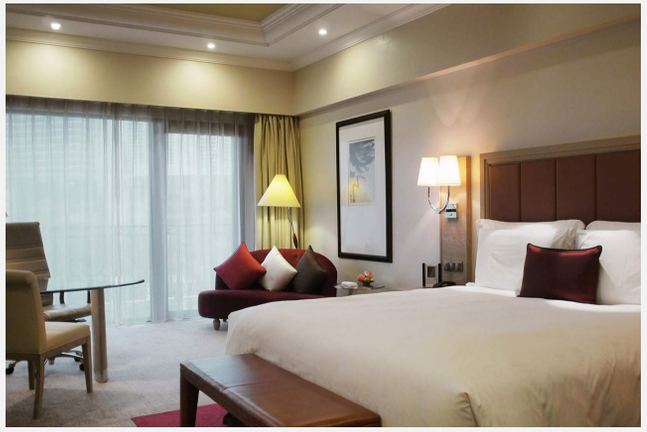
220.56 Kitchen Equipment Other Than Dwelling Unit(s).

Calculating the load for commercial electric cooking equipment, dishwasher booster heaters, water heaters, and other kitchen equipment in accordance with Table 220.56 shall be permitted. Other kitchen equipment shall include equipment that is fastened in place and rated 1⁄4 hp or greater, or 500 watts or greater. These demand factors shall be applied to all equipment that has either thermostatic control or intermittent use as kitchen equipment. These demand factors shall not apply to space-heating, ventilating, or air-conditioning equipment. In no case shall the feeder or service calculated load be less than the sum of the largest two kitchen equipment loads.

Table 220.56 Demand Factors for Kitchen Equipment — Other Than Dwelling Unit(s)

Number of Units of Equipment	Demand Factor (%)
1	100
2	100
3	90
4	80
5	70
6 and over	65

Article 220 – Part 3 Non-Dwelling Units



220.44 Hotel and Motel Occupancies.

In guest rooms or guest suites of hotels and motels, the following lighting and receptacle outlets are included in the minimum unit load in Table 220.42(A), and no additional load calculations shall be required for such outlets:

(1) All general-use receptacle outlets of 20-ampere rating or less, including receptacles connected to the circuits in 210.11(C)(3) **(bathrooms)** and (C)(4) **(garages)**

(2) The receptacle outlets specified in 210.52(E)(3) **(Balconies and Decks)**

(3) The lighting outlets specified in 210.70 **(lighting outlets required in each habitable room or space including hallways, attics, and underfloor spaces)**

Article 220 – Part 3 Non-Dwelling Units

220.46 Show-Window and Track Lighting.

220.46(A) Show Windows.

For show-window lighting, a load of not less than 660 volt-amperes/linear meter or 200 volt-amperes/linear foot shall be included for a show window, measured horizontally along its base.

Informational Note: See 220.14(G) for branch circuits supplying show windows. **(Same wattage 200 VA / LF)**

Minimum of 200 VA/LF Load allowance can be more!

Article 220 – Part 3 Non-Dwelling Units

220.46(B) Track Lighting.

For track lighting in other than dwelling units or guest rooms or guest suites of hotels or motels, an additional load of 150 volt-amperes shall be included for every 600 mm (2 ft) of lighting track or fraction thereof. Where multi-circuit track is installed, the load shall be considered to be divided equally between the track circuits.

Exception: If the track lighting is supplied through a device that limits the current to the track, the load shall be permitted to be calculated based on the rating of the device used to limit the current.

Feeder and Service Load Calculations for Motors and Air Conditioning

Article 220 – Part 3 Non-Dwelling Units

The 2023 NEC finally included Air Conditioning Equipment in this article. Previously only said Motors…This is a huge addition to the code!

220.50 Motors and Air-Conditioning Equipment.

N **220.50(A) Motors.**

The conductor sizing requirements specified in 430.24 and 430.25 and the feeder demand factor calculation method specified in 430.26 shall be used to determine motor loads.

N **220.50(B) Air-Conditioning Equipment.**

The conductor sizing requirements **(MCA)** specified in Part IV of Article 440 shall be used to determine air-conditioning loads for hermetic refrigerant motor-compressors.

Article 220.51 Fixed Heating Load

220.51 Fixed Electric Space Heating.

Fixed electric space-heating loads shall be calculated at 100 percent of the total connected load. However, in no case shall a feeder or service load current rating be less than the rating of the largest branch circuit supplied.

Exception: If reduced loading of the conductors results from units operating on duty-cycle or intermittently, or from all units not operating at the same time, the authority having jurisdiction shall be permitted to grant permission for feeder and service conductors to have an ampacity less than 100 percent if the conductors have an ampacity for the load so determined.

ARTICLE 220.60 Noncoincident Loads.

220.60 Noncoincident Loads.

If it is unlikely that two or more noncoincident loads will be in use simultaneously, using only the largest load(s) that will be used at one time for calculating the total load of a feeder or service shall be permitted. If a motor or air-conditioning load is part of the noncoincident load and is not the largest of the noncoincident loads, 125 percent of either the motor load or air-conditioning load, whichever is larger, shall be used in the calculation.

Article 220.70 EMS

N 220.70 Energy Management Systems (EMSs).

If an energy management system (EMS) is used to limit the current to a feeder or service in accordance with 750.30, a single value equal to the maximum ampere setpoint of the EMS shall be permitted to be used in load calculations for the feeder or service.

The setpoint value of the EMS shall be considered a continuous load for the purposes of load calculations.

Load Calculations to Existing Branch Circuits

ARTICLE 220.16 Additions to Existing

220.16 Loads for Additions to Existing Installations.

220.16(A) Dwelling Units.

Loads added to an existing dwelling unit(s) shall comply with the following as applicable:

(1) Loads for structural additions to an existing dwelling unit or for a previously unwired portion of an existing dwelling unit shall be calculated in accordance with 220.14.

(2) Loads for new circuits or extended circuits in previously wired dwelling units shall be calculated in accordance with 220.14.

ARTICLE 220.16 Additions to Existing

220.16(B) Other Than Dwelling Units.

Loads for new circuits or extended circuits in other than dwelling units shall be calculated in accordance with either 220.42 or 220.14, as applicable.

Article 220.83 Existing Dwelling Unit.

220.83(A) Where Additional Air-Conditioning Equipment or Electric Space-Heating Equipment Is Not to Be Installed.

The percentages listed in Table 220.83(A) shall be used for existing and additional new loads.

Table 220.83(A) Without Additional Air-Conditioning or Electric Space-Heating Equipment

Load (kVA)	Percent of Load
First 8 kVA of load at	100
Remainder of load at	40

Article 220.83 Existing Dwelling Unit.

Load calculations shall include the following:

(1) General lighting and general-use receptacles at 33 volt-amperes/m2 or 3 volt-amperes/ft2 as determined by 220.42

(2) 1500 volt-amperes for each 2-wire, 20-ampere small-appliance branch circuit and each laundry branch circuit covered in 210.11(C)(1) and (C)(2)

(3) The nameplate rating of the following:

a. All appliances that are fastened in place, permanently connected, or located to be on a specific circuit

b. Ranges, wall-mounted ovens, counter-mounted cooking units

c. Clothes dryers that are not connected to the laundry branch circuit specified in item (2)

d. Water heaters

Article 220.83 Existing Dwelling Unit.

Table 220.83(B) With Additional Air-Conditioning or Electric Space-Heating Equipment	
Load	Percent of Load
Air-conditioning equipment	100
Central electric space heating	100
Less than four separately controlled space-heating units	100
First 8 kVA of all other loads	100
Remainder of all other loads	40

220.83(B) Where Additional Air-Conditioning Equipment or Electric Space-Heating Equipment Is to Be Installed.

The percentages listed in Table 220.83(B) shall be used for existing and additional new loads. The larger connected load of air conditioning or space heating, but not both, shall be used.

Article 220.83 Existing Dwelling Unit.

Other loads shall include the following:

(1) General lighting and general-use receptacles at 33 volt-amperes/m2 or 3 volt-amperes/ft2 as determined by 220.42

(2) 1500 volt-amperes for each 2-wire, 20-ampere small-appliance branch circuit and each laundry branch circuit covered in 210.11(C)(1) and (C)(2)

(3) The nameplate rating of the following:

a. All appliances that are fastened in place, permanently connected, or located to be on a specific circuit

b. Ranges, wall-mounted ovens, counter-mounted cooking units

c. Clothes dryers that are not connected to the laundry branch circuit specified in item (2)

d. Water heaters

Load Calculations to Multifamily Dwellings

Article 220.84 Multifamily Dwelling.

220.84 Multifamily Dwelling.

220.84(A) Feeder or Service Load.

It shall be permissible to calculate the load of a feeder or service that supplies three or more dwelling units of a multifamily dwelling in accordance with Table 220.84(B) instead of Part III of this article if all the following conditions are met:

(1) No dwelling unit is supplied by more than one feeder.

(2) Each dwelling unit is equipped with electric cooking equipment.

Exception: When the calculated load for multifamily dwellings without electric cooking in Part III of this article exceeds that calculated under Part IV for the identical load plus electric cooking (based on 8 kW per unit), the lesser of the two loads shall be permitted to be used.

(3) Each dwelling unit is equipped with either electric space heating or air conditioning, or both. Feeders and service conductors whose calculated load is determined by this optional calculation shall be permitted to have the neutral load determined by 220.61.

Article 220.84 Multifamily Dwelling.

Table 220.84(B) Optional Calculations — Demand Factors for Three or More Multifamily Dwelling Units

Number of Dwelling Units	Demand Factor (%)
3–5	45
6–7	44
8–10	43
11	42
12–13	41
14–15	40
16–17	39
18–20	38
21	37
22–23	36
24–25	35
26–27	34
28–30	33
31	32
32–33	31
34–36	30
37–38	29
39–42	28
43–45	27
46–50	26
51–55	25
56–61	24
62 and over	23

220.84(B) House Loads.

House loads shall be calculated in accordance with Part III of this article and shall be in addition to the dwelling unit loads calculated in accordance with Table 220.84(B).

ARTICLE 220.84(C) Calculated Loads.

220.84(C) Calculated Loads.

The calculated load to which the demand factors of Table 220.84(B) apply shall include the following:

(1) 33 volt-amperes/m^2 or 3 volt-amperes/ft^2 for general lighting and general-use receptacles

(2) 1500 volt-amperes for each 2-wire, 20-ampere small-appliance branch circuit and each laundry branch circuit covered in 210.11(C)(1) and (C)(2)

(3) The nameplate rating of the following:

a. All appliances that are fastened in place, permanently connected, or located to be on a specific circuit

b. Ranges, wall-mounted ovens, counter-mounted cooking units

c. Clothes dryers that are not connected to the laundry branch circuit specified in item (2)

d. Water heaters

(4) The nameplate ampere or kVA rating of all permanently connected motors not included in item (3)

(5) The larger of the air-conditioning load or the fixed electric space-heating load

ARTICLE 220.85 Two Units.

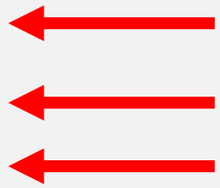
220.85 Two Dwelling Units.

Where two dwelling units are supplied by a single feeder or service and the calculated load under Part III of this article exceeds that for three identical units calculated under 220.84, the lesser of the two loads shall be permitted to be used.

Finding the existing load

ARTICLE 220.87 Determining Existing Loads.

Account Summary	Amount Due
Previous Balance	3,235.65
Payments/Adjustments	-3,235.65
Balance at Billing on Aug 27, 2021	**0.00**
The Illuminating Company	1,656.08
MP2 Energy NE LLC - Consumption	1,538.64
Total Current Charges	**3,194.72**
Amount Due by Sep 17, 2021	**$3,194.72**
Usage Information for Meter Number 908439318	
Aug 24, 2021 KWH Reading (Actual)	3,104
Jul 23, 2021 KWH Reading (Actual)	2,394
Difference	710
Multiplier	40
KWH used	28,400
Metered Load in KW	1.911
Measured Lagging Reactive Demand	12.76
Billed Load in KW/KVA	76.4
Billed Reactive Demand	1.5



40 x 1.911 = 76.44 KW

For utility this is the sustained KW demand over a 15-minute interval.

220.87 Determining Existing Loads.

The calculation of a feeder or service load for existing installations shall be permitted to use actual maximum demand to determine the existing load under all of the following conditions:

ARTICLE 220.87 Determining Existing Loads.

Account Summary	Amount Due
Previous Balance	3,235.65
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Measured Lagging Reactive Demand	12.76
Billed Load in KW/KVA	76.4
Billed Reactive Demand	1.5

28,400 / 264 hours = 107 KW

28,400 / 350 hours (blended) = 81.1 KW

Finding KW from KWH is a little more difficult. Since KWH = KW X Hours in the month.

For an Office, a 30-day month only has 22 workdays at 12 hours per day = 264 hours per month working and 456 non-working.

A factory with three shifts could have 720 working hours in the month.

ARTICLE 220.87 Determining Existing Loads.

(1) The maximum demand data is available for a 1-year period.

Exception: If the maximum demand data for a 1-year period is not available, the calculated load shall be permitted to be based on the maximum demand (the highest average kilowatts reached and maintained for a 15-minute interval) continuously recorded over a minimum 30-day period using a recording ammeter or power meter connected to the highest loaded phase of the feeder or service, based on the initial loading at the start of the recording. The recording shall reflect the maximum demand of the feeder or service by being taken when the building or space is occupied and shall include by measurement or calculation the larger of the heating or cooling equipment load, and other loads that might be periodic in nature due to seasonal or similar conditions. This exception shall not be permitted if the feeder or service has a renewable energy system (i.e., solar photovoltaic or wind electric) or employs any form of peak load shaving.

ARTICLE 220.87 Determining Existing Loads.

(2) The maximum demand at 125 percent plus the new load does not exceed the ampacity of the feeder or rating of the service.

(3) The feeder has overcurrent protection in accordance with 240.4, and the service has overload protection in accordance with 230.90.

End of Class
NEC Load Calculations

Questions?

Thank-you !!!
Tim Pool

File Attachments for Item:

ER-11 Significant Changes to the 2023 NEC (Mansfield Area Electrical JATC)

All certifications (8 hours)

Staff Notes:

ESIAC Recommendation:

Committee Recommendation:

Ohio Department of Commerce

Mike DeWine, Governor
Jon Husted, Lt. Governor

Sheryl Maxfield, Director

Board of Building Standards

Application for Continuing Education Course Approval

Provider Information:

Name: Tory Gorka

Organization: Mansfield Area Electrical JATC

Address: 67 South Walnut Street

E-mail: Jatc@ibew688.org Telephone: 419-545-2780

Website:

Conference Sponsor (if applicable) Conference Email:

Check here if Course Renewal: ☐ Prior course number BBS 2023-469 *(i.e. BBS2018-429)*

Renewals will only be granted for identical content and certifications, within the current code cycle.
Attach a copy of prior course approval letter for confirmation. No further information is required.

New Course Information:

Course title: Significant Changes to the 2023 NEC

Course instructor: Donald Fox

Course description: Latest changes and updates to stay Compliant and Maintain Safety

Instructional hours per session: 8 Number of Sessions: 1

Course Date(s) and Location: 2/24/24

Special Content:

Code Administration: ☒
Existing Buildings: ☒
Electrical Instruction: ☒
Plumbing Instruction: ☐

Conference Course:
Conference Name:
Conference location:

Course to be offered online? ☐ **On Demand** ☐ **Webinar** ☐

Course Website:

Detail online course participation confirmation method *(i.e. test, quizlets, participant activity confirmation)*:

Course applicable for the following certifications

Residential Certifications Only: ☐
Administrative Course, All Certifications: ☒
Commercial Certifications: ☐

Application materials included:

☒ Course Outline or Course Learning Objectives
☒ Presentation Materials/Slides (not required for roundtable courses)
☐ Assessment Materials (for online courses)
☒ Presenter Bio

Please submit application and materials in .pdf format to: michael.lane@com.ohio.gov or BBS@com.ohio.gov

Donald Fox

7632 Lynx Ave Ne
Canton, OH 44721
(330)354-4489
dfox@cantonjatc.org

Education

- 1997 Canton Mckinley high School
- 1998-2001 Residential Apprenticeship
- 2006-2010 Inside apprenticeship
- 2003-2006 NTI

Skills

Electrician

Experience

August 1998 - July 2006

WW Schaub Electric, North Canton Ohio

- Residential journeyman /Foreman
- Supervisor 2005..

July 2006 - August 2007

Wood Electric, New Philadelphia Ohio

- 3rd year Inside Apprentice

August 2007- 2019

Hilscher-Clarke Electric , Canton Ohio

- 2007-2008 (4th & 5th Year) Apprentice
- 2008 -2010 Inside journeyman
- 2010 - 2019 Commercial Foreman .

August 2019- Present

Greater Stark County Electrical Trades Center

- Curriculum Coordinator

August 2002 - July 2006 , August 2010 - Present

Instructor Canton JATC

- Residential 2002 -2006
- Inside 1st year 2010 - present

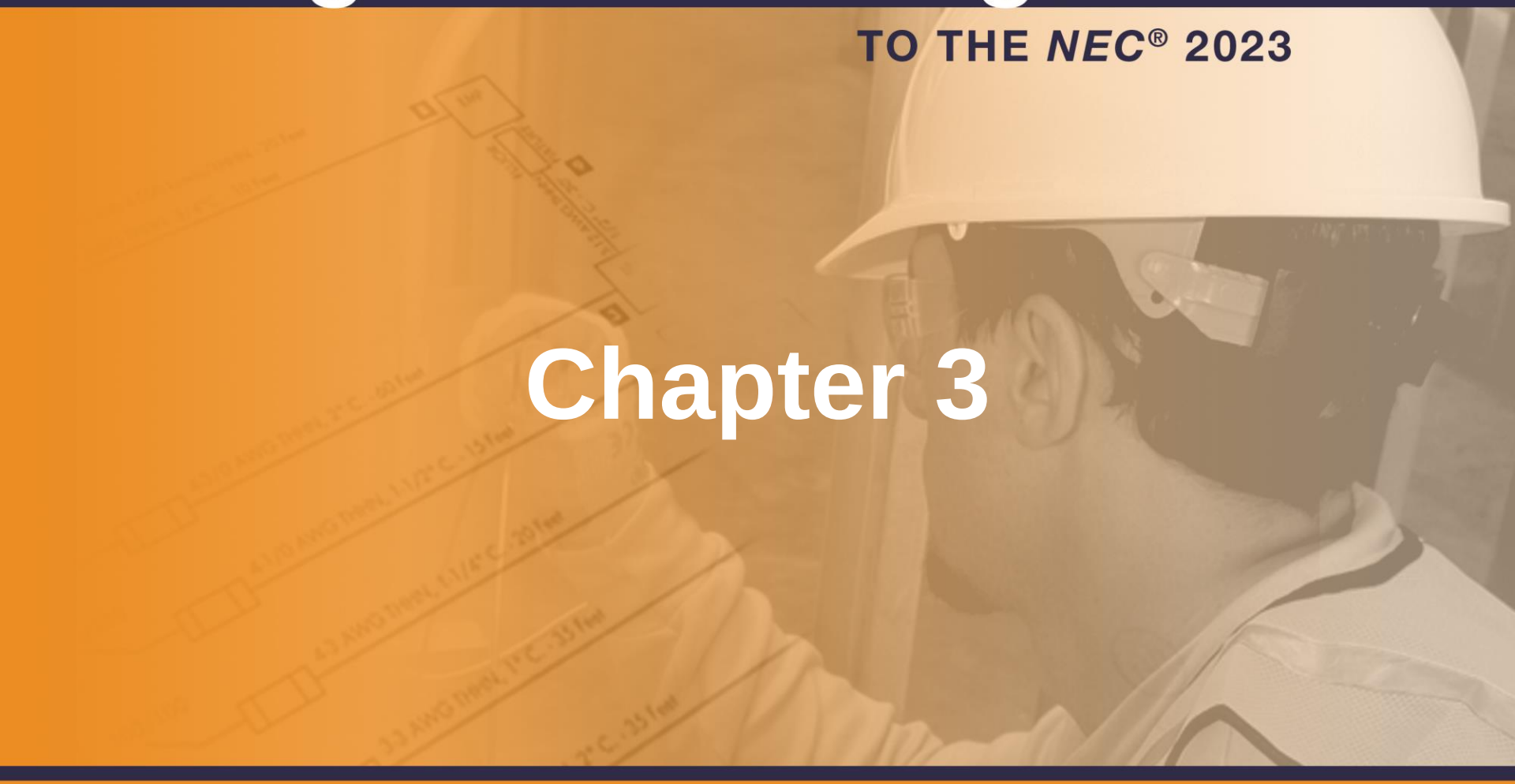
SIGNIFICANT CHANGES TO THE 2023 N.E.C.

Saturday Feb.24, 2024
7am-4:30pm @ the Hall
67 S. Walnut St.
Mansfield, OH 44902
419-526-4688

Course Outline for Eight Hour C/E
Article 90 through Chapters 8
Questions and Discussions
We will be using the 2023 significant changes workbook as well as the 2023 NEC

Significant Changes

TO THE *NEC*® 2023



Chapter 3

electrical training ALLIANCE IBEW - NECA IN COLLABORATION WITH NECA NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION

Article 300

REORGANIZE NEW

Limitations

Change Summary

- Article 300 was reorganized to limit it to systems rated 1,000 volts ac, nominal, or less and 1,500 volts dc, nominal, or less.
- Medium- and high-voltage requirements have been moved to the new Article 305.
- This is the first cycle that 1,500 volts dc has been established as a limit.

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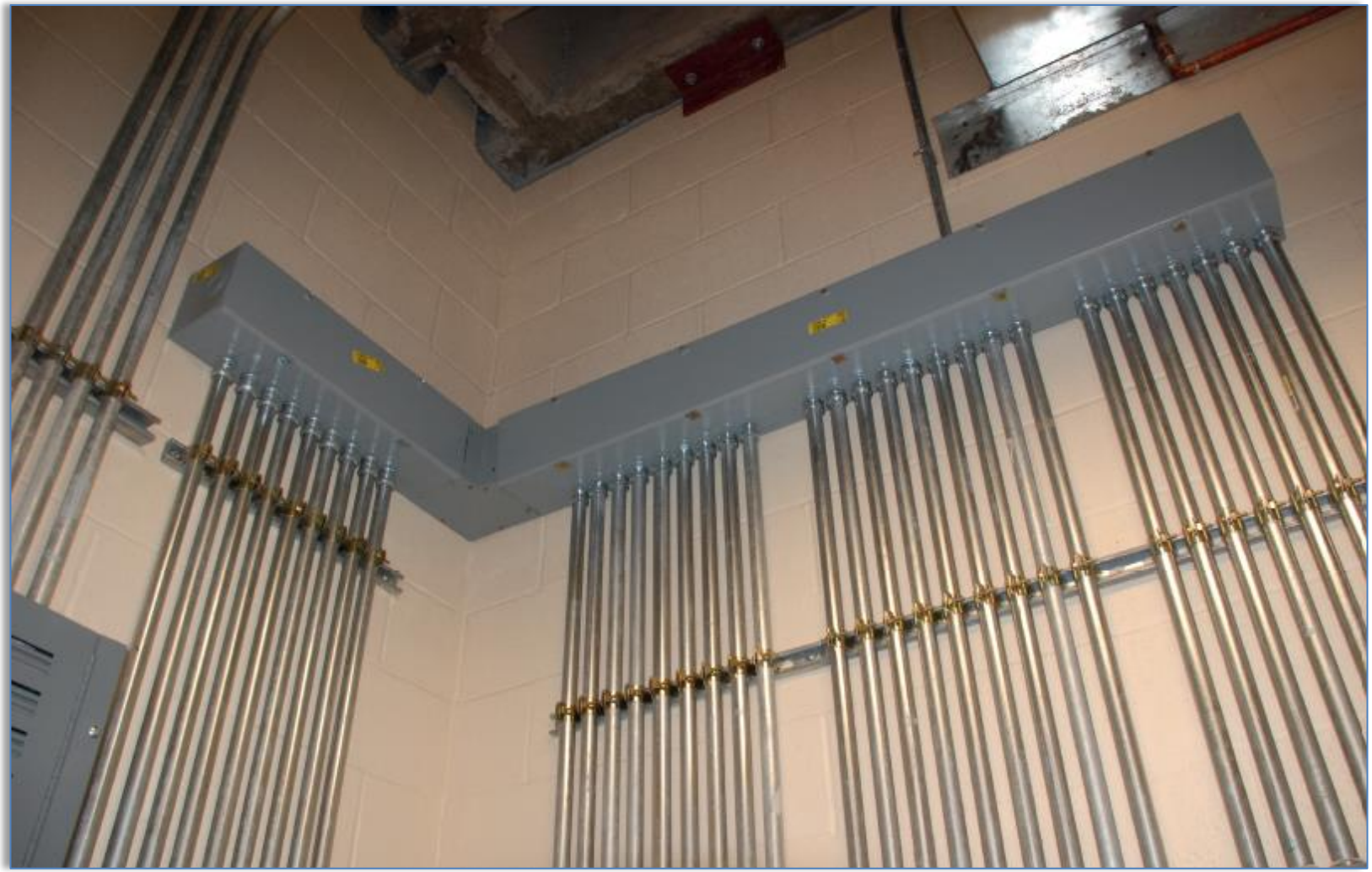
Article 300

REORGANIZE NEW



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Courtesy of Bill McGovern, City of Plano, TX

300.2 & 300.3

REVISION

Limitations

Change Summary

- Section 300.2 has added a voltage limitation for dc systems that are covered by Article 300.
- Chapter 3 wiring methods apply to systems operating at 1,000 volts ac or less or 1,500 volts dc or less.
- Chapter 3 wiring methods are only permitted on systems operating over 1,000 volts ac and 1,500 volts dc if specifically permitted elsewhere in the *Code*.
- The scope of Article 305 states that it applies to installations exceeding 1,000 volts ac or exceeding 1,500 volts dc.

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300.2 & 300.3

REVISION

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Courtesy of PDE Total Energy Solutions

300.4(E)

REVISION

Cables, Raceways, or Boxes Under Metal Decking

Change Summary

- Section 300.4(E) will now only apply to installations beneath metal-corrugated roof decking.
- Exception No. 1 was revised to recognize that listed steel or malleable metal fittings and boxes provide protection from nail penetration.
- A new exception was added for corrugated roof decks that have a minimum 2-inch slab installed over the corrugated metal roof deck.

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300.4(E)

REVISION

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300.7(B)

NEW

Expansion, Expansion-Deflection, Deflection Fittings

Change Summary

- Section 300.7(B) requires raceways to be provided with expansion-deflection or deflection fittings where necessary to compensate for expansion, deflection, and contraction.
- Failure to provide these fittings can result in damage to the installation.
- Informational Note No. 1 provides references to tables that provide expansion information. It also provides information on the rate of expansion.
- A new informational note was added that references NEMA FB 2.40, *Installation Guidelines for Expansion and Expansion/Deflection Fittings.*

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300.7(B)

NEW

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Courtesy of ABB Inc.

300.15

REVISION

Boxes, Conduit Bodies, or Fittings – Where Required

Change Summary

- Section 300.15 was clarified to indicate that a box or conduit body is required at conductor splice, termination, junction, and pull points.
- Wording was added to indicate that boxes or conduit bodies are required at “wiring method transition points,” which indicates a change in wiring method.
- Section 300.15(G) was revised to clarify that it also applies to direct-buried cables in addition to direct-buried conductors.

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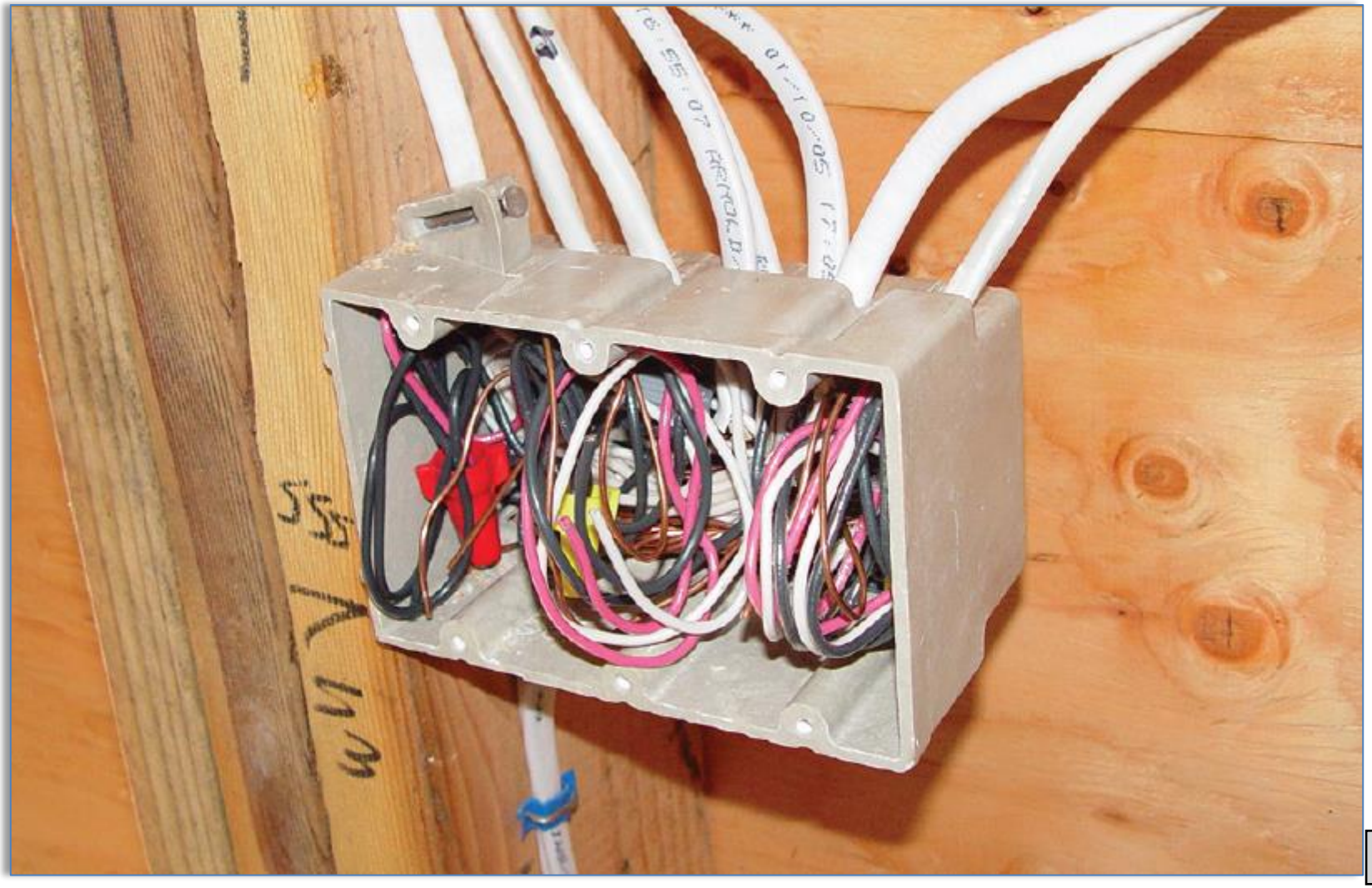
300.15

REVISION



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300.25 & Exception

REVISION

Exit Enclosures (Stair Towers)

Change Summary

- Many buildings have exit enclosures (stair towers) to protect personnel who need to exit during a fire. These are often supported independently of the building.
- Exit enclosures that are required to have a fire rating must be served only by wiring methods serving equipment that is permitted by the AHJ to be in the stair tower.
- Luminaires for the exterior lighting of exit doors of exit enclosures are permitted to be supplied by a circuit that supplies the inside of the exit enclosure.

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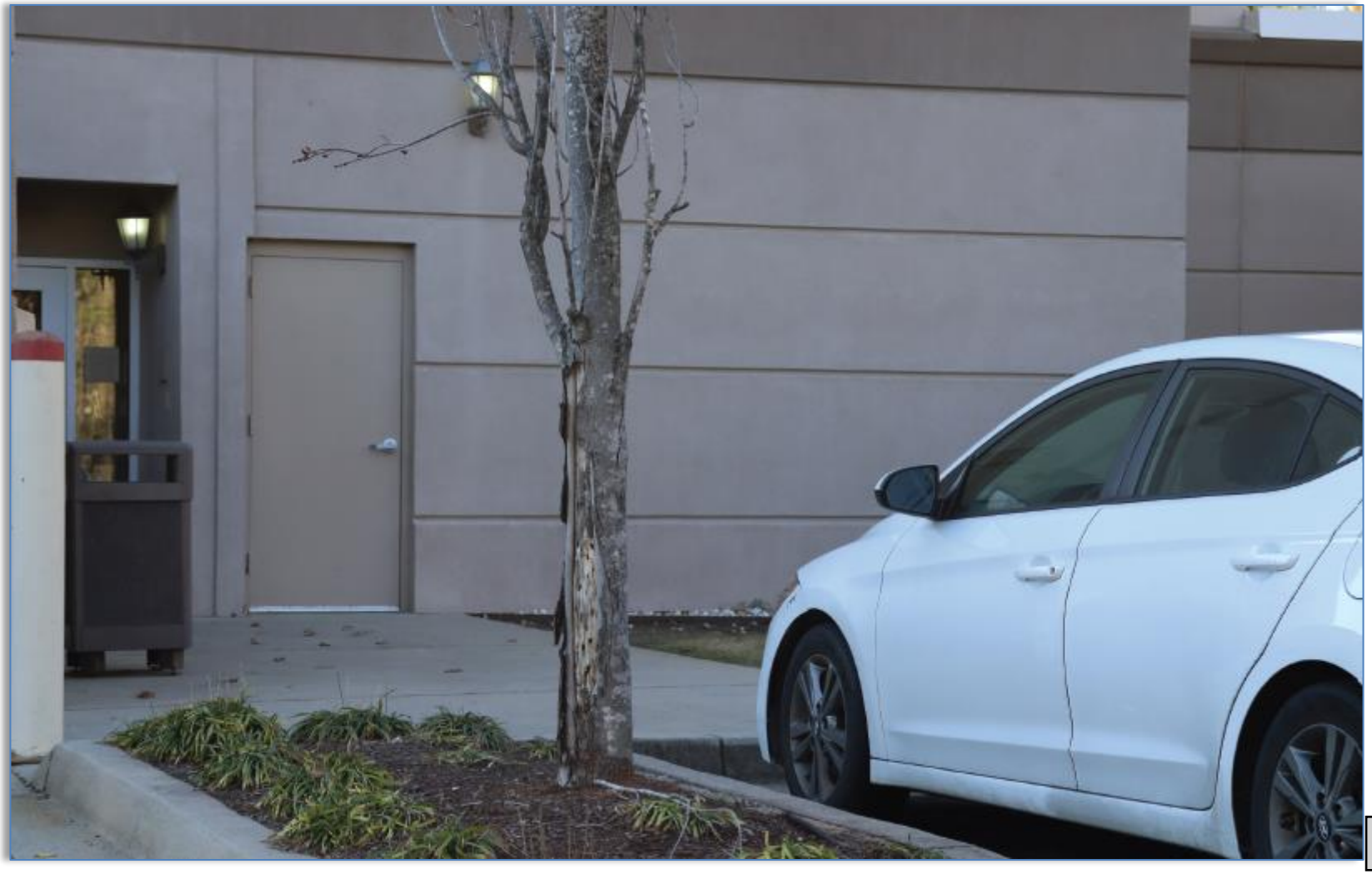
300.25 & Exception

REVISION



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300.26

NEW

Remote-Control and Signaling Circuits Classification

Change Summary

- The scope of Article 725 has been changed, requiring this clarification.
- Class 2 and 3 power-limited remote-control and signaling circuits remain in Article 725.
- Class 1 power-limited remote-control and signaling circuits were relocated to the new Article 724.
- Non–power-limited remote-control and signaling circuits are governed by the requirements of Chapters 1 through 4 of the *Code*.

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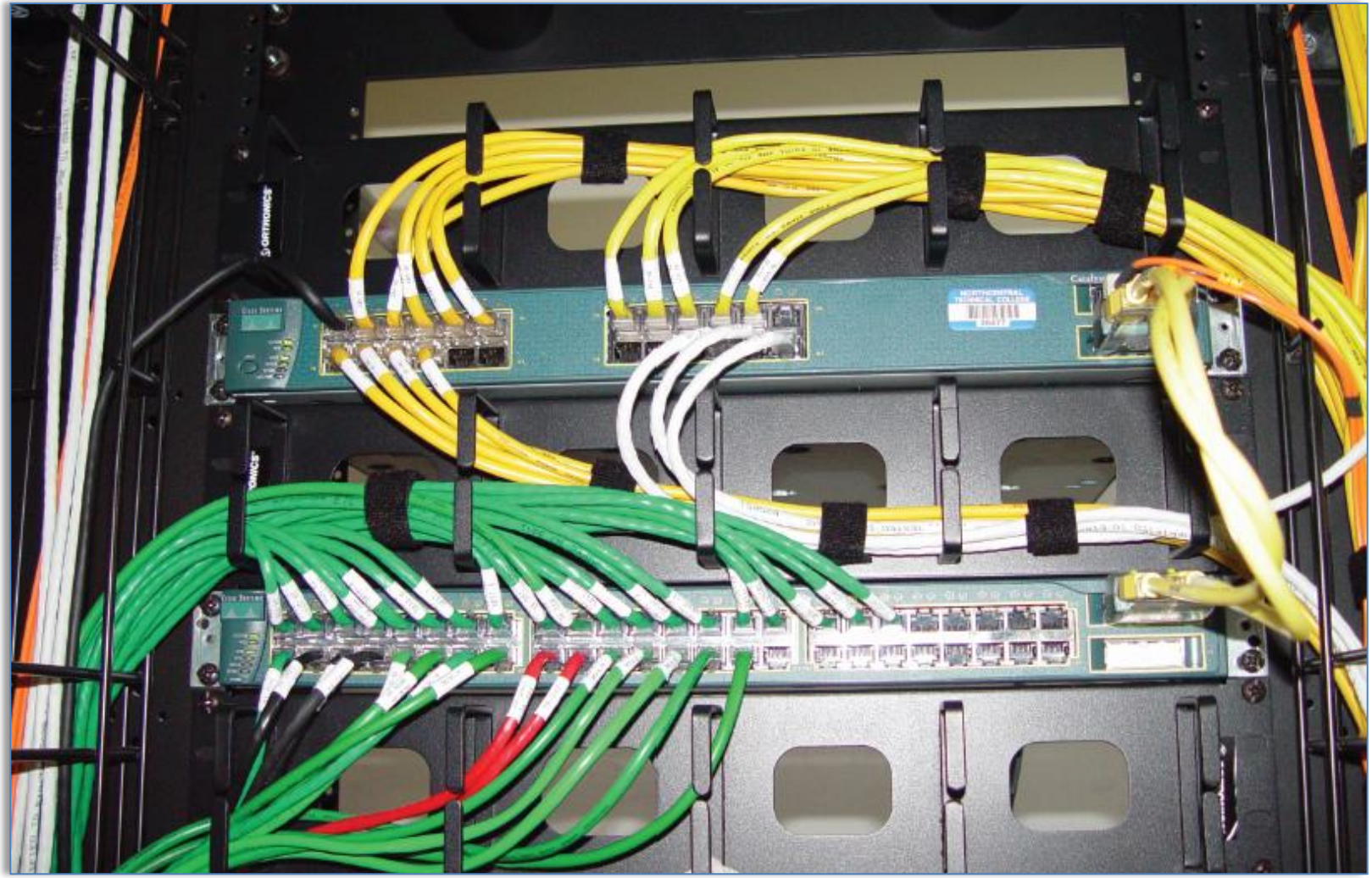
300.26

NEW



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Article 305

NEW

Systems Rated Over 1000 V ac, 1500 V dc, Nominal

Change Summary

- Article 305 has been created to separate the requirements for medium-voltage systems from the requirements of systems rated 1,000 volts ac or less and 1,500 volts dc or less.
- The bulk of Article 305 came from Part II of Article 300.
- Section 305.3 references the wiring methods permitted to be used over 1,000 volts ac and 1,500 volts dc.
- Requirements for services, feeders, and branch circuits for systems rated over 1,000 volts ac and over 1,500 volts dc are found in Article 235.

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Article 305

NEW

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Courtesy of Michael J. Johnston

312.8

NEW

Splices, Taps, and Feed-Through Conductors

Change Summary

- A new 312.8(A)(3) has been added to recognize the additional bending space needed for conductors 4 AWG and larger.
- Where splices or where angle or U pulls are made with insulated conductors, 314.28(A)(2) requires the distance between the raceway and the opposite wall to be at least six times the largest trade size in a row.
- The six times rule also applies to straight-through conduit entries if the conductors are spliced.

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312.8

NEW

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Courtesy of Tom Garvey

312.10

NEW

Screws or Other Fasteners

Change Summary

- Screws and other fasteners installed in the field that enter the wiring space are required to be those provided by or specified by the manufacturer.
- If not supplied or specified by the manufacturer, this section provides three criteria that can be used, where applicable.
- An exception allows screws that enter to extend into the enclosure not more than 7/16 inch if located within 3/8 inch of an enclosure wall.
- A similar requirement was added for screws and fasteners in 314.5.

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312.10

NEW

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Courtesy of Michael J. Johnston

314.5

NEW

Screws or Other Fasteners

Change Summary

- New requirements for screws and other fasteners have been added to 314.5. Screws and other fasteners are required to have blunt ends.
- Specific requirements are provided for the permitted length, based on where in the box the screw or fastener is used.
- Longer screws are permitted where protected with an approved means.

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314.5

NEW

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314.16(B)

REVISION

Box Fill Calculations

Change Summary

- The second paragraph of 314.16(B)(2) was deleted because the product line that it was intended for is not being produced.
- Equipment bonding jumpers were removed for the conductor fill calculation requirements in 314.16(B)(5). The panel concluded that if equipment bonding jumpers are run within raceways, they are considered an expansion of the equipment grounding conductor.
- 314.16(B)(6) was added to require a single volume allowance for a terminal block assembly based on the largest conductor terminated to the assembly.

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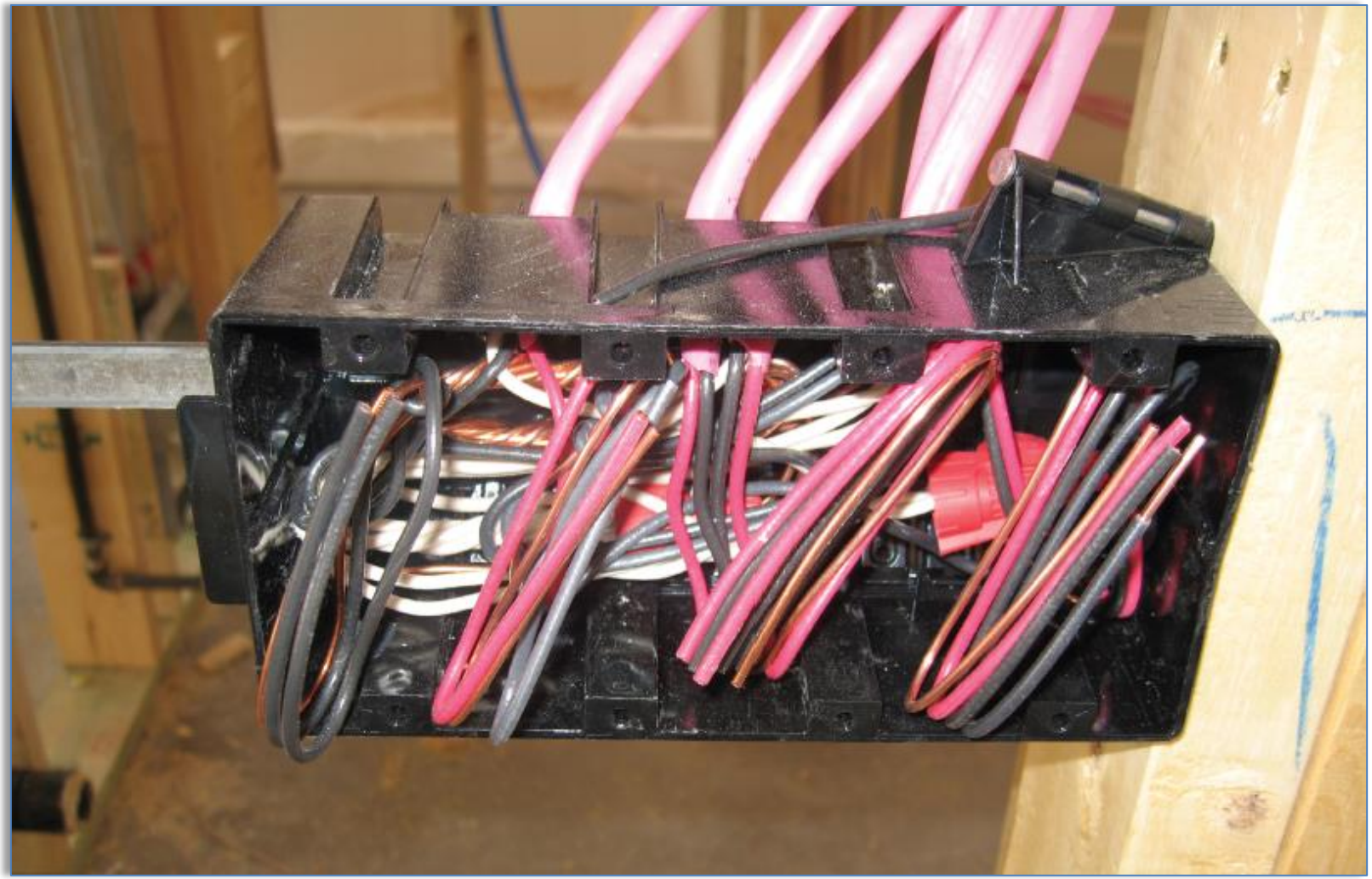
314.16(B)

REVISION



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314.24

REVISION

Dimensions of Boxes

Change Summary

- The title of 314.24 has been changed from “depth of boxes” to “dimensions of boxes” to recognize that this section deals with more than depth.
- The rearward projection of devices or equipment must not be greater than the center line of a knockout used for a side wiring entrance or a ½-inch clearance must be maintained between the device and the sidewall of the box.
- Where wiring enters the center portion of the rear of a box opposite the equipment, the minimum clearance must be increased to ½ inch.

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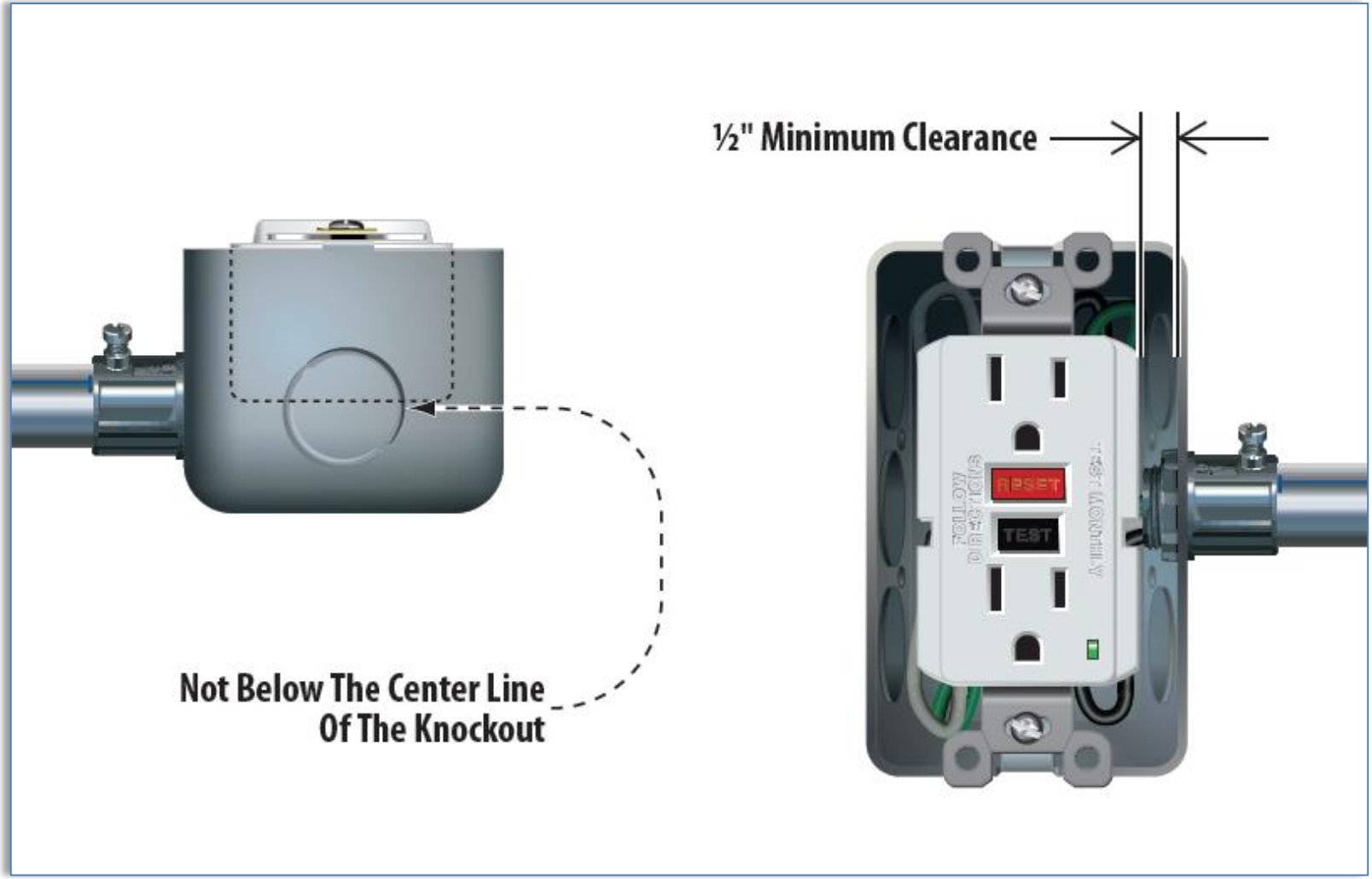
314.24

REVISION



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314.25

REVISION

Covers and Canopies

Change Summary

- Section 314.25 was revised to clarify that conduit body enclosures must be enclosed by a cover, a lampholder, or a device.
- Like boxes, conduit bodies can contain splices, terminations, and devices. Therefore, conduit bodies should also be covered.
- The language in 314.25(A) and the informational note were revised to clarify that they apply to equipment grounding conductors.

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314.25

REVISION

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314.27(C) & (E)

REVISION

Outlet Boxes, Ceiling-Suspended (Paddle Fans)

Change Summary

- Outlet boxes used as the sole support of ceiling-suspended (paddle) fans are now required to be marked on the inside of the box so that the marking can be seen during a rough-in inspection.
- 314.27(C)(2) was simplified to recognize boxes that provide direct access through the box to structural framing capable of supporting a paddle fan, without the need to remove the box.
- The locking support and locking receptacle and the compatible attachment fitting have been renamed as “weight-supporting ceiling receptacle” and “weight-supporting attachment fitting.”

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314.27(C) & (E)

REVISION

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Article 315

REVISION RELOCATE

Medium Voltage Conductors and Cables

Change Summary

- Article 311 has been relocated to become Article 315, consistent with the numbering scheme for medium-voltage articles.
- The title and scope of Article 315 have been expanded to include cable joints and cable terminations.
- The scope of this article for dc cables is limited to cables rated 2,001 through 2,500 volts.

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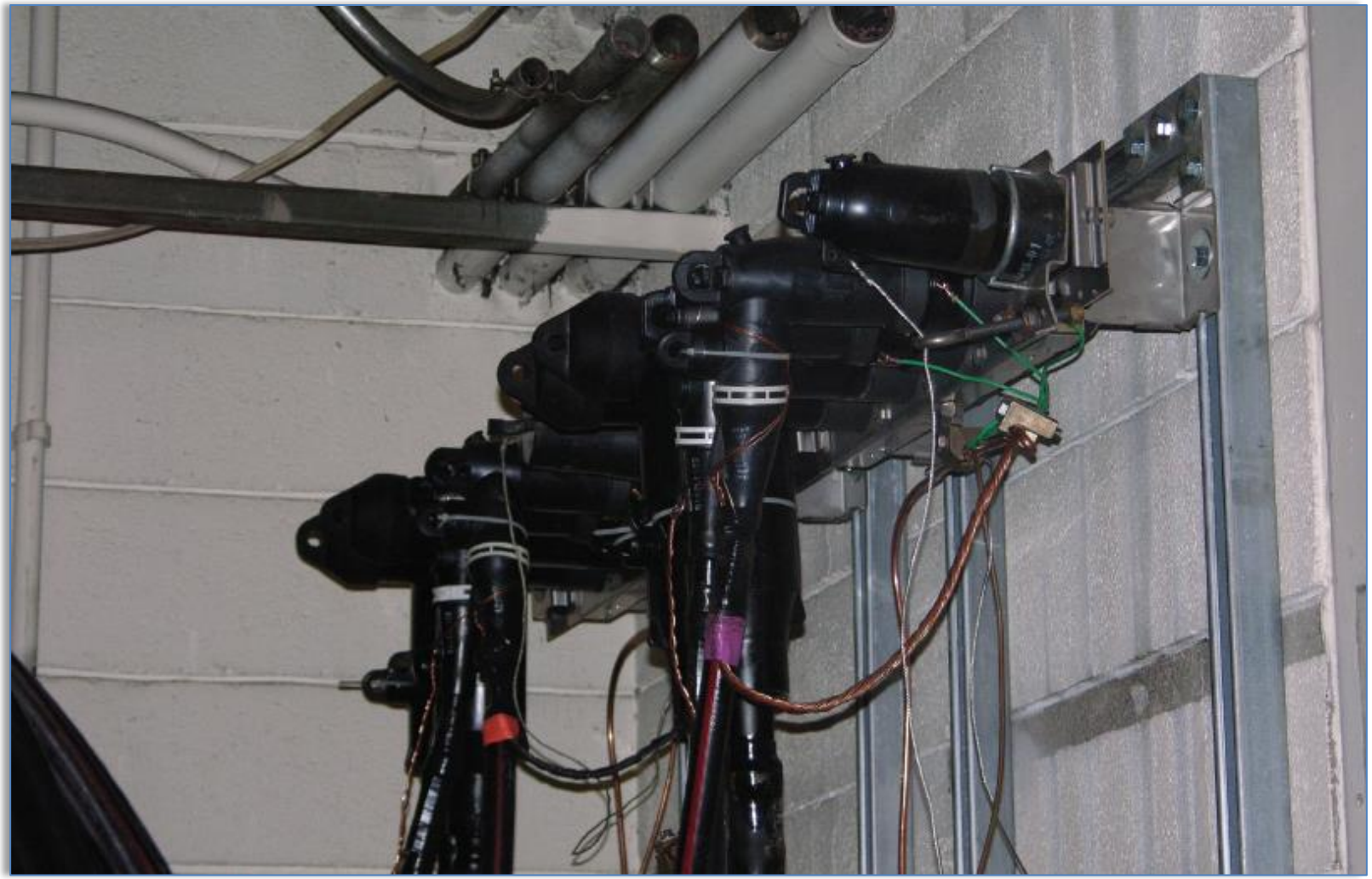
Article 315

REVISION RELOCATE



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342.24

REVISION REORGANIZE

Bends

Change Summary

- Sections 342.24 and 342.25 have been combined into a 342.25, Bends.
- This now clarifies the total degrees of bends between pull points.
- Since Chapter 3 articles follow the same format, the same change was made in Article 344, 348, 350, 352, 353, 354, 355, 356, 358, 360, and 362.

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342.24

REVISION **REORGANIZE**

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342.30(A)

NEW

Securing and Supporting

Change Summary

- Section 342.30(A) requires intermediate metal conduit (IMC) to be securely fastened.
- A new exception permits IMC in concealed work to be fished in finished buildings or in prefinished wall panels where secure fastening is impractical.
- This exception only applies to unbroken lengths of IMC without couplings in the concealed space.

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342.30(A)

NEW

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344.28

REVISION

Reaming and Threading

Change Summary

- PVC-coated RMC is often used in areas subject to corrosion.
- New text was added to this section to require that the manufacturer's instructions be followed when threading PVC-coated RMC to prevent damage to the exterior coating.
- A new informational note was added that references NECA 101, *Standard for Installing Steel Conduits (RMC, IMC, EMT)*, which provides information on threading PVC-coated RMC.

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344.28

REVISION

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Courtesy of Corrosion College

352.10

REVISION REORGANIZE

Insert Uses Permitted

Change Summary

- The uses permitted for PVC conduit have been clarified.
- PVC conduit is permitted to be embedded in concrete.
- Exposure to physical damage requirements have been removed from 352.10(G) and moved to the new 352.10(K), Physical Damage.
- Where subject to physical damage, Schedule 80 PVC conduit, along with listed Schedule 80 PVC conduit fittings, must be used.

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352.10

REVISION **REORGANIZE**

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Courtesy of Michael J. Johnston and Tom Garvey

358.10

REVISION

Uses Permitted

Change Summary

- Section 358.10 was revised to recognize two new permitted uses for EMT.
- EMT is permitted in direct burial applications where it is used with fittings that are identified for direct burial.
- EMT is recognized for manufactured wiring systems as permitted in 604.100(A)(2).

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358.10

REVISION

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Courtesy of Michel J. Johnston

362.10

REVISION

Uses Permitted

Change Summary

- Section 362.10(2) was revised to clarify that ENT is permitted to be installed in combustible or noncombustible buildings where the walls, floors, and ceilings meet the finish rating.
- The mandatory reference to *NFPA 13* was changed to an informational note reference.
- Section 362.10(6) was split into two sections to separate requirement for installations in poured concrete floors, ceilings, walls, and slabs from those where the ENT is embedded in concrete slabs.

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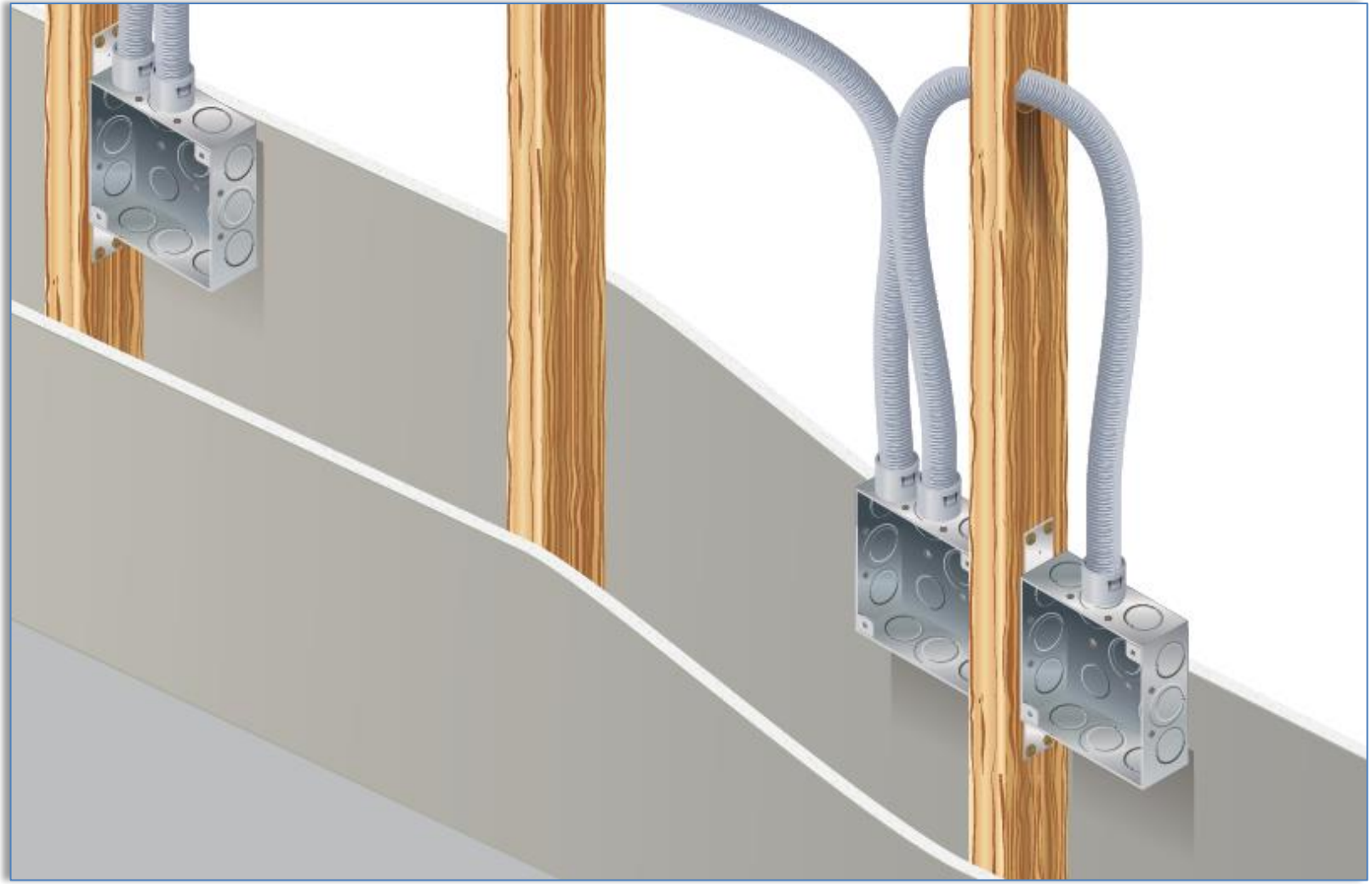
362.10

REVISION



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Article 369

NEW

Insulated Bus Pipe (IBP)/Tubular Covered Conductors

Change Summary

- The new Article 369 covers Insulated Bus Pipe (Type IBP).
- IBP is a cylindrical solid or hollow conductor with a solid insulation system having conductive grading layers and a grounding layer embedded in the insulation that is provided with an overall insulation or metallic material. It is permitted for up to 35 kV.
- IBP is required to be listed.
- IBP is permitted to be used in wet or damp locations when listed for wet or damp locations.
- IBP must not be accessible to unqualified persons.

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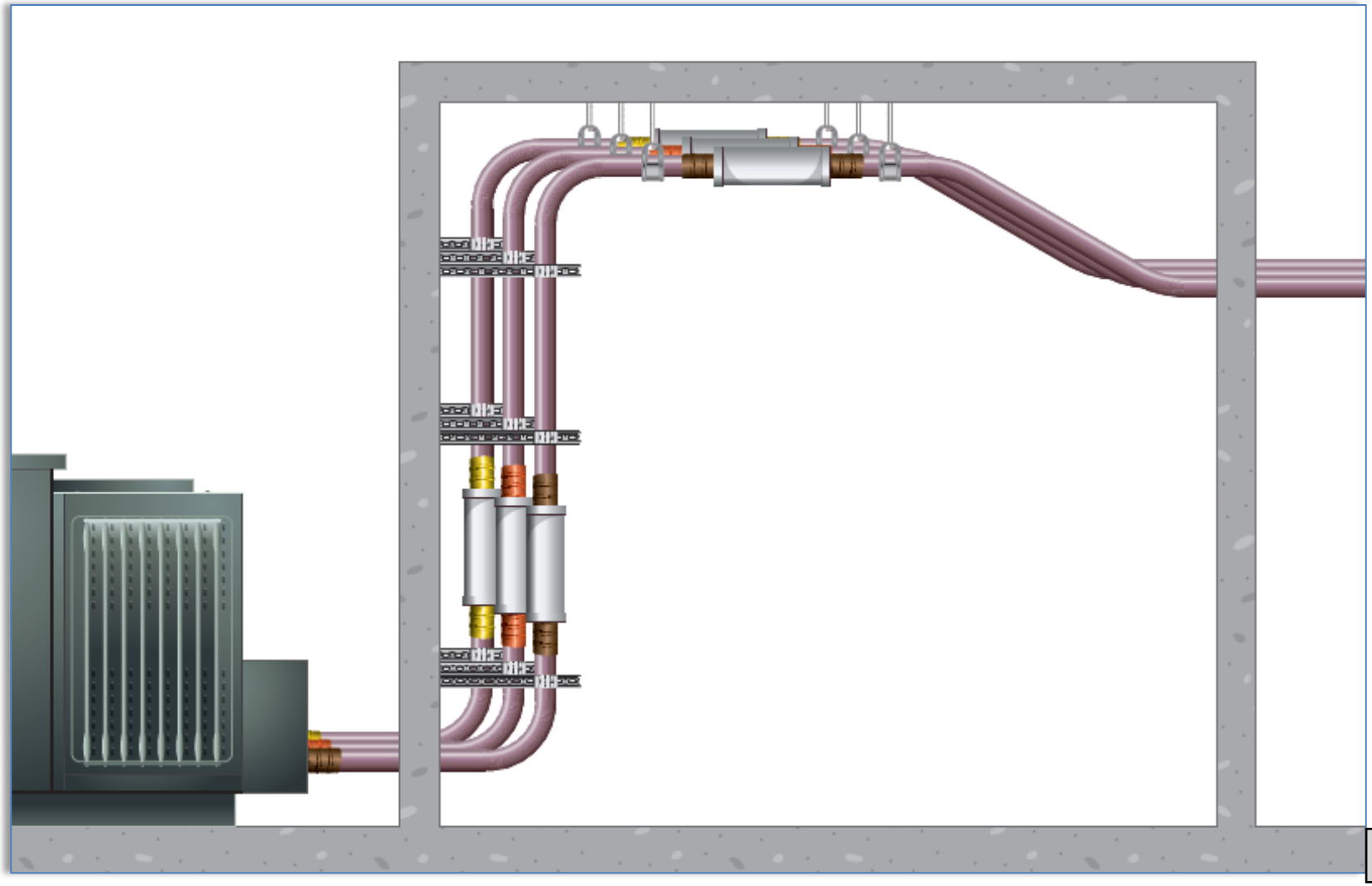
Article 369

NEW



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370.18

REVISION

Cablebus Installation

Change Summary

- Cablebus installation requirements have been simplified.
- Cablebus is permitted to be run through fire walls in accordance with 300.21.
- Since cablebus is a support system, similar to cable trays, the firestop requirements now refer to 300.21.
- The previous requirement for curbs where cablebus penetrates floors has been removed because cablebus is permitted in wet locations.

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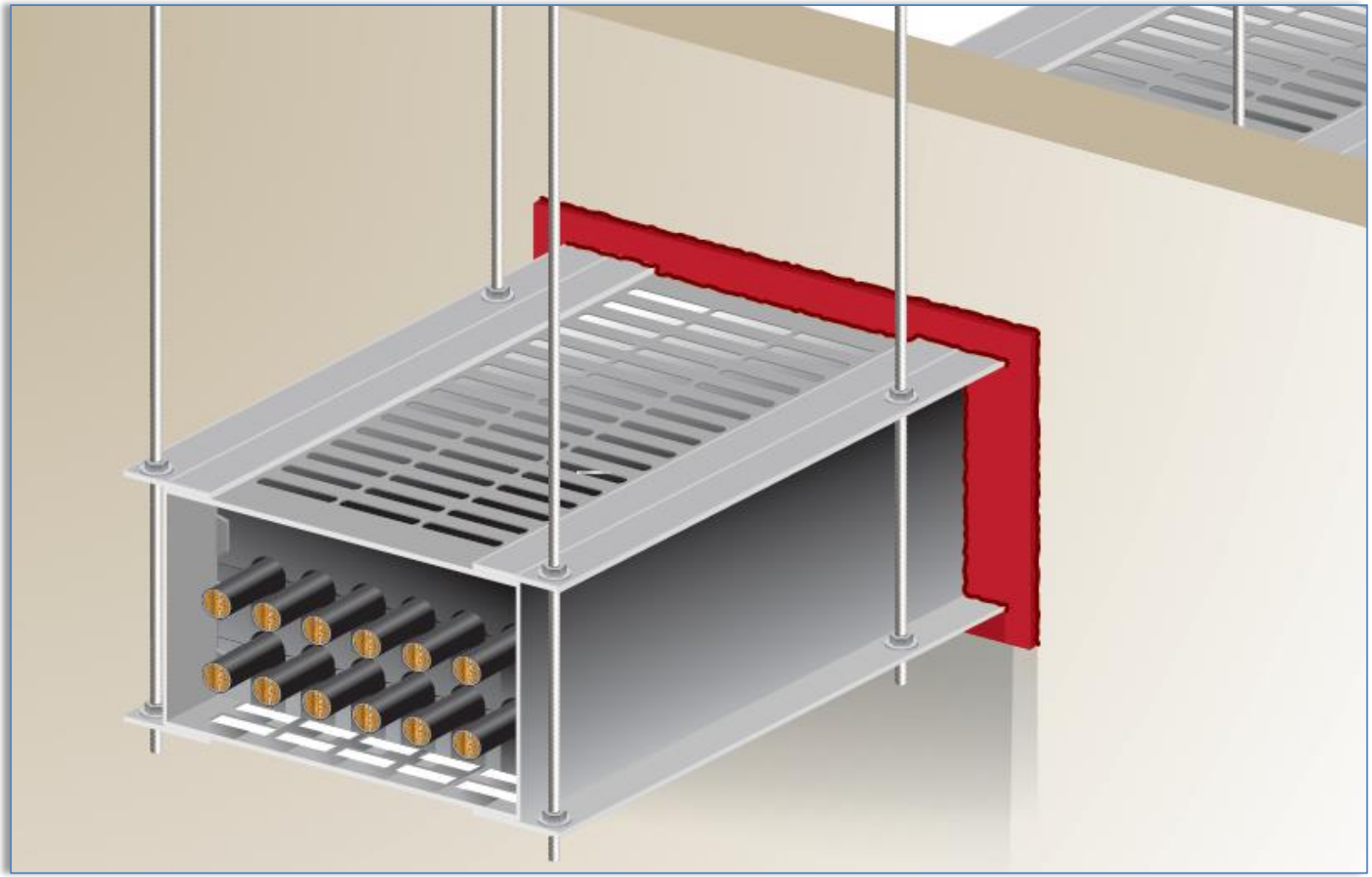
370.18

REVISION



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370.120

REVISION

Marking

Change Summary

- Section 370.120 was revised to clarify cablebus marking requirements and to harmonize with requirements in Canada.
- Nameplates are required at each terminating end of the system, identifying the manufacturer as well as the ratings.
- Nameplates are required to be visible after installation.
- Each section and fitting of a cablebus system is required to be identified with a marking that corresponds with the installation instruction.

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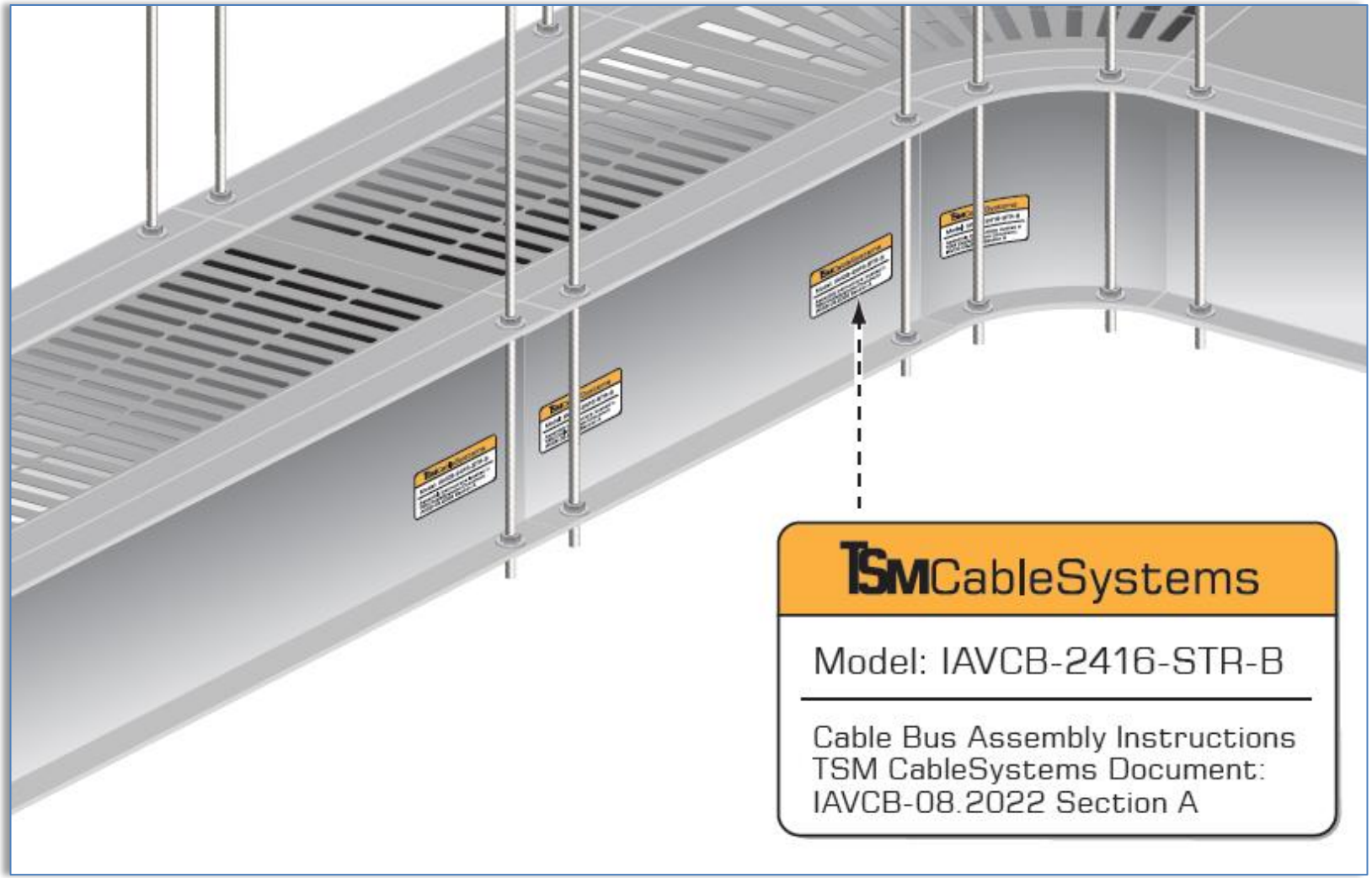
370.120

REVISION



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Article 371

NEW

Flexible Bus Systems

Change Summary

- A new Article 371 was created for flexible bus systems, which are assemblies of flexible bus with associated fittings to secure, support, and terminate the bus.
- Flexible bus is permitted for services, feeders, and branch circuits.
- Flexible bus is permitted indoors, or outdoors if identified for outdoor use.
- Flexible bus is permitted to be used exposed or behind access panels as long as the space behind the access panels is not used for air handling.

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Article 371

NEW

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Courtesy of Ward Judson, nVent

Significant Changes

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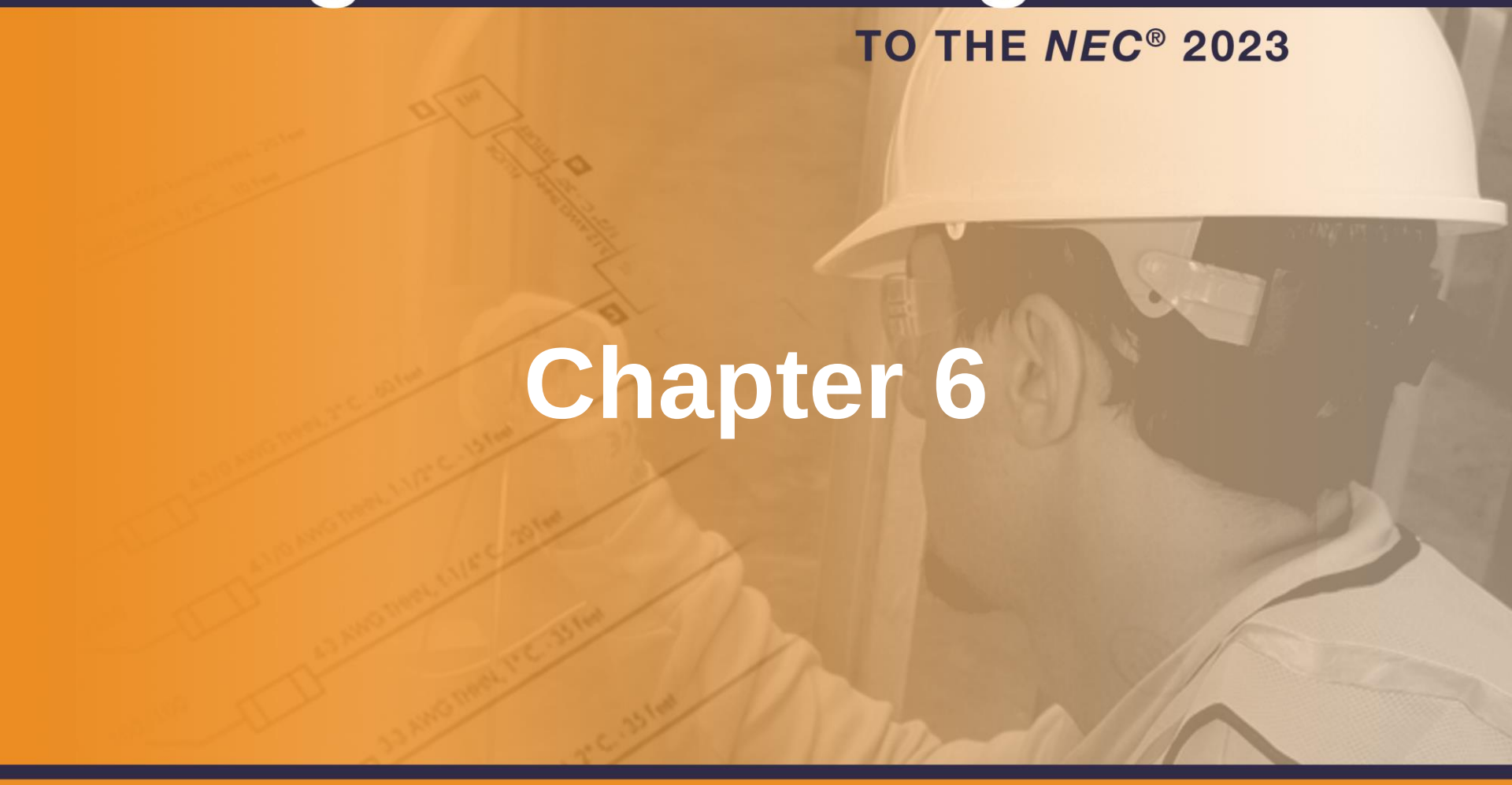

Chapter 6

electrical training ALLIANCE IBEW - NECA IN COLLABORATION WITH NECA NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION

600.5

REVISION

Branch Circuits

Change Summary

- The last sentence of 600.5(A) was converted into an exception that exempts some entrances, corridors, and hallways.
- A second exception was added that permits the branch circuit to supply other loads that are directly related to the control of the sign.
- Section 600.5(D)(2) now permits electrical enclosures integral to the sign that are listed and labeled as electrical enclosures to be used as pull or junction boxes for up to 600 volts.

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600.5

REVISION

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600.6

REVISION

Disconnects

Change Summary

- The general requirements of Chapters 1 through 4 of the *Code* apply, including the requirements of 404.7, requiring disconnects to indicate whether they are open or closed.
- The disconnecting means is required to be accessible and located at the point of entry to the sign, within sight of the sign, or within sight of the controller.
- If the disconnecting means is remote from the sign, it must be mounted at an accessible location that is available to first responders and service personnel.

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600.6

REVISION

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620.12(A)

REVISION

Traveling Cables

Change Summary

- A new 620.12(A)(2) has been added to recognize Class 2 and communications cables used on Class 2 circuits, including power over Ethernet, in traveling cables.
- The minimum size of Class 2 and communications circuit conductors is 24 AWG.
- New requirements were added to require parallel conductors of traveling cables to be not smaller than 20 AWG.

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620.12(A)

REVISION

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620.22

REVISION

Branch Circuits for Car Lighting, Receptacles, HVAC

Change Summary

- Section 620.22(A) permits car lighting branch circuits to supply additional loads.
- The lighting circuit is now permitted to supply emergency responder radio coverage circuits, car ventilation purification systems, car emergency signaling, and communications devices, including charging circuits.
- The permitted location of the OCPD for the circuit for the air conditioning and heating source has been revised to correlate with the OCPD locations permitted for other branch circuits in 620.22(A).

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620.22

REVISION

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620.23

REVISION

Branch Circuits for Machine Room, Control Room…

Change Summary

- The title of 620.23 was revised to include truss interior lighting.
- Truss interiors are the structure of moving walkways and escalators.
- At least one 125-volt, single-phase, 15- or 20-ampere duplex receptacle is now required for truss interiors.

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620.23

REVISION

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Courtesy of Tom Garvey

625.1 Info. Notes

NEW

Scope

Change Summary

- Two new informational notes were added to 625.1 to provide additional information for installation of electric vehicle infrastructure.
- UL 2750 provides information that was developed by UL when they were investigating wireless power transfer equipment.
- NECA 413 provides information on installation and maintenance of AC Level 1 and 2 and fast-charging dc EVSE.

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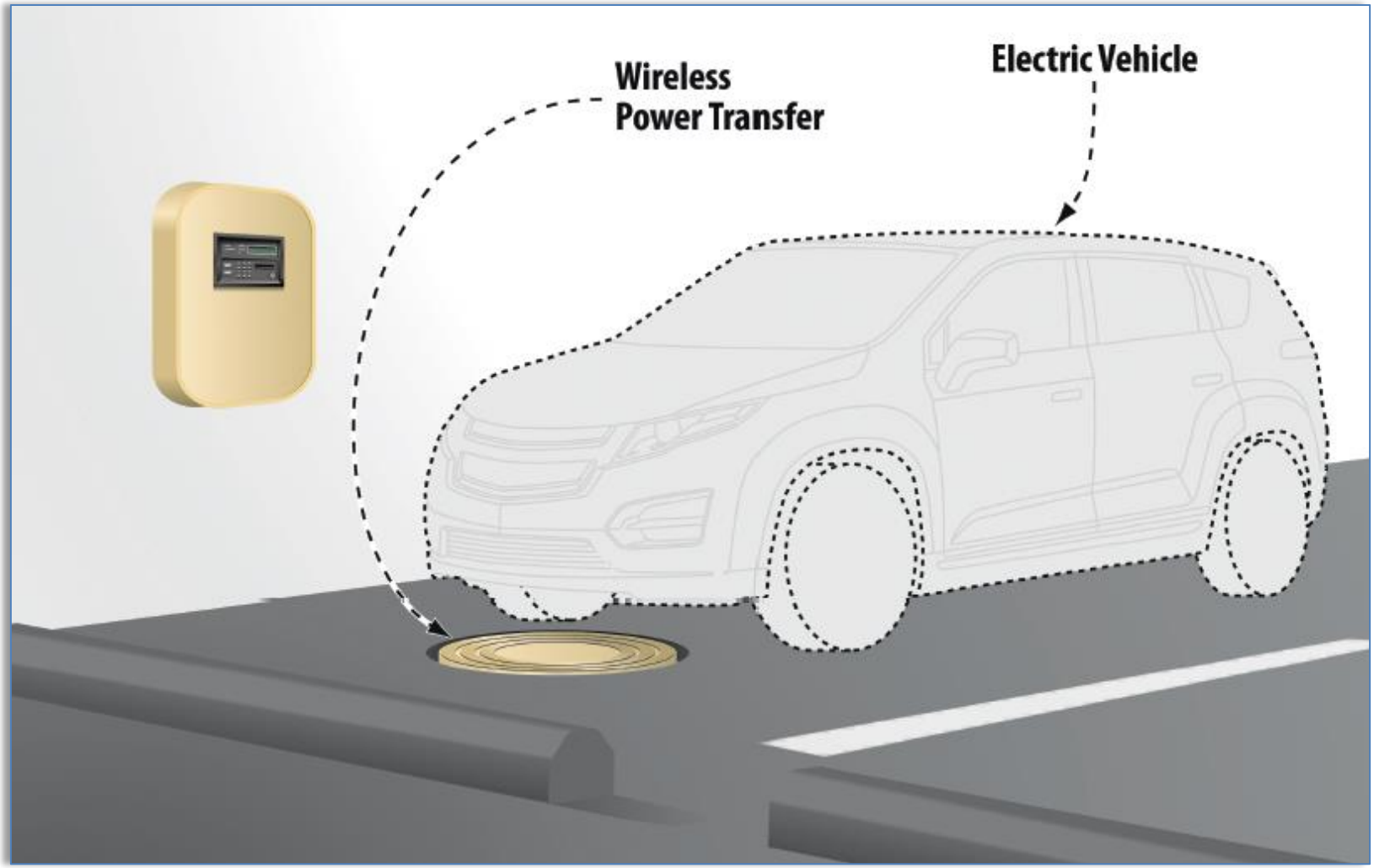
625.1 Info. Notes

NEW



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625.17

REVISION

Cords and Cables

Change Summary

- “Stationary equipment” was changed to “fastened-in-place equipment” for consistency with 625.44(B).
- The overall cord and cable length is not permitted to exceed 25 feet unless equipped with a cable management system.
- Section 625.17(C) has been revised to indicate how the power supply cords for the output cable is measured.

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625.17

REVISION

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625.40

REVISION

Electric Vehicle Circuit

Change Summary

- Section 625.40 requires each outlet installed for supplying EVSE to be supplied by an individual branch circuit.
- The requirement for an individual branch circuit applies to outlets greater than 16 amperes or 120 volts.
- A new exception has been added that permits branch circuits to supply multiple EVSEs in accordance with 625.42(A) or (B).

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625.40

REVISION

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625.42

REVISION

Rating

Change Summary

- Section 624.42 was split into two subsections to clearly provide separate requirements for load management systems and EVSE with adjustable settings.
- Energy management systems are permitted to be integral to one piece of equipment or to a listed system. If integral load management is provided, the system must be marked to indicate that control is provided.
- EVSE with adjustable settings is permitted if access to the settings is restricted.

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625.42

REVISION

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625.43

REVISION

Disconnecting Means

Change Summary

- Section 625.43 was revised so that it applies to EVSE and WPTE rather than to all equipment.
- The disconnect must be installed in a readily accessible location.
- If the disconnect is in a remote location, a plaque must be installed on the equipment indicating the location of the disconnecting means.

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625.43

REVISION

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625.49

NEW

Island Mode

Change Summary

- EVPE and EVSE with a power export function is now permitted to be part of an interconnected power system that operates in island mode.
- Some electric vehicle installations can function as optional standby power systems.
- The rest of the connected system must be capable of operating in island mode.

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625.49

NEW

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625.102

REVISION

Installation

Change Summary

- Changes were made to 625.102 to better integrate wireless power transfer into the *Code*.
- The title of 625.102(B) was changed to “Control Box.” The term *charger power converter* is no longer used.
- The title of 625.102(D) has been changed from “Protection of Cables” to “Protection of Cords and Cables to the Primary Pad.”
- If there is not a control box, the cord or cable supplying power to the primary pad must be secured in place to restrict movement and prevent strain at the connection points.

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625.102

REVISION

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630.8

NEW

Ground-Fault Circuit-Interrupter Protection

Change Summary

- All 125-volt, single-phase, 15- and 20-ampere receptacles installed in work areas where welders are operated are required to be GFCI protected.
- This requirement is to protect workers who are using electric hand tools or portable lighting equipment.
- The work area is not defined in this requirement.

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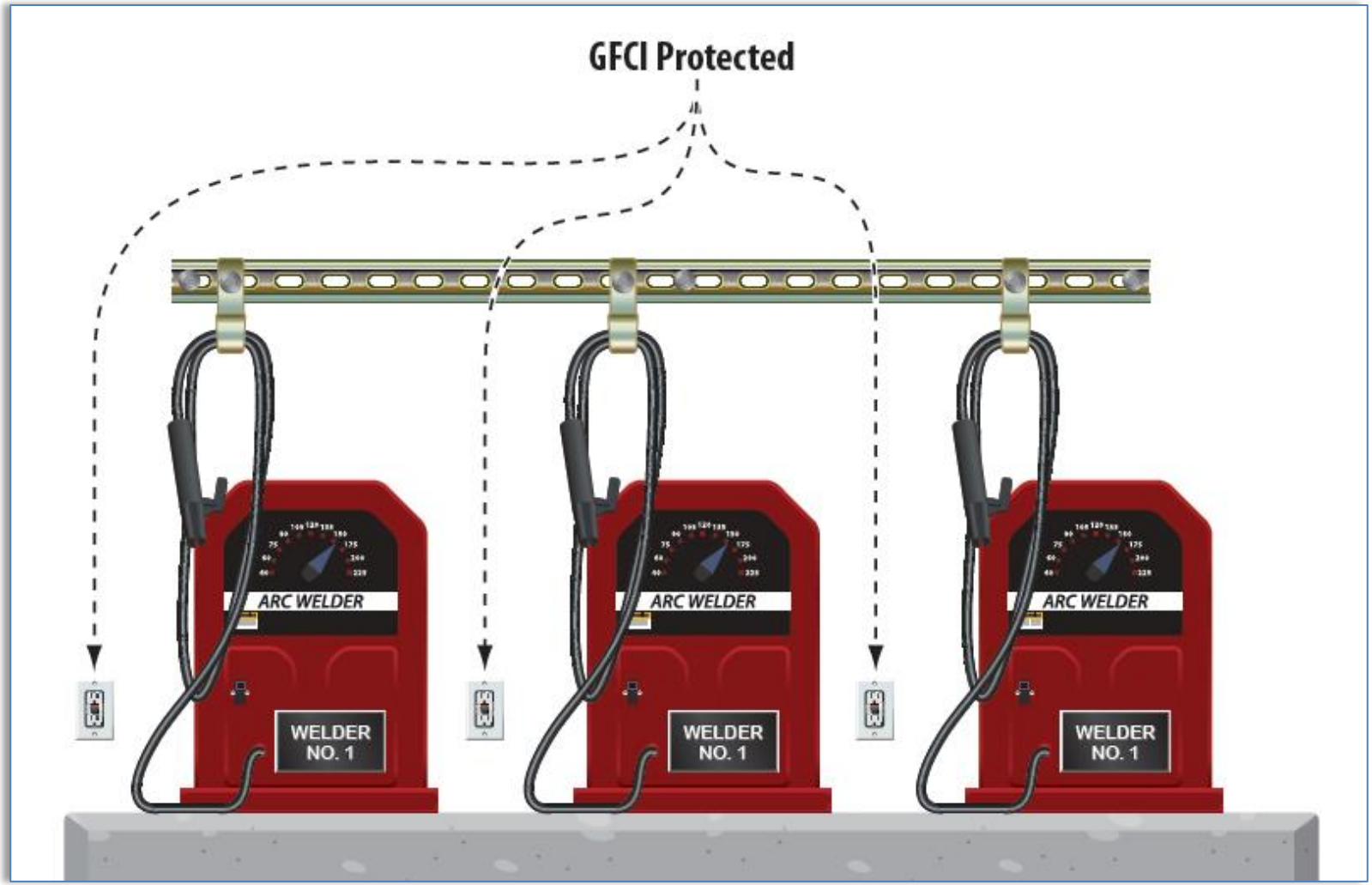
630.8

NEW



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645.5

REVISION

Supply Circuits and Interconnecting Cables

Change Summary

- New 645.5(B)(3) was added to ensure that the plugs and receptacles that connect power supply cords are listed and have properly-mated components.
- Sections 645.5(D), (E), and (F) were modified to use properly descriptive terminology.
- Section 645.5(H) was rearranged into list format to improve clarity.

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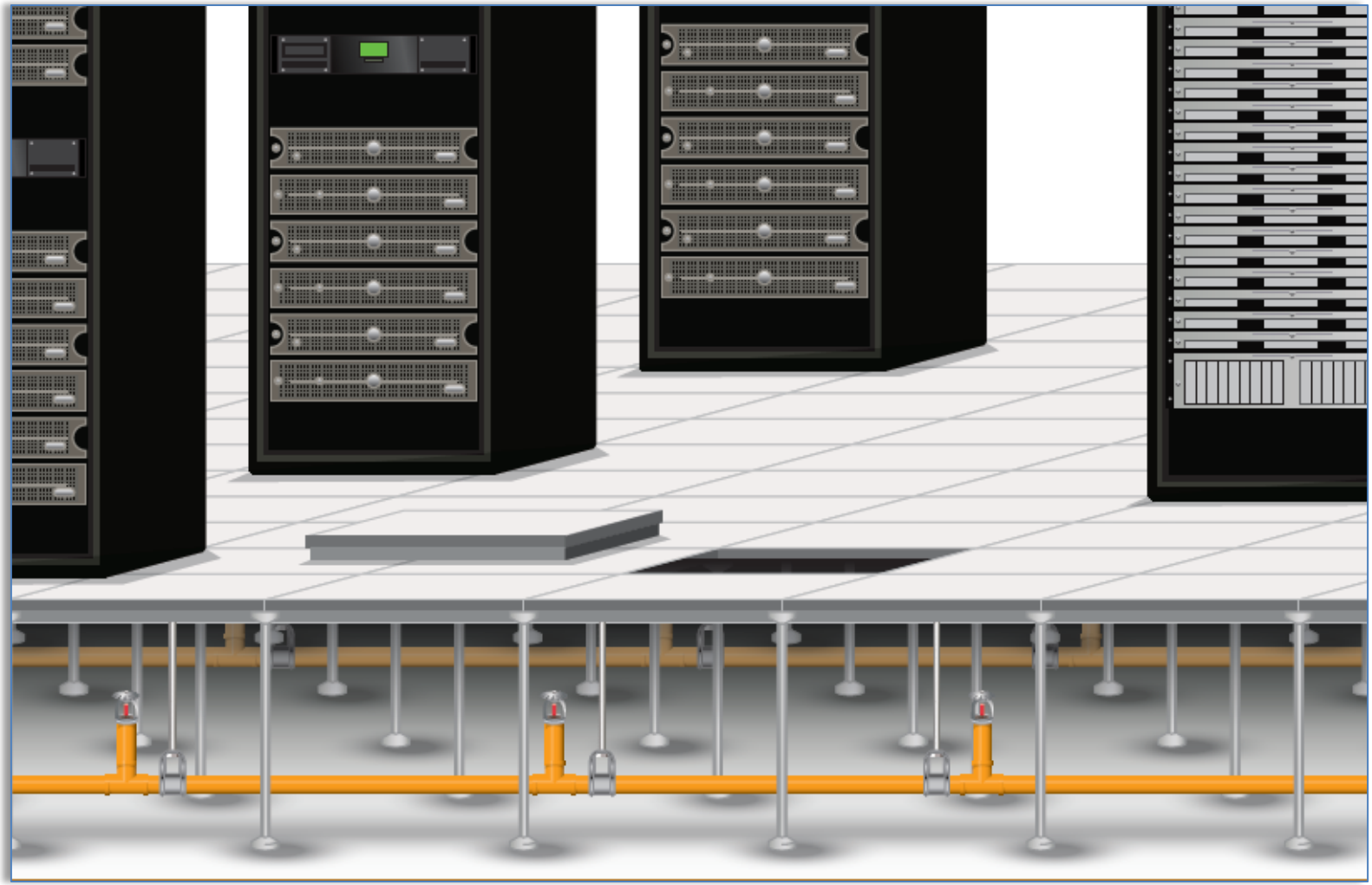
645.5

REVISION



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670.3(A)

REVISION

Permanent Nameplate

Change Summary

- The requirements for nameplates on industrial machinery were revised for consistency with *NFPA 79* regarding industrial machinery.
- The nameplate must be attached to the outside of the control equipment enclosure or on the machine immediately adjacent to the main control equipment enclosure so that it is visible after installation.
- The requirement previously required that the nameplate be “plainly visible,” which was unenforceable.

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670.3(A)

REVISION

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680.5

REVISION

GFCI and SPGFCI Protection

Change Summary

- The first sentence of 680.8 was deleted because it described the types of devices used for GFCI protection, which was not needed.
- Some GFCI requirements from other parts of Article 680 were consolidated into 680.5.
- The informational note to 680.5(B) points out that the high leg of a 120/240-volt, 4-wire, delta-connected system exceeds the limits for Class A GFCIs.
- A new 680.5(C) has been added to address ground-fault protection of receptacles and outlets on single- and 3-phase circuits exceeding 150 volts to ground.

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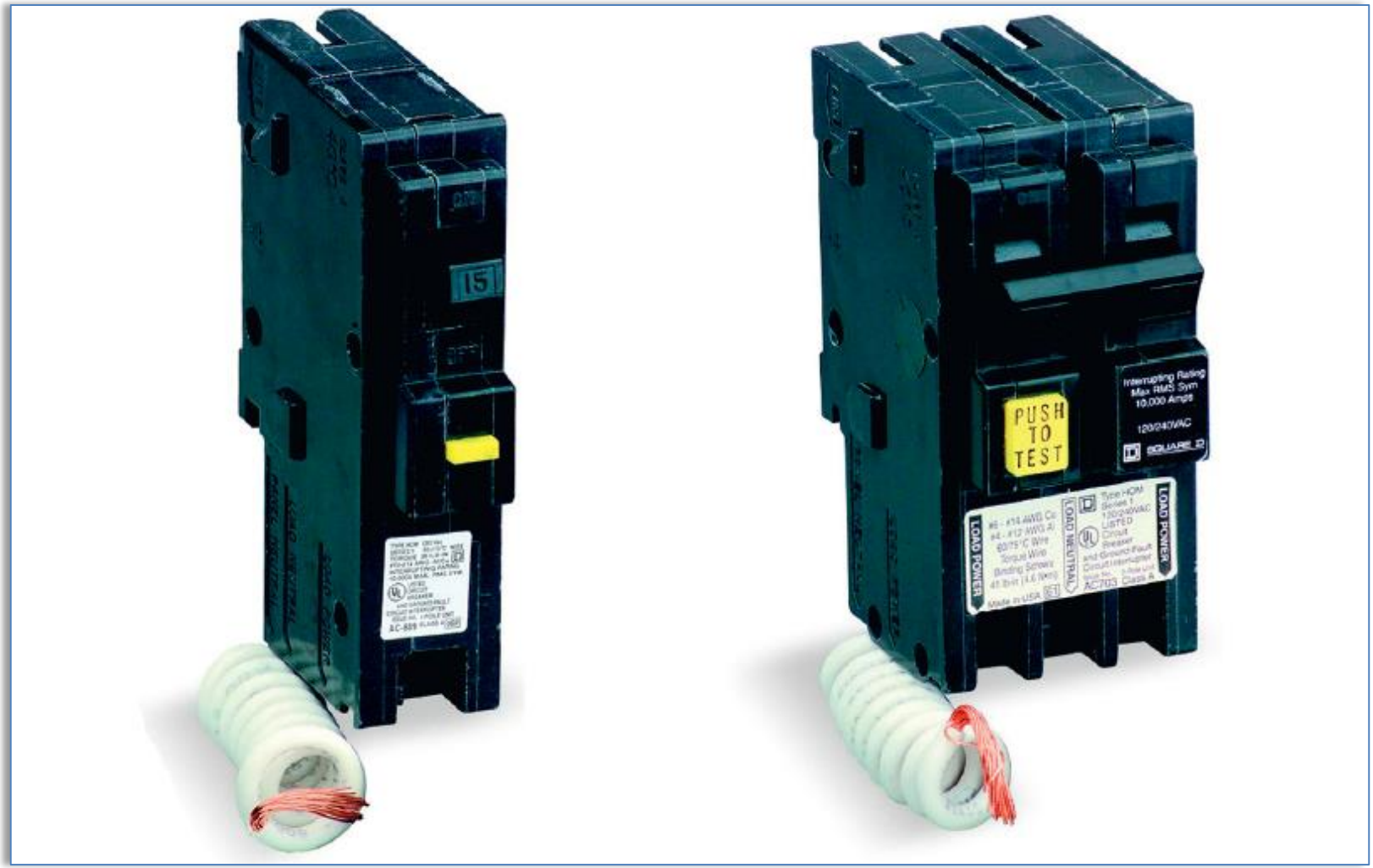
680.5

REVISION



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Courtesy of Schneider Electric

680.6 & 680.7

DELETION REVISION

Grounding and Bonding

Change Summary

- Section 680.6, Bonding and Equipment Grounding, was deleted as it was redundant with requirements in Article 250.
- Section 680.7 was retitled “Grounding and Bonding.” The previously existing text was revised and relocated to 680.7(C).
- The requirements for cord- and plug-connected equipment were relocated to 680.7(B) from 680.21(A)(3) and 680.8(B).
- Requirements for feeders and branch circuits were relocated into 680.7(A) from 680.21(A)(3) and 680.8(B).

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680.6 & 680.7

DELETION **REVISION**

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680.10

REVISION

Electric Pool Water Heater

Change Summary

- The title of 680.10 has been changed to indicate that it applies to heaters incorporating resistive heating elements and electrically-powered swimming pool heat pumps and chillers.
- Section 680.10(A) only applies to heaters incorporating the traditional resistive heating elements.
- Section 680.10(B) recognizes the newer technology of electric heat pumps and chillers to heat or cool the pool water. They may do both.

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680.10

REVISION

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680.12

REVISION

Equipment Rooms, Vaults, and Pits

Change Summary

- The title of the section and 680.12(A) have been revised so that the requirements also apply to equipment in vaults.
- Equipment in rooms or vaults that do not have drainage that prevents water accumulation must be identified for submersion.
- A new 680.12(B) has been added to require at least one GFCI-protected, 125-volt, 15- or 20-ampere receptacle in the equipment room or vault.
- All other receptacles rated 150 volts or less to ground must be GFCI protected.

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680.12

REVISION

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Courtesy of Mark Ode

680.14

REVISION

Corrosive Environments

Change Summary

- Section 680.14 now covers wiring methods and other equipment in corrosive environments.
- Liquidtight flexible nonmetallic conduit is now permitted to be used in corrosive environments.
- Aluminum conduit and tubing are not permitted for use in corrosive environments.
- Other equipment in corrosive environments must be installed in identified corrosion-resistant enclosures.
- Equipment listed for spa and pool use is suitable.

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680.14

REVISION

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680.21

REVISION

Motors

Change Summary

- The requirements for corrosive environments were removed from this section because they are covered by 680.14.
- The title of 680.21(C) has been changed to “Ground-Fault Protection,” which now refers to 680.5(B) or (C).
- Section 680.21(D) has been revised to require that pool pump motors that are replaced or repaired be provided with ground-fault protection in accordance with 680.5.

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680.21

REVISION

© 2022 *electrical training ALLIANCE*

680.41

REVISION

Location of Other Equipment

Change Summary

- This section was retitled “Location of Other Equipment.”
- The emergency switch for spas and hot tubs has been relocated to 680.41(A). It will not apply to installations in one- and two-family dwellings.
- A new 680.41(B) was added to provide requirements for equipment exceeding the low-voltage contact limit.

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680.41

REVISION

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680.43(A)

REVISION

Ground-Fault Protection for Receptacles

Change Summary

- The requirements for ground-fault protection for receptacles have been revised.
- All receptacles rated 125 through 250 volts, 60 amperes or less, that are located within 10 feet of the inside walls of a spa or hot tub must have ground-fault protection complying with 680.5(B) or (C).
- Receptacles that provide power for spas and hot tubs are not permitted to exceed 150 volts to ground.

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680.43(A)

REVISION

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680.44

REVISION

GFCI and SPGFCI Protection

Change Summary

- The first sentence of this section has been relocated to become 680.44(A), and has been revised so that it requires the outlet that supplies a self-contained spa or hot tub, a packaged spa or hot tub equipment assembly, or a field-assembled spa or hot tub to have ground-fault protection in accordance with 680.5(B) or (C), as applicable.
- Section 680.44(C), “Other Units,” has been deleted because the reference to 680.5(C) covers ground-fault protection for 3-phase units.
- The new 680.44(C) provides requirements for gas-fired water heaters operating above the low-voltage contact limit.

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680.44

REVISION

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680.54

REVISION

Bonding

Change Summary

- Section 680.54(B) was revised to require that a conductor used for bonding be a minimum 8 AWG solid copper conductor.
- Section 680.54(B)(6) was revised by replacing *devices and controls* with the more general term *equipment*.
- A new first-level subdivision 680.54(C) was added to require equipotential bonding of splash pads.

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680.54

REVISION

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680.58

REVISION

GFCI and SPGFCI Protection for Receptacles

Change Summary

- The requirements for ground-fault protection for adjacent receptacle outlets have been expanded to apply to all receptacles rated 125 through 250 volts, 60 amperes or less.
- The requirements apply to single-phase and 3-phase receptacles within 20 feet of the edge of the fountain.
- The protection will be GFCI or SPGFCI protection, in accordance with 680.5(B) or (C), as applicable.

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680.58

REVISION

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680.59

REVISION

Ground-Fault Protection for Nonsubmersible Pumps

Change Summary

- The title of 680.59 has been revised to recognize that it applies to GFCI and SPGFCI protection for permanently installed nonsubmersible pumps.
- If the voltage to ground is 150 volts or less, GFCI protection is required.
- If the voltage to ground exceeds 150 volts, SPGFCI protection is required.
- An exception was added for listed low-voltage motors not requiring grounding that do not exceed the low-voltage contact limit, if the motor is supplied by listed transformers or power supplies that comply with 680.23(A)(2).

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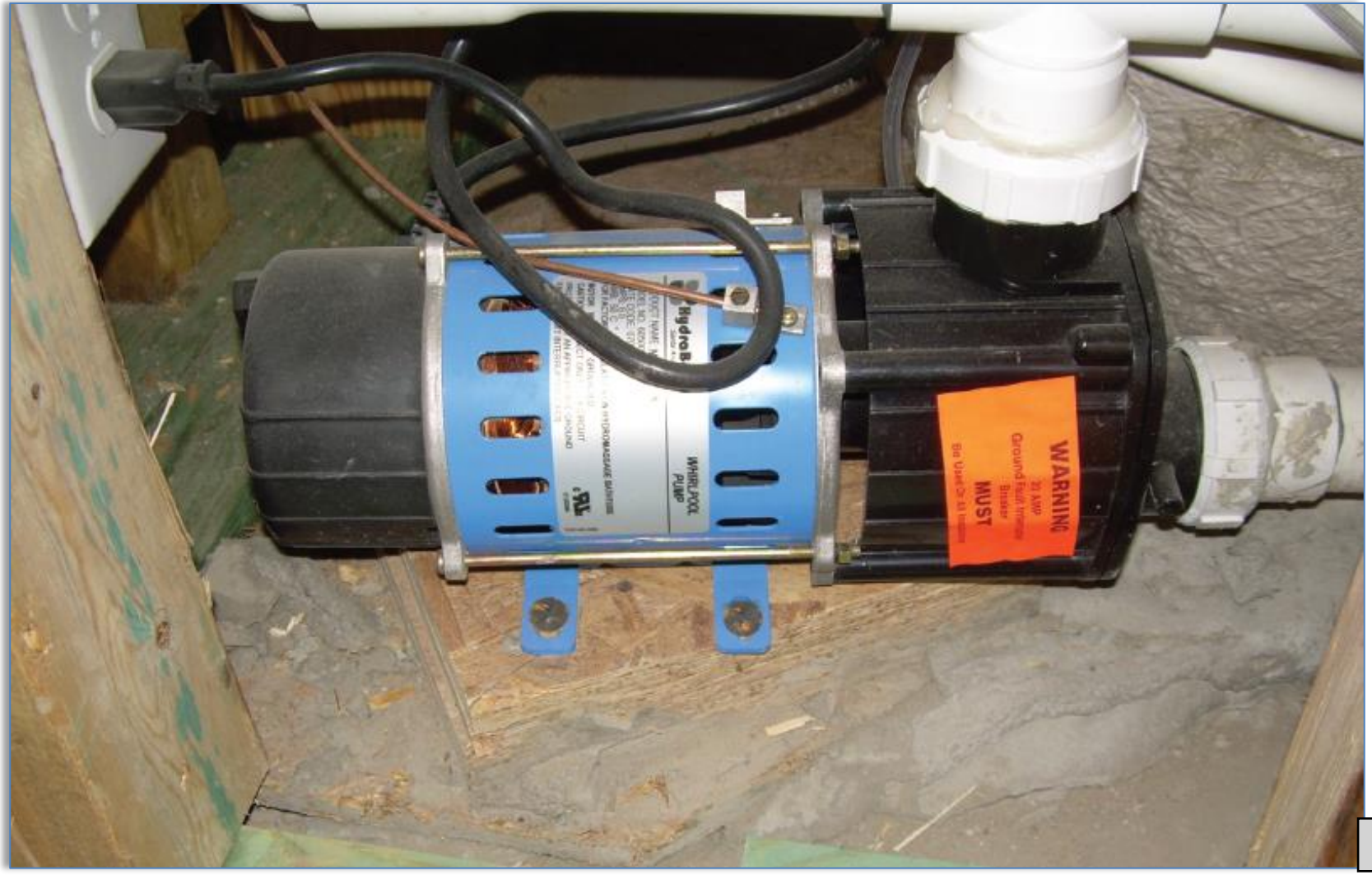
680.59

REVISION



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680.83

REVISION

Equipotential Bonding

Change Summary

- Equipotential bonding of pool lift equipment must use solid copper conductors that are not smaller than 8 AWG and may be covered, insulated, or bare.
- Connection to bonded parts must comply with 250.8.
- The bonding jumpers in the pool area are not required to be extended to remote panelboards, service equipment, or electrodes.

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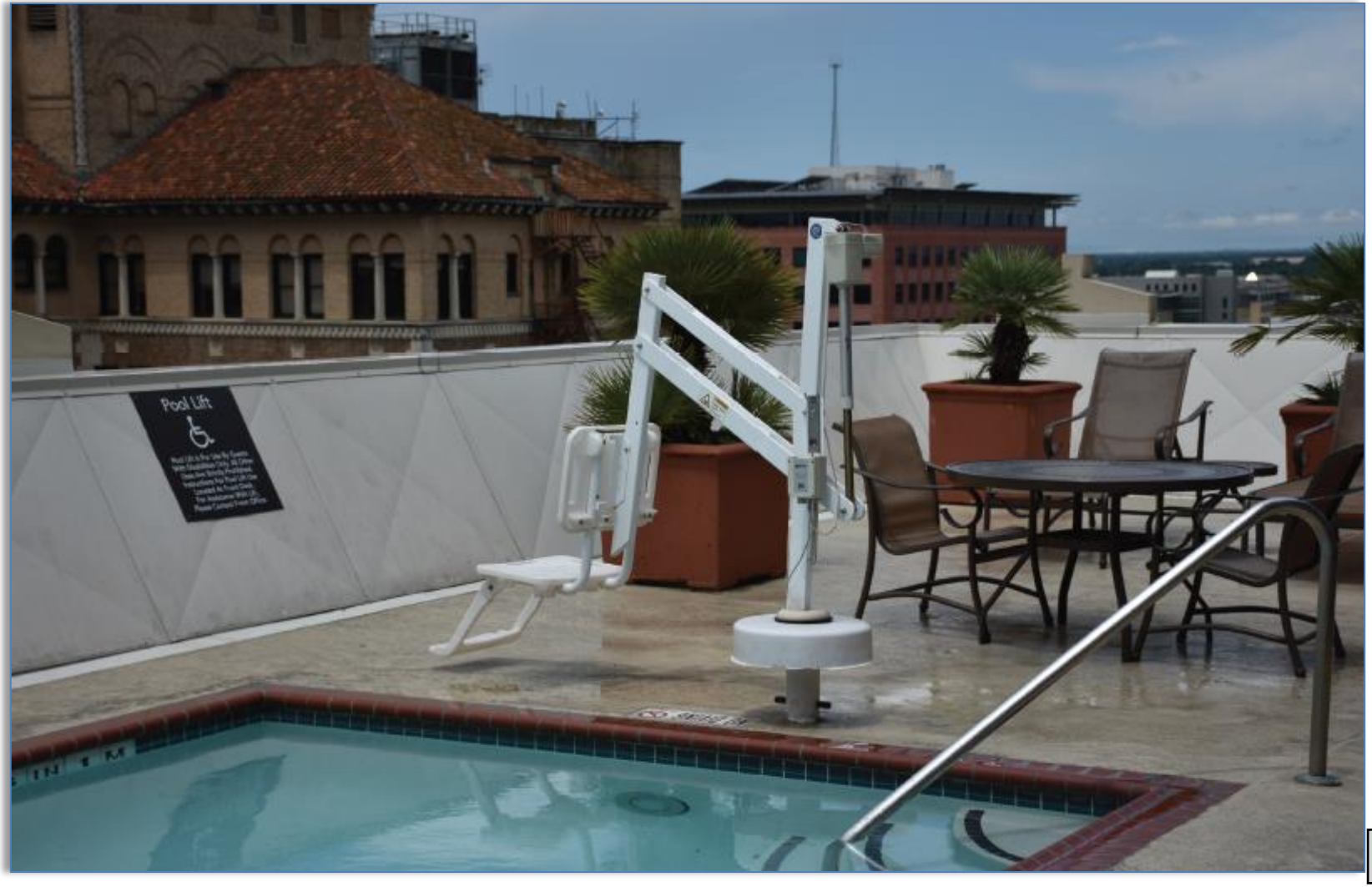
680.83

REVISION



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682.11

REVISION

Location of Electrical Distribution Equipment

Change Summary

- Section 682.11 has been revised to apply to electrical distribution equipment. It previously applied only to service equipment. It now provides two options for the location of the installation.
- Electrical distribution equipment can be located at least five feet horizontally from the shoreline where live parts of the equipment are located at least 12 inches above the datum plane.
- Electrical equipment can be located no closer than the shoreline where live parts of equipment are located at least 10 feet above the datum plane.

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682.11

REVISION

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682.12

REVISION

Electrical Connections

Change Summary

- Section 682.12, Electrical Connections, was divided into two subsections.
- Conductor splices located above the waterline but below the datum plane must be in junction boxes identified for wet locations, using sealed wire connector systems listed and identified for submersion.
- Replacement electrical connections that are located below the electrical datum plane and above the waterline must be listed and identified for submersion.

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682.12

REVISION

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Article 690

REVISION

Solar Photovoltaic (PV) Systems

Change Summary

- The three informational note figures in 690.1 have been combined into a single figure.
- Requirements for stand-alone systems were deleted from 690.10. Article 710 covers stand-alone systems.
- Parts VI and VIII were deleted. Part VII, Connection to Other Sources, became Part VI, Source Connections. Part VIII, Energy Storage Systems, was deleted because that is covered in Article 706.

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Article 690

REVISION

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690.4

REVISION

General Requirements

Change Summary

- There is a new definition of “electronic power converter” in Article 100, which includes inverters and dc-to-dc converters. Electronic power converters were added to the list of equipment in 690.4(B) to replace inverters and dc-to-dc converters. PV hazard control equipment and PV hazard control systems were also added.
- Acronyms were added for rapid shutdown (PVRSE), hazard control system (PVHCS), and hazard control equipment (PVHCE).
- New requirements were added for PV equipment floating on or attached to structures floating on bodies of water.

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690.4

REVISION

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690.7

REVISION

Maximum Voltage

Change Summary

- Section 690.7 was revised for clarity and to remove requirements for systems over 1,000 volts.
- Section 690.7(A) through (D) were revised to eliminate the terminology *source and output* and to add the defined term *PV string circuit* in 690.7(B).
- Section 690.7(B) was also updated by deleting “source and output” from the term *dc-to-dc converter circuits*.
- The marking requirements for dc PV circuits were relocated to 690.7(D) from 690.53.

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690.7

REVISION

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690.8

REVISION

Circuit Sizing and Current

Change Summary

- An informational note was added to 690.8(A)(1) noting that some modules can produce electricity when exposed to light on multiple surfaces.
- Section 690.8(B) requires a minimum conductor size without adjustment and correction factors based on an ampacity not less than the current calculated in 690.8(A) multiplied by 125%.
- Section 680.8(D) was updated to use the term *PV string circuits*, which describes how some PV circuits are arranged.

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690.8

REVISION

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690.9(D)

REVISION

Transformers

Change Summary

- The requirements for protection of transformers are now covered in 705.30(C).
- The requirements in 450.3 are based on the primary being one side at a time.
- Section 705.30(F) is based on interconnected power production sources. It is applicable to installations where there can be multiple sources.

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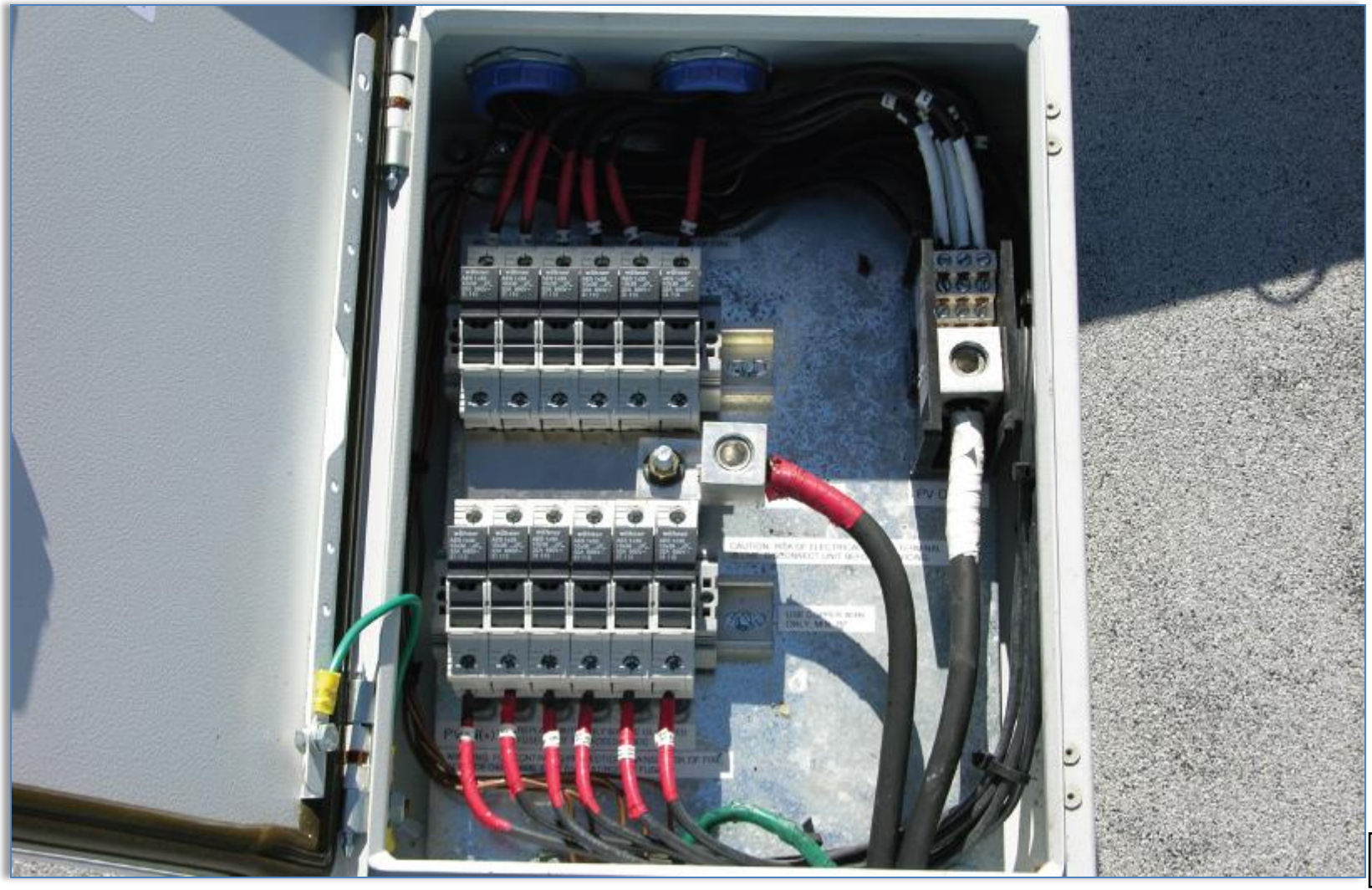
690.9(D)

REVISION



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690.12, Exception

REVISION

Rapid Shutdown of PV Systems on Buildings

Change Summary

- Section 690.12 establishes requirements for rapid shutdown of PV systems on buildings.
- A new exception was added to exempt non-enclosed detached structures, such as those that provide parking shade, carports, solar trellises, and similar structures.
- The exception aligns with requirements for firefighter rooftop access in the building and fire codes.

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690.12, Exception

REVISION

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690.15

REVISION

Disconnecting Means for Isolating PV Equipment

Change Summary

- 690.15(D), Type of Disconnecting Means, has been relocated to 690.15(A). Revised wording clarifies that disconnecting means complying with 690.15(C) are permitted in any circuit, regardless of current rating.
- 690.15(A)(2) was revised to permit an isolating device that is part of listed equipment where an interlock prevents opening the isolating switch under load.
- 690.15(D) was rewritten to remove the distances and to replace them with the terms *readily accessible* and *in sight from*.

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690.15

REVISION

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690.31

REVISION

Wiring Methods

Change Summary

- Section 690.31(A)(2) has been expanded to cover all PV dc circuits, and it has been clarified to indicate the conditions to which it applies.
- Section 690.31(B)(1) has been rewritten into list format and clarified regarding which conductors can be intermingled.
- Requirements have been added that provide more detail on cable tray installations.

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690.31

REVISION

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691.1 & 691.4

REVISION

Large-Scale Photovoltaic (PV) Electric Supply Stations

Change Summary

- Large-scale PV systems are those that have an inverter generating capacity of 5,000 kW or larger that are not under exclusive utility control.
- The 5,000 kW lower limit was moved from the scope to 691.4(7).
- Section 691.4(6) now requires large-scale PV systems to be monitored from a central command center.

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691.1 & 691.4

REVISION

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Article 692

REVISION

Fuel Cell Systems

Change Summary

- Section 692.4(B) now points to the requirement of a plaque or directory in 705.10.
- Part V, Grounding, was deleted because it did not modify the general rules of Article 250.
- Part VI, Marking, became Part V, Marking.
- Sections 692.60 through 692.65 were deleted in order to remove sections that did not modify the requirements of Chapters 1 through 4. In addition, requirements that are addressed during product listing were also deleted.

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Article 692

REVISION

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694.50 & 694.68

DELETION

Interactive System Point of Interconnection

Change Summary

- The marking requirement for interactive points of interconnection with other sources that was in Section 694.50 was deleted. The new requirement is located in 705.14, which is a more general requirement for labeling an interactive point of connection to other sources.
- The requirement for points of connection was deleted from 694.68. The intent is that all sources combined with other sources must comply with Article 705.
- Requirements for identification of power sources in 694.54 requires a plaque or directory installed in accordance with 705.10.

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694.50 & 694.68

DELETION

600

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695.1(B)

NEW

Not Covered

Change Summary

- The small water pumps that may be installed in one- and two-family dwellings for fire suppression are not the fire pumps covered by Article 695.
- These water pumps would have to comply with Article 430 rather than Article 695.
- Larger homes may have a sprinkler system in accordance with *NFPA 13* or *NFPA 13R*, which could require a fire pump in accordance with *NFPA 20* and Article 695.

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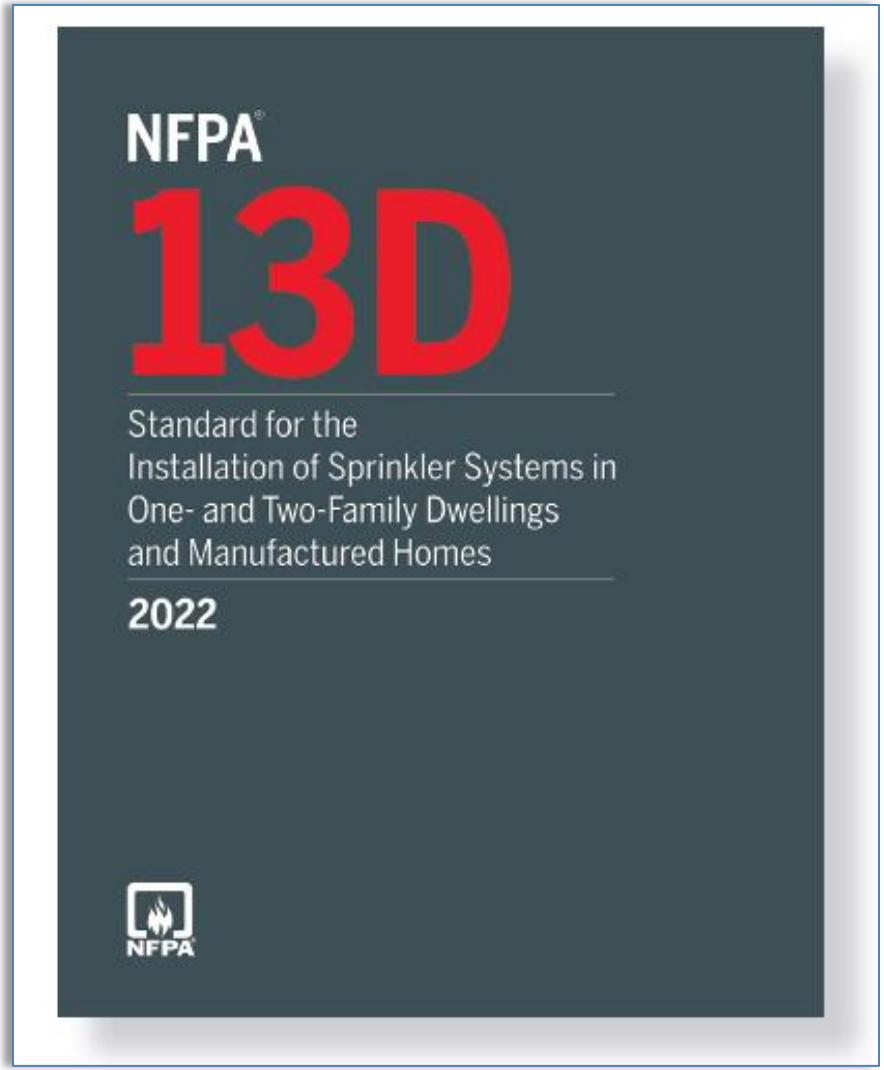
695.1(B)

NEW



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695.7

NEW

Voltage Drop

Change Summary

- The exception to 695.7(A) which permits the voltage to drop more than 15% below normal is now 695.7(B), Emergency Run.
- A new 697.5(C) has been added to recognize bypass mode.
- Both emergency run mode and bypass mode are permitted to exceed 15% voltage drop, provided the pump can still be started while supplied by a generator.

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695.7

NEW

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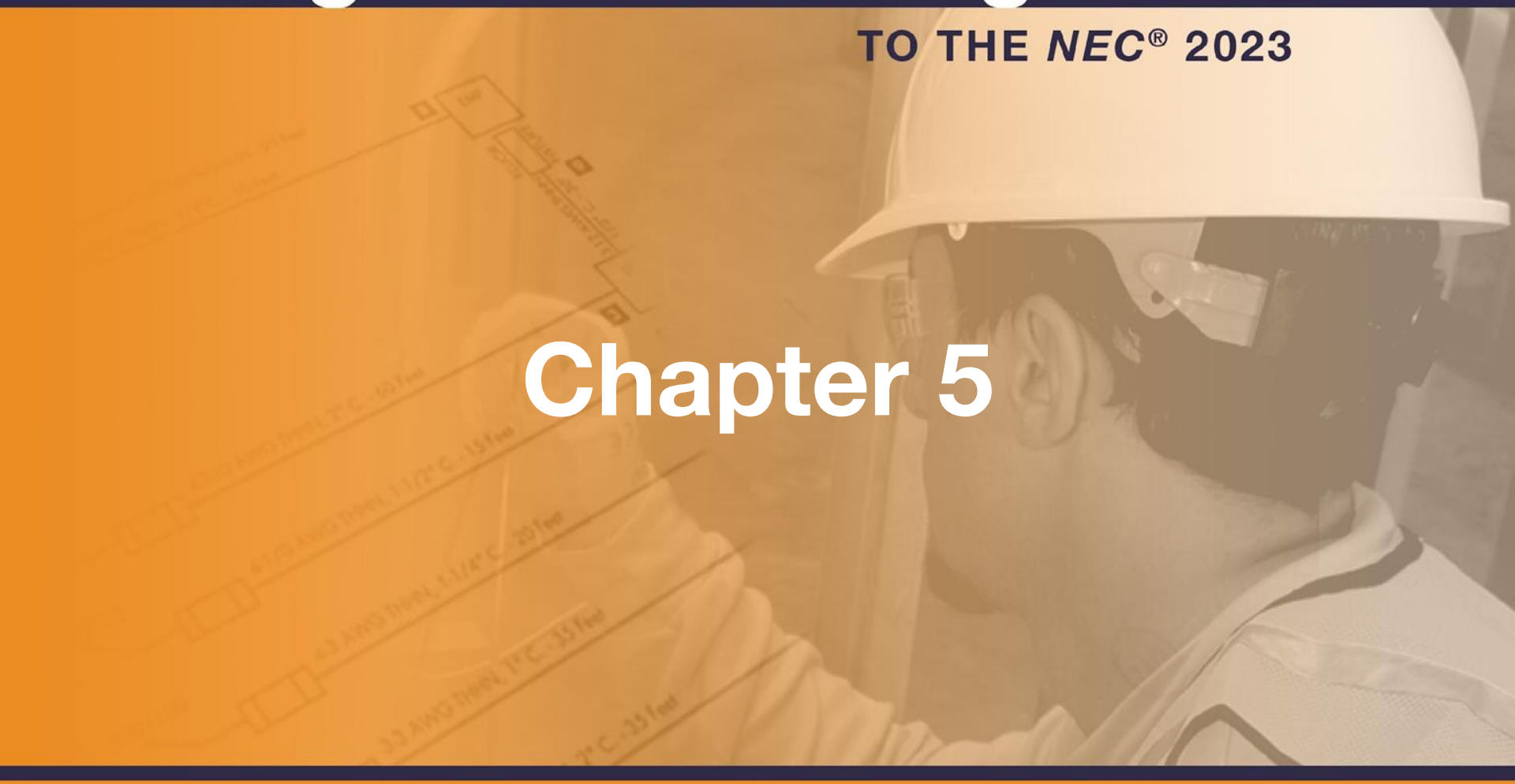
Significant Changes

TO THE *NEC*® 2023

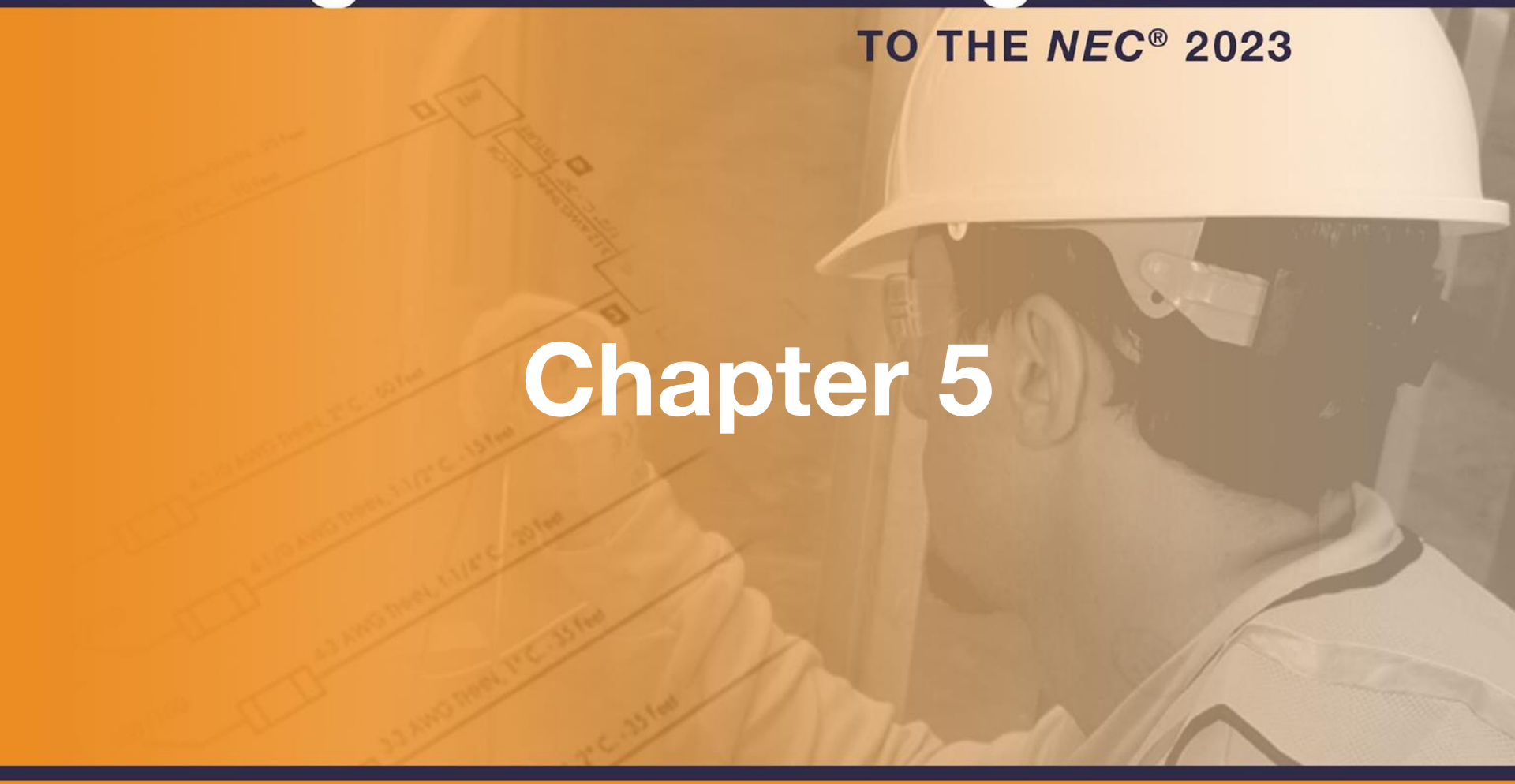


Chapter 5

electrical training ALLIANCE IBEW - NECA IN COLLABORATION WITH NECA NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION

Significant Changes

TO THE *NEC*® 2023



Chapter 5

electrical training ALLIANCE IBEW - NECA IN COLLABORATION WITH NECA NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION

500.1

REVISION

Scope

Change Summary

- The scope of Article 500 was revised. As previously written, it provided a scope for Articles 500 through 504.
- The new scope only covers what is in Article 500.
- Article 500 now only covers the traditional Class I, II, and III locations.
- The zone classification systems are covered in Article 505 for Zones 0, 1, and 2, and Article 506 for Zones 20, 21, and 22.

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500.1

REVISION

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500.4

REVISION

Documentation

Change Summary

- The documentation required by 500.4 now includes areas that have been determined to be unclassified.
- The documentation of the hazardous location must also be available to the authority having jurisdiction.
- The edition dates have been deleted for many of the referenced standards.
- It is important to remember that referenced standards are for information only.

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500.4

REVISION

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500.5(D)

REVISION

Class III Locations

Change Summary

- The definitions of Class III locations have been rewritten.
- The new definitions now align with the definitions of Class II locations.
- A Class III, Division 1 location is one in which combustible fibers/flyings can be present in the air under normal conditions in quantities to produce explosive or ignitible mixtures. Previously, combustible fibers/flyings were considered fast burning fire hazards, rather than explosion hazards.
- A Class III, Division 2 location is one in which nonmetal combustible fibers/flyings can be released through the abnormal operation of equipment and will not interfere with equipment operation.

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500.5(D)

REVISION

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500.6(C) & (D)

NEW

Class III Combustible and Ignitible Fibers/Flyings

Change Summary

- New 500.6(C) and (D) were added to correlate with *NFPA 499: Recommended Practice for the Classification of Combustible Dusts and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas.*
- Combustible fibers/flyings are materials with any dimension that is greater than 500 µm in nominal size that can form an explosible mixture when suspended in air at standard atmospheric pressure and temperature.
- Ignitible fibers/flyings are larger than 500 µm in nominal size, which are not likely to be in suspension in quantities to produce an explosible mixture but could produce an ignitable layer fire hazard.

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500.6(C) & (D)

NEW

2021

NFPA 499

Recommended Practice for the Classification of Combustible Dusts and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas

Origins

Committee Personnel

> Chapter 1 – Administration

> Chapter 2 – Referenced Publications

> Chapter 3 – Definitions

> Chapter 4 – Combustible Dusts

> Chapter 5 – National Electrical Code (NEC) Criteria

> Chapter 6 – Classification of Combustible Dust Locations

> Annex A – Explanatory Material

Annex B – Informational References

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500.7

REVISION

Protection Techniques

Change Summary

- A reference was added for the new Chapter 9, Table 13 on protection techniques.
- Section 500.7(E) was revised to delete references to entire articles.
- New protection techniques were added to this section, including electrical resistance trace heating, impedance heating, enclosed break, non-sparking, sealed, and other techniques that are identified for use in hazardous (classified) locations.

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500.7

REVISION

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500.8(E)(3)

REVISION

Unused Openings

Change Summary

- Unused openings must be closed with blanking elements or close-up plugs that are listed for the location.
- If the equipment has threaded entries of NPT-threaded conduit or fittings, the NPT-threaded entries must be made up with at least five threads fully engaged.
- For listed explosionproof equipment, joints with factory-threaded entries must be made up with at least 4 ½ entries fully engaged.
- For metric threaded entries, either the entry must be listed as being metric or listed adapters must be used.

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500.8(E)(3)

REVISION

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501.10

REVISION

Wiring Methods, Class I

Change Summary

- The previous Exception to 501.10(A)(1)(1) was converted into positive text and now appears as (A)(1)(2).
- The wiring methods in (A)(4), (5), (7), and (8) are for restricted industrial establishments.
- Requirements for cable tray applications have been added to 501.10(B)(3), (6), and (7), which now reference 392.22.
- The reference to 337.10 has been corrected to Article 337, Part II.

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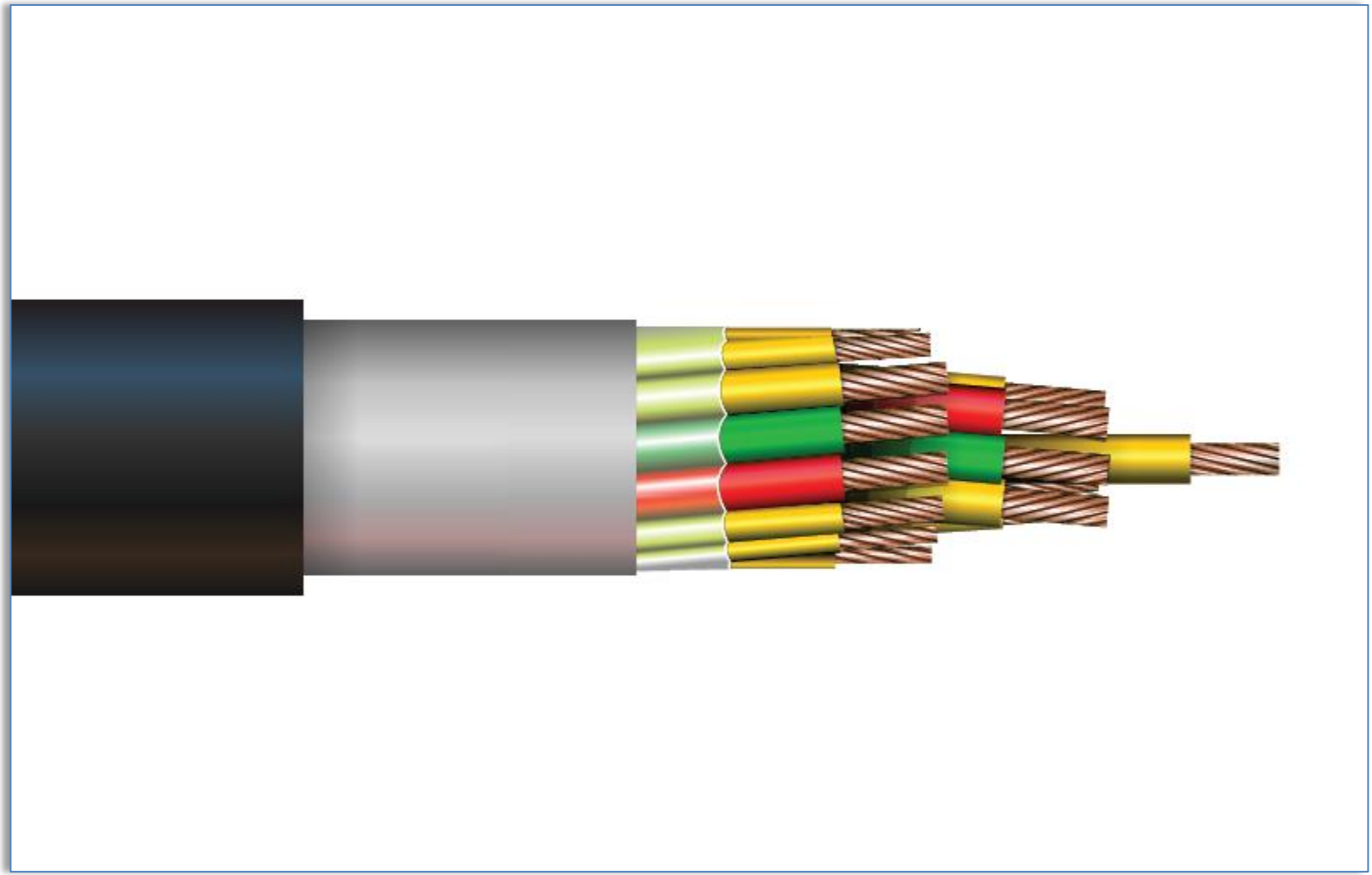
501.10

REVISION



620

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501.15

REVISION

Sealing and Drainage

Change Summary

- The boundary seal requirement for seals in Division 2 locations has been relocated to 501.15(A)(4). This requires Division 1 wiring methods up to the seal fitting in the Division 2 location.
- A revision to 501.15(B)(2) permits Type RTRC to be used from the boundary conduit seal to the point where it exits the Division 2 location.
- Types TC-ER-HL and Type P cable were inadvertently omitted from the cable seal requirements in 501.15(D)(1) in the 2020 *Code*.

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501.15

REVISION

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Courtesy of Michael J. Johnston

501.141

NEW

Flexible Cables, Class I, Division 2

Change Summary

- A new Section 501.141 was added to provide requirements for flexible cables in Class I, Division 2 locations.
- This new section is primarily focused on permitting the use of Type P cable.
- The means of terminating the cables requires the use of cable connectors that are listed for Class I, Division 2 locations.
- A new definition of “cable connector [as applied to hazardous (classified) locations]” has been added to Article 100.

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501.141

NEW

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501.145

REVISION

Receptacles and Attachment Plugs, Class I Locations

Change Summary

- Section 501.145 now requires receptacles and attachment plugs to be listed for the location, except as permitted by 501.105(B)(6) for meters, instruments, and relays.
- Listing for Class I, Division 2 is not required if the circuit only involves nonincendive wiring.
- Listing is not required in restricted industrial establishments complying with 501.105(B)(6), Exception No. 2, which also requires compliance with 501.6(B)(6)(2) through (4).

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501.145

REVISION

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Courtesy of Michael J. Johnston

502.10

REVISION

Wiring Methods Class II Locations

Change Summary

- PVC-coated metal conduit is permitted in Class II, Division 2 locations, even where there is not an increased level of corrosion.
- EMT with compression-type fittings or connectors is now permitted in Class II, Division 2 Locations.
- Type RTRC-XW conduit is permitted in industrial establishments with restricted public access where conditions of maintenance and supervision ensure that only qualified persons service the installation.

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502.10

REVISION

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502.15

REVISION

Sealing, Class II, Divisions 1 and 2

Change Summary

- The informational note was changed to become 502.15(5). It indicates that electrical sealing putty is a recognized means to prevent the entrance of dust into a dust-ignition-proof enclosure.
- Informational notes cannot be used to provide permissions or recommendations.
- Seal fittings are required to be accessible, but they are not required to be explosionproof.

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502.15

REVISION

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502.30

REVISION

Grounding and Bonding

Change Summary

- References to Article 250 were changed to refer to Article 250, Part VI for grounding and Part V for bonding.
- Cable trays were added to 502.30(B)(1), which addresses specific bonding means, to make it clear that cable trays must be bonded in the same manner as raceways.
- Requirements were added for bonding of metal struts, angles, or channels if used with Types TC-ER, PLTC-ER, or ITC-ER.
- Section 502.30(B)(2)(3) was changed from “not a power utilization load” to “part of a meter, instrument, or relay circuit.”

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502.30

REVISION

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503.10

REVISION

Wiring Methods

Change Summary

- Type P cable is now permitted in Class III, Division 1 locations in restricted industrial establishments.
- Criteria is established for the installation of Type P cable in cable trays.
- Wiring in Class III, Division 2 locations must comply with the Division 1 requirements.
- In sections, compartments, or areas that do not contain machinery and are used solely for storage, open wiring on insulators is permitted.

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503.10

REVISION

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503.30

REVISION

Grounding and Bonding

Change Summary

- References to Article 250 were changed to refer to the general requirements in Part I of Article 250, as well as to Part VI for grounding and Part V for bonding.
- Cable trays were added to 503.30(B)(1), on specific bonding means, to make it clear that cable trays must be bonded in the same manner as raceways.
- Requirements were added for bonding of metal struts, angles, or channels if used with Types TC-ER, PLTC-ER, or ITC-ER.

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503.30

REVISION

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504.30

REVISION

Separation of Intrinsically Safe Conductors

Change Summary

- Section 504.30(A)(1), installations in raceways, cable trays, and cables, had a simple rule, four exceptions, and three informational notes. It has been converted into more usable positive text.
- Section 504.30(A)(2), installations within enclosures, had three informational notes that were incorporated into enforceable *Code* text.
- Section 504.30(A)(3), other installations, contained an exception that was converted into positive text and incorporated into the existing text.

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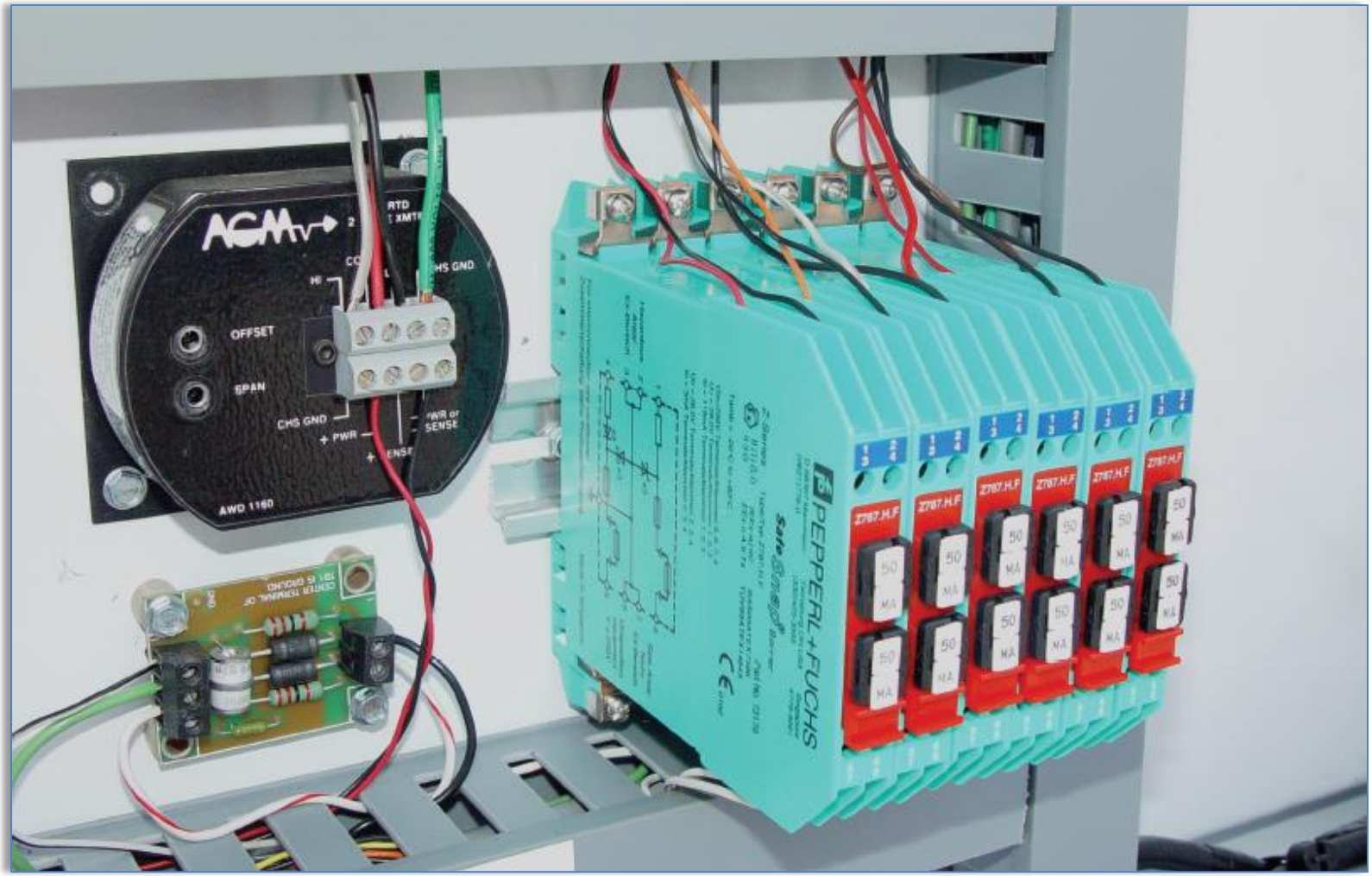
504.30

REVISION



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Article 505

DELETION REVISION

Zone 0, 1, and 2 Locations

Change Summary

- 505.1 was revised to make it clear that this article does not cover the class/division classification system and that it does not cover explosives, pyrotechnics, or blasting agents.
- Section 505.3 was deleted because 90.3 makes it unnecessary.
- Section 505.4 on documentation was revised for consistency with the requirements for documentation in other articles in Chapter 5.
- Section 505.5(A) was revised for consistency with 500.5(A).

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Article 505

DELETION **REVISION**

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505.8

NEW

Protection Techniques

Change Summary

- Section 505.8 has been revised to recognize new protection techniques.
- Impedance heating is a protection technique that is now recognized. Its design is based on IEEE 844.3.
- A pressurized room “p” is a protection technique that is recognized for Zone 1 or 2 locations.
- Special protection “s” is a protection technique that is recognized for Zones 0, 1, and 2.

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505.8

NEW

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505.16

REVISION

Sealing and Drainage

Change Summary

- Section 505.16(B)(3) has been expanded to include pressurized rooms. An informational note was added to reference the IEC Standard for pressurized rooms.
- Section 505.16(C)(1) was rewritten into list format, and the exceptions were rewritten into positive language.
- New requirements were added to provide sealing requirements for cables that enter breathing-type enclosures “nR.”

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505.16

REVISION

2021

NFPA 496

Standard for Purged and Pressurized Enclosures for Electrical Equipment

Committee Personnel

> Chapter 1 – Administration

> Chapter 2 – Referenced Publications

> Chapter 3 – Definitions

> Chapter 4 – General Requirements for Pressurized Enclosures

> Chapter 5 – Pressurized Enclosures for Class I, or Zone 1, or Zone 2

> Chapter 6 – Pressurized Enclosures for Class II

> Chapter 7 – Pressurized Control Rooms

> Chapter 8 – Pressurized Enclosures Having an Internal Source of Flammable Gas or Vapor

> Chapter 9 – Pressurized Analyzer Rooms Containing a Source of Flammable Gas, Vapor, or Liquid

Annex A – Explanatory Material

Annex B – Informational References

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505.20(C), Exc. Nos. 5 & 6

NEW

Equipment Requirements, Zone 2

Change Summary

- Two new exceptions were added to 505.20(C) to make the requirements for Zone 2 locations consistent with the requirements for Class I, Division 2 locations.
- Exception No. 5 permits the use of certain space heaters in Zone 2 locations where the space heaters are used to reduce condensation during shutdown periods.
- Exception No. 6 permits the use of sliding contact shaft bonding devices that are used on certain motors where the potential discharge is determined to be nonincendive.

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505.20(C), Exc. Nos. 5 & 6

NEW

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Article 506

REVISION

Zone 20, 21, and 22 Locations

Change Summary

- 506.1 was revised to clarify that this article does not cover the class/division classification system and that it does not cover explosives, pyrotechnics, or blasting agents.
- 506.3 was deleted because 90.3 makes it unnecessary.
- 506.4, on documentation, was revised for consistency with similar requirements in other articles in Chapter 5.
- Table 506.9(C)(2)(3) has been deleted. The information is now located in Chapter 9, Table 13.

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Article 506

REVISION

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506.6

REVISION

Material Groups

Change Summary

- The definition of the material groups has been updated for consistency with *NFPA 499: Recommended Practice for the Classification of Combustible Dusts and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas*.
- Group IIIC consists of combustible metal dusts and combustible metal fibers/flyings.
- Group IIIB includes combustible dusts other than combustible metal dust.
- Group IIIA, includes combustible fibers/flyings or ignitible fibers/flyings.

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506.6

REVISION

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511.2

NEW

Other Articles

Change Summary

- A new Section 511.2 was created with a table that points to requirements in Articles 500, 501, and 505.
- The table is intended to simplify the use of either the traditional class/division classification system or the zone classification system.
- Articles 511 through 516 provide occupancy-specific requirements that are predicated on the use of Articles 500 and 501, or Article 505.
- Similar tables have been added to 512.2, 513.2, 514.2, 515.2, and 516.2.

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511.2

NEW

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511.7(A)

REVISION

Fixed Wiring Above Hazardous (Classified) Locations

Change Summary

- Section 511.7(A)(1) was converted into list format to make it easier to navigate.
- “Rigid Nonmetallic Conduit” was changed to “PVC Conduit.”
- Reinforced thermosetting resin conduit, RTRC, was added as a permitted fixed wiring method.
- The same changes were made in 514.7 for Wiring Above Hazardous (Classified) locations in Motor Fuel Dispensing Facilities.

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511.7(A)

REVISION

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511.8

REVISION

Underground Wiring Below Hazardous Locations

Change Summary

- The title of this section was changed to “Underground Wiring Below Hazardous (Classified) Locations.”
- The language permitting intermediated metal conduit has been revised to clarify that it must be threaded.
- The exception has been rewritten into positive language.

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511.8

REVISION

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Article 512

NEW

Cannabis Oil Equipment and Cannabis Oil Systems

Change Summary

- A new Article 512 has been created on cannabis oil equipment and cannabis oil systems using flammable materials.
- Flammable materials are used to extract cannabis oil, including butane, ethanol, hexane, pentane, propane, and LPG.
- Article 512 provides detailed classification diagrams to help to evaluate hazardous areas.

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Article 512

NEW

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516.7(A)

REVISION

Wiring & Equipment Not Within Hazardous Locations

Change Summary

- Section 516.7(A) was converted into a list format to make it easier to navigate.
- “Rigid Nonmetallic Conduit” was changed to “PVC Conduit.”
- Reinforced thermosetting resin conduit, RTRC, was added as a permitted fixed wiring method.
- Similar changes were made in 511.7(A) and 514.7(A).

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516.7(A)

REVISION

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517.6

NEW

Patient Care-Related Electrical Equipment

Change Summary

- A new requirement has been added that indicates that patient care-related equipment is not subject to the reconditioning requirements in the *Code*.
- Patient care-related equipment is subject to a recertification process after it is reconditioned.
- Patient care-related equipment is also subject to recommissioning or recertification when it is relocated.

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517.6

NEW

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Courtesy of Michael J. Johnston

517.10(B)

REVISION

Not Covered

Change Summary

- Informational Note No. 1 was added to point to certain receptacles in health care business offices that are required to be tamper-resistant.
- Informational Note No. 2 was added to point to requirements for AFCI protection for branch-circuit outlets in patient sleeping rooms that are required to be AFCI protected.
- A new list item (3) was added to exempt pharmacy services not contiguous to health care facilities from the requirements of Article 517.

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517.10(B)

REVISION

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517.13

REVISION

Equipment Grounding Conductor

Change Summary

- 517.13(B)(1), Exception No. 2 was relocated to 517.13 following the main rule.
- The requirement for grounding and bonding of metal faceplates was relocated from 517.13(B)(1)(3) to 517.13(B)(1), Exception No. 2. Faceplates are normally grounded through the attachment screws that connect them to the yoke of the switch or receptacle.
- All branch-circuit wiring for a patient care space must comply with 517.13, including wiring that originates outside of the patient care space.

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517.13

REVISION

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517.14

REVISION

Panelboard Bonding

Change Summary

- An exception was added to 517.14 on panelboard bonding to permit an insulated copper conductor not smaller than 10 AWG to be terminated on listed connections to an aluminum or copper busbar.
- The busbar must be at least ¼ inch thick by two inches wide and of sufficient length to accommodate the number of terminations necessary for the bonding of the panelboards.
- The busbar must be securely fastened and installed in an accessible location.

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517.14

REVISION

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517.20(A)

REVISION

Wet Procedure Locations

Change Summary

- Wet procedure locations are required to be provided with protection against electric shock.
- 517.20(A)(1) was clarified to indicate that it applies to isolated power systems that remain in operation in the event of a single line-to-ground fault.
- The informational note was revised to clarify that isolated power systems can eliminate the danger of electric shock.

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517.20(A)

REVISION

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517.22

NEW

Demand Factors

Change Summary

- New demand factors have been added for general-use receptacles and individual branch circuits not exceeding 150 volts to ground.
- This information is based on hospital load studies and a study by the Fire Protection Research Foundation.
- For cord-connected equipment, the table provides two sets of demand factors. One set applies to Category 1 and 2 spaces. The second applies to Category 3 and 4 spaces.
- For receptacle loads, the first 5 kVA is calculated at 100%, the next 5– 10 kVA is calculated at 50%, and the remainder is calculated at 25%.

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517.22

NEW

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517.30

REVISION

Sources of Power

Change Summary

- 517.30 requires that essential electrical systems (EES) have two or more independent sources or sets of sources.
- At least one source or set of sources must be entirely onsite and it must be capable of serving the entire EES load.
- 517.30(B) now provides a list of power sources for the EES, which includes utility supply power, generating units, fuel cell systems, energy storage systems, and health care microgrids.

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517.30

REVISION

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517.41

REVISION

Required Power Sources

Change Summary

- Section 517.41 requires that the essential electrical system (EES) have two or more independent sources or sets of sources, one of which must be onsite and capable of supplying the entire EES load.
- At least one source or one set of sources must be entirely onsite.
- EES components are required so that they are not exposed to interruptions from storms, floods, earthquakes, or hazards from adjoining structures or nearby activities.

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517.41

REVISION

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Article 517, Part V.

REVISION

Diagnostic Imaging and Treatment Equipment

Change Summary

- The title of Part V has been changed to “Diagnostic Imaging and Treatment Equipment.”
- A new Informational Note No. 3 has been added that provides examples of 12 types of diagnostic imaging equipment covered by Part V.
- A new Informational Note No. 4 was added that provides examples of five types of treatment equipment covered by Part V.

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Article 517, Part V.

REVISION

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517.80

REVISION

Patient Care Spaces

Change Summary

- Section 517.80 was revised to recognize that Class 2 circuits that transmit power and data to a powered device do not need to comply with the grounding requirements in 517.13.
- Power over Ethernet (PoE) is an example of a Class 2 circuit that can transmit power for applications, such as wireless access points and lighting, while also transmitting data.
- A new informational note was added to reference a NEMA standard on PoE lighting.

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517.80

REVISION

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518.2(A)

REVISION

Examples

Change Summary

- Casinos and gaming facilities have been added to the list of examples of assembly occupancies that are covered by Article 518.
- Casinos can have transient crowds of people hovering over machines and table games that can grow larger than in traditional places of assembly.
- Many casinos also have entertainment to retain customers at the machines.

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518.2(A)

REVISION

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518.4

REVISION

Wiring Methods-General

Change Summary

- Section 518.4 was reformatted into list format.
- Section 518.4(B)(4) was added to recognize power over Ethernet (PoE) supplying lighting.
- A new informational note was added to 518.4(B)(4) that references a NEMA standard for the installation of PoE lighting.
- The wiring methods for buildings or portions of buildings of non-fire rated construction were expanded to include the permitted Chapter 3 wiring methods.

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518.4

REVISION

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520.53(C)

REVISION

Construction

Change Summary

- A new sentence was added to the main rule to clarify that the requirements of 408.18(C) do not apply to portable stage switchboards.
- In the 2020 *Code*, single-pole separable connectors were relocated into 406.13.
- This section has been revised to point to 406.13. Since the general requirements would continue to apply to this section, there is no reason to repeat the requirements here.
- Section 520.53(C) now only covers those requirements that are unique to occupancies that are covered by Article 520.

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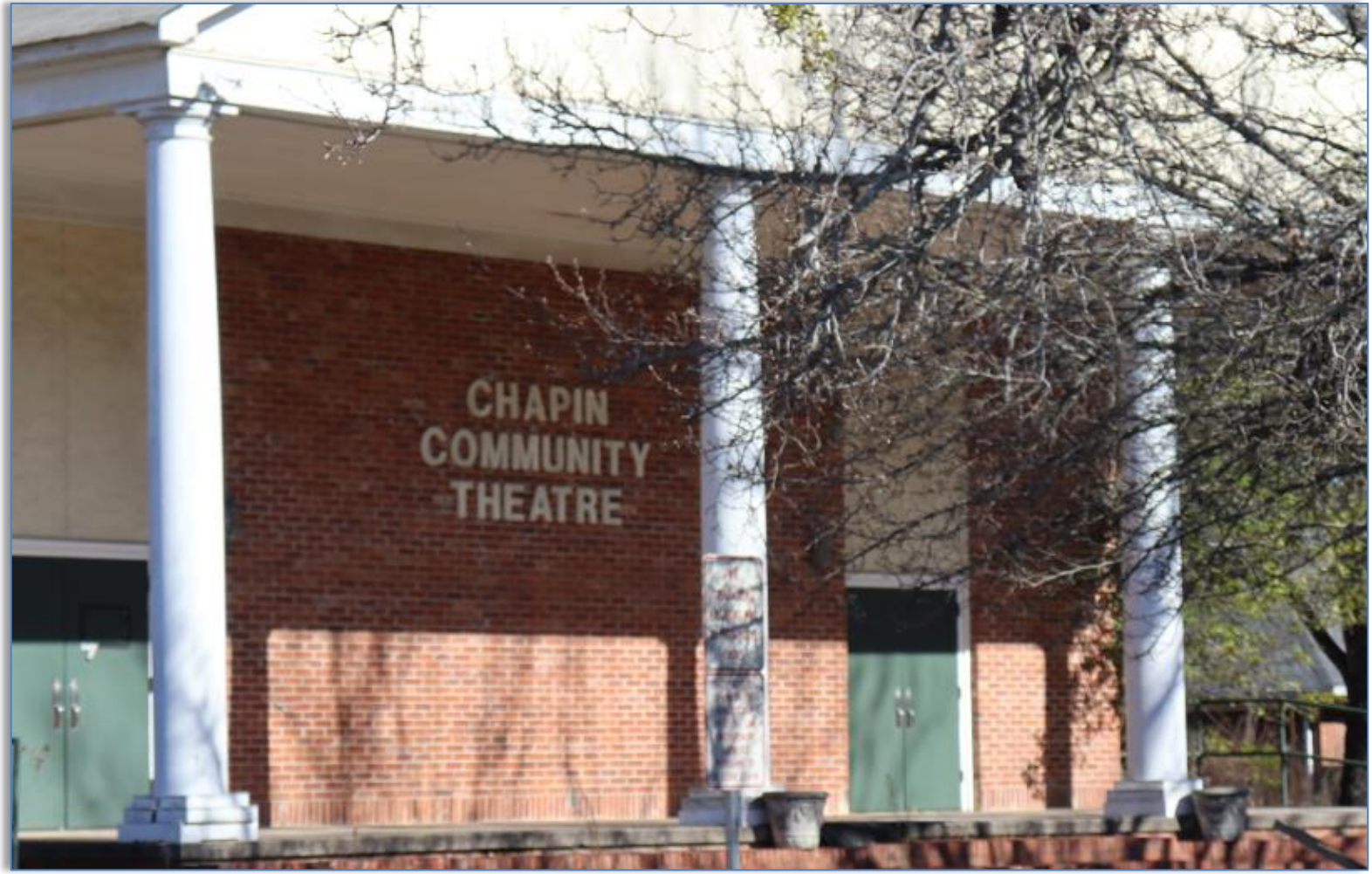
520.53(C)

REVISION



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520.68(D)

NEW

Special-Purpose Multi-Circuit Cable Systems

Change Summary

- A new 520.68(D) was created to provide requirements for multi-circuit cable systems.
- These circuits are limited to not more than 20 amperes and not more than 150 volts to ground.
- Trunk cables, breakout assemblies, and multi-circuit enclosures are required to be listed.
- Installation and operation of special-purpose multi-circuit cable systems requires qualified persons.

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520.68(D)

NEW

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Article 530

REVISION

Motion Picture and TV Studios and Remote Locations

Change Summary

- Article 530 has been rewritten and updated.
- Several technologies have disappeared or are being phased out, including carbon arc luminaires, tungsten luminaires, fused extension cables, video tape, and film.
- Several newer technologies are being used, including the use of generators, AC enclosed arc luminaires, and digital cameras.

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Article 530

REVISION

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545.22

REVISION

Power Supply

Change Summary

- This section was revised to clarify that relocatable structures must be supplied by a feeder.
- This correlates with Article 550, which does not allow service equipment on a structure without a permanent foundation.
- Two or more relocatable structures joined into a single unit are permitted to use a chassis bonding conductor as the tap conductor.

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545.22

REVISION

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547.26

REVISION

Physical Protection

Change Summary

- Section 547.26 has been revised to prohibit nonmetallic sheathed cable from being concealed within walls and above ceilings of buildings or portions thereof which are contiguous with or physically adjoined with livestock areas.
- Rodents and other pests frequently chew through cables.
- The requirement also provides examples of areas where this commonly happens, including within walls and ceilings of offices, lunchrooms, and ancillary areas adjoining animal confinement areas.

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547.26

REVISION

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547.44(B)

REVISION

Bonding of Equipotential Planes

Change Summary

- The bonding requirements in agricultural buildings have been clarified.
- Equipotential planes must be bonded to the grounding electrode system or an equipment grounding terminal in any panelboard associated with the equipotential plane.
- The bonding conductor must be an insulated, covered, or bare solid copper conductor that is not smaller than 8 AWG.

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547.44(B)

REVISION

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550.10(I)

REVISION

Mast Weatherhead or Raceway

Change Summary

- The reference to Article 230 has been clarified to indicate that Part II applies.
- This section previously permitted metal raceways. It has been clarified to indicate that the permitted metal raceways are rigid metal conduit or intermediate metal conduit.
- Previously, this section permitted rigid nonmetallic conduit. It now recognizes rigid polyvinyl conduit or other raceways suitable for the location.

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550.10(I)

REVISION

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550.16(C)(1)

REVISION

Exposed Non-Current-Carrying Metal Parts

Change Summary

- Mobile homes often consist of multiple units that are joined together.
- Multiple sections of a mobile home are now required to be bonded with a solid copper conductor that is at least 8 AWG. It can be insulated or bare.
- Bonding conductor terminations must be in accordance with 250.8 and 250.12.

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550.16(C)(1)

REVISION

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550.32(A)

REVISION

Mobile Home Service Equipment

Change Summary

- Section 550.32(A) was revised to make it clear that mobile home service equipment is not permitted to be mounted in or on the mobile home.
- The service equipment must be mounted in a readily accessible outdoor location, and it must be visible from the mobile home it serves.
- The mobile home service disconnect is permitted to serve as the emergency disconnect specified in 230.85.

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550.32(A)

REVISION

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550.33(A)

NEW

Feeder Equipment

Change Summary

- A new 550.33(A) has been added. The previous 550.33(A) has become 550.33(B).
- Service equipment is not permitted to be mounted in or on a mobile home.
- The feeder assembly is not permitted to be mounted in or on the mobile home.
- Manufactured home feeder disconnecting means are permitted to be installed in or on the manufactured home in accordance with 550.33(B).

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550.33(A)

NEW

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551.3

NEW

Electrical Datum Plane Distances

Change Summary

- Electrical datum plane requirements were added to Article 551 because RV parks often border bodies of water.
- In areas subject to tidal fluctuations, the datum plane is two feet above the highest high-tide level under normal conditions.
- In areas not subject to tidal fluctuation, the plane is two feet above the normal high-tide level.

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551.3

NEW

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551.40(D)

NEW DELETION

Loss of Ground Device

Change Summary

- The previous 551.40(D), titled “Reverse Polarity Device,” was deleted.
- The reverse polarity device may only indicate that the pedestal is mis-wired but may not interrupt power.
- A new 551.40(D) was added to require a listed grounding monitor interrupter to be installed between the feeder assembly connection to the vehicle and before either a transfer switch (if installed) or the panelboard.

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551.40(D)

NEW DELETION

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551.72

REVISION

Distribution System

Change Summary

- Section 551.72(A) was revised to recognize 208Y/120 three-phase distribution systems in RV parks.
- The prohibition against reducing the size of the neutral conductor was moved from 551.72(C) to (D).
- An informational note was added indicating that RV loads are line-to-neutral and non-permanently connected loads.
- The prohibition of the use of cord- and plug-connected autotransformers used on RV park distribution systems has been deleted.

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551.72

REVISION

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552.4

REVISION

General Requirements

Change Summary

- Park trailers are designed for seasonal use. They are not permitted as permanent dwelling units.
- Section 552.4 makes it clear that trailers used as banks, clinics, offices, or similar applications are considered relocatable structures and are covered in Part II of Article 545.
- This change correlates with the action of CMP 7 to create a new Part II in Article 545 on relocatable structures.

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552.4

REVISION

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555.4

REVISION

Location of Service Equipment

Change Summary

- Service equipment for a floating building, dock, or marina must be no closer than five feet horizontally from and adjacent to the structure.
- Service equipment must also be located a minimum of 12 inches above the datum plane.
- An electrical datum plane is a specified vertical distance above the normal high-water level at which electrical equipment can be installed and connections can be made.

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555.4

REVISION

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555.14

NEW

Equipotential Planes and Bonding of the Planes

Change Summary

- Articles 555 and 682 have overlaps in coverage. This change is intended to improve correlation between the articles.
- A new 555.14 has been added to correlate requirements for equipotential planes and bonding of equipotential planes with Article 682.
- This section is intended to reduce step and touch potentials. It is also intended to reduce the hazards that have resulted in electric shock drownings.

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555.14

NEW

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555.15

NEW

Replacement of Equipment

Change Summary

- A new requirement has been added titled “replacement of equipment,” which addresses modification of equipment as well as repairs.
- This new requirement recognizes the harsh environment that exists at marinas. The intent is to ensure that the installation remains in compliance.
- *NFPA 303* requires annual inspections of marinas. Periodic inspections are outside the scope of the *NEC*.

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555.15

NEW

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555.30

REVISION

Electrical Equipment and Connections

Change Summary

- The term *pier* has been replaced with the term *structure* to apply to all fixed and floating structures.
- The separate section on fixed piers has been deleted as the requirements apply to both fixed and floating piers.
- Electrical components within electrical equipment and connections that are not intended for use while submerged are required to be located at least 12 inches above the deck of the structure.

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555.30

REVISION

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555.35

REVISION

GFPE and GFCI

Change Summary

- The requirements for GFPE of feeder-supplied installations have been rewritten. Coordination with downstream GFPE is permitted.
- Requirements for GFCI protection of boat hoist receptacles have been relocated from 555.9 to 555.35(C).
- The requirements for GFCI protection have been expanded to include all docking facilities, not just those at dwelling unit docks.
- A new requirement was added in 555.35(B)(2) for GFCI protection of outlets for other than shore power not exceeding 150 volts and 60 amperes and 100 amperes or less, three-phase.

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555.35

REVISION

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555.36(C)

NEW

Disconnecting Means for Shore Power Connection(s)

Change Summary

- A new requirement has been added for an emergency disconnect for each power outlet or enclosure that provides shore power to boats.
- The emergency disconnect must be a listed emergency shutoff device or disconnect that is clearly marked “emergency shutoff.”
- The emergency shutoff must be located within sight of the marina power outlet or other device that provides shore power.

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555.36(C)

NEW

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555.37

REVISION

Equipment Grounding Conductor

Change Summary

- Section 555.37(B) and (C) were consolidated to require that the EGCs be insulated wire-type EGCs, sized in accordance with 250.122, but not smaller than 12 AWG.
- Section 555.37(E) has been added to provide requirements for EGCs for equipment that is not double-insulated.
- An exception was added to (E) that permits the EGC to be uninsulated if it is part of a listed cable assembly that is identified for the environment.

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555.37

REVISION

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555.38

NEW

Luminaires

Change Summary

- New requirements have been added for luminaires in marinas, boatyards, and docking facilities.
- Luminaires and retrofit kits are required to be listed and identified for use in the environment.
- Luminaires and their supply connectors must be secured to the structural elements of the marina in a manner that limits damage from watercraft impacts and from marine life.

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555.38

NEW

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590.8

REVISION

Overcurrent Protective Devices

Change Summary

- A new requirement has been added for wye-connected temporary service installations of more than 150 volts to ground, but not more than 1,000 volts phase-to-phase.
- If the available fault current exceeds 10,000 amperes, the overcurrent protection is required to be current-limiting.
- Where available fault current is less than 10 kA, conventional OCPDs will operate quickly enough to clear a fault before damage occurs.

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590.8

REVISION

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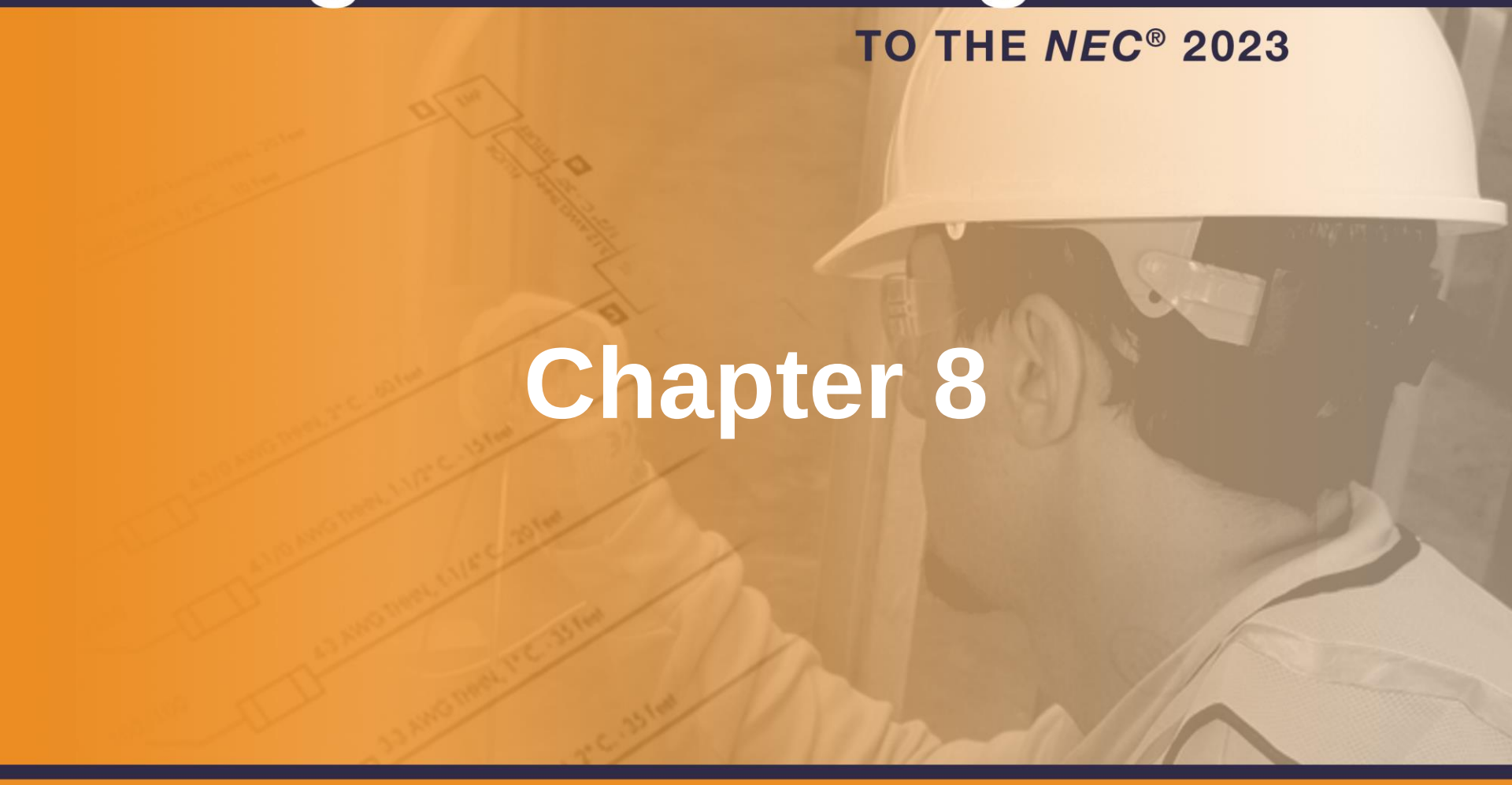
Significant Changes

TO THE *NEC*® 2023



Chapter 8

electrical training ALLIANCE IBEW - NECA IN COLLABORATION WITH NECA NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION

Article 800

REVISION

General Requirements for Communications Systems

Change Summary

- During the 2020 cycle, communications circuit requirements were moved from Article 800 to Article 805.
- A new Article 800, General Requirements for Communications Circuits, was created as a location for the Chapter 8 articles.
- The task was incomplete in the 2020 cycle. This cycle, several additional sections have been moved into Article 800.

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Article 800

REVISION

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Article 810

REVISION

Antenna Systems

Change Summary

- The title of Article 810 has been changed from “Radio and Television Equipment” to “Antenna Systems.”
- Most radio receiving equipment covered by Article 810 is cord- and plug connected to branch-circuit wiring.
- This article covers all radio receiving equipment.
- The only radio transmitting equipment covered by Article 810 is transmitters used for amateur radio and citizens band radio.

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Article 810

REVISION

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Courtesy of David Nelson, WV1H

Significant Changes

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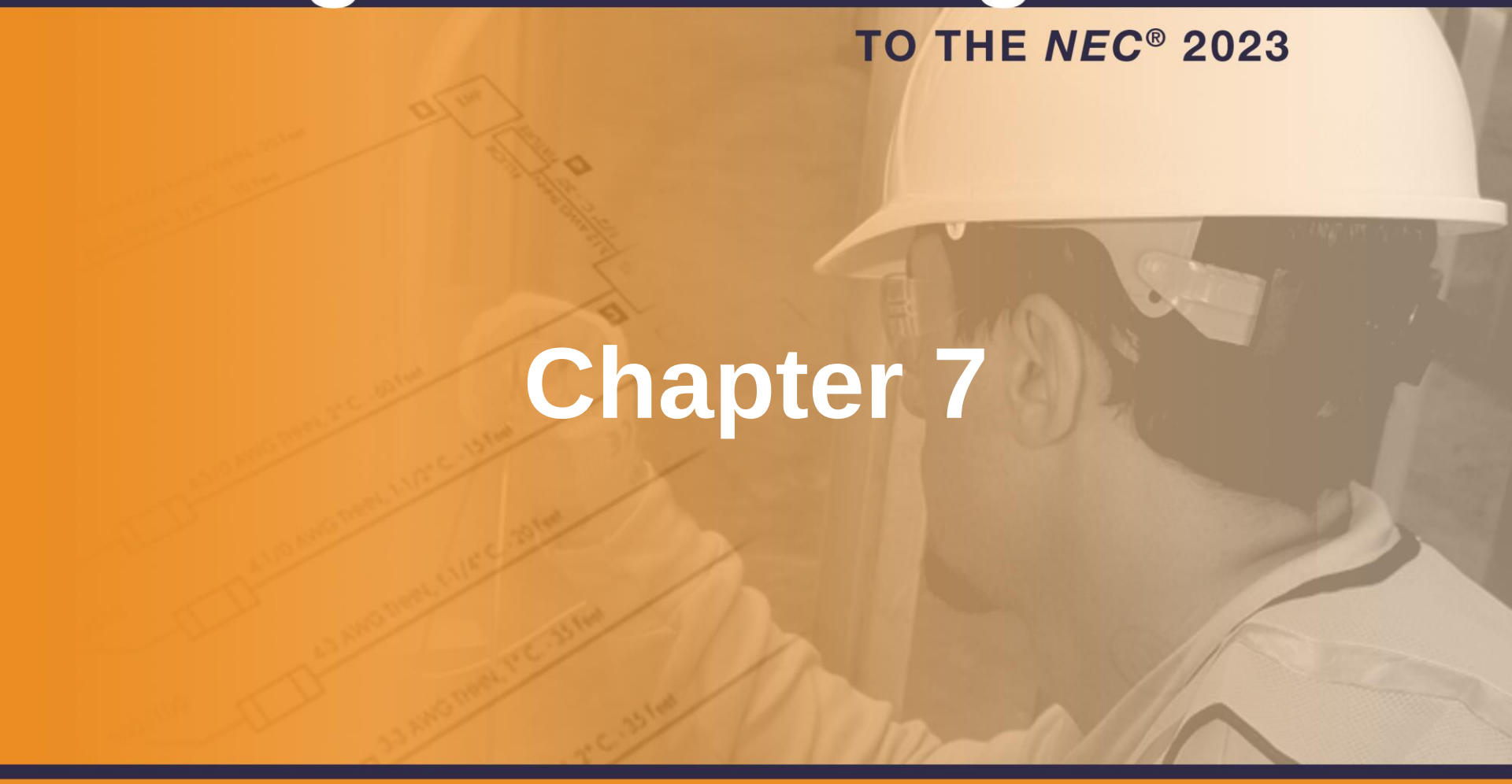

Chapter 7

electrical training ALLIANCE IBEW - NECA IN COLLABORATION WITH NECA NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION

700.3

REVISION

Tests and Maintenance

Change Summary

- The permanent connection point for the temporary generator must be located outdoors. Cables must not be run through exterior windows, doors, or similar openings.
- The switching means, including the interlocks, are required to be listed to prevent inadvertent interconnection of power sources.
- A permanent label must be field-applied at the permanent connection point that indicates the system voltage, maximum load, and short-circuit current rating of the load-side equipment.

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700.3

REVISION

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700.4

REVISION

Capacity and Rating

Change Summary

- Section 700.4(A) was deleted because this is a general requirement covered by 110.9 and 110.10.
- Emergency systems are now required to have sufficient capacity for rapid load changes and transient energy requirements associated with expected loads.
- Peak load shaving requirements are now covered in 700.4(C), Parallel Operations.
- A new 700.4(C) addresses requirements for the two types of parallel operations. Section 700.4(C)(1) covers parallel operation of normal and emergency sources, while 700.4(C)(2) covers emergency sources that operate in parallel.

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700.4

REVISION

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700.5

REVISION

Transfer Equipment

Change Summary

- The requirement in 700.5(A) for approval by the AHJ of transfer equipment was deleted.
- The prohibition of reconditioning emergency transfer switches has been relocated to 700.2.
- A new 700.5(D), Redundant Transfer Equipment, has been added to require emergency loads that are supplied by a single feeder to have a redundant transfer switch or a bypass isolation switch.
- Where the redundant transfer switch or bypass isolation switch is manual or not automatic, it must be supervised when the primary is out of service.

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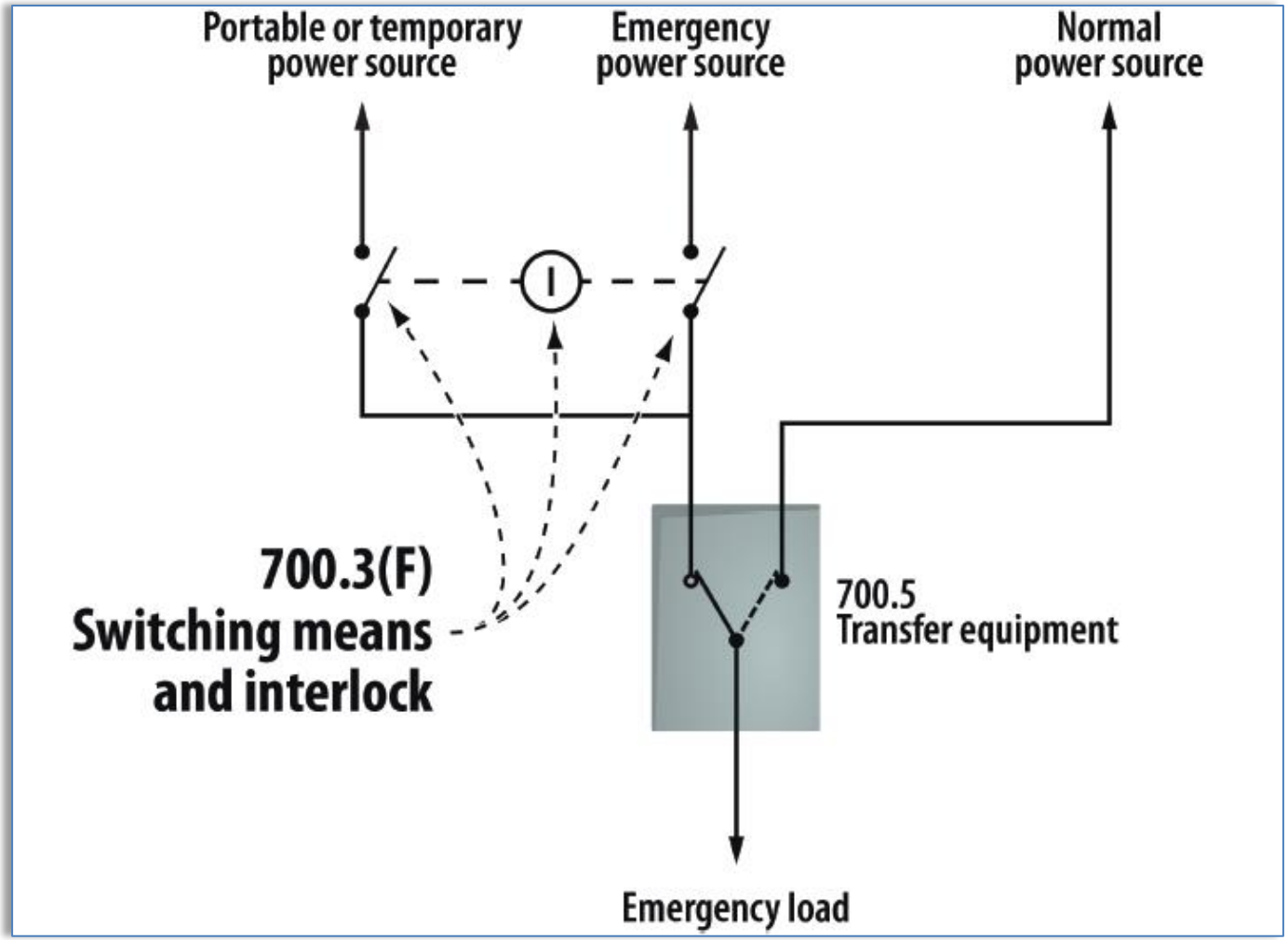
700.5

REVISION



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700.11

NEW

Wiring, Class-2-Powered Emergency Lighting Systems

Change Summary

- New Section 700.11 recognizes Class 2 emergency lighting systems that could use power over ethernet technology or low-power LED luminaires.
- These are directly-controlled luminaires and must comply with 700.24.
- In addition to other separation requirements, Class 2 emergency circuits must be separated from nonemergency Class 2 circuit conductors. If bundled, they must be bundled separately.
- Wiring must comply with 300.4 and be installed in a raceway, armored or metal-clad cable, or cable tray.

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700.11

NEW

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Courtesy of Electronic Theatre Controls Incorporated

700.12

REVISION

General Requirements

Change Summary

- Section 700.12(B) was revised to correlate with the occupancy requirements in 700.10(D)(1).
- The title of 700.12(C) has been changed from “storage battery” to “supply duration” to cover the duration of all supplies. Battery and UPS durations are covered under 700.10(C)(4).
- The exception to 700.12(C)(3) recognizes that where the AHJ approves a public gas system to supply an emergency source, an onsite fuel supply is not required.

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700.12

REVISION

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Courtesy of Eaton

700.24

REVISION

Directly Controlled Emergency Luminaires

Change Summary

- Directly controlled luminaires can be energized in two different ways.
- An active control signal can be sent from a listed external control system. This requires the controller and the luminaire to be listed for use in emergency systems.
- Systems that are activated by disconnection of the control input by a listed control device, such as an automatic load control relay, would not require the luminaire to be listed for use in emergency systems.

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700.24

REVISION

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700.32

NEW

Selective Coordination

Change Summary

- Selective coordination of emergency systems is required to ensure that overcurrent protective device operation does not affect other loads supplied by the emergency systems.
- The text has been revised by adding “load-side” to ensure that coordination applies upstream and downstream.
- New text states that if OCPDs are replaced, modified, deleted, or added, coordination must be reevaluated.

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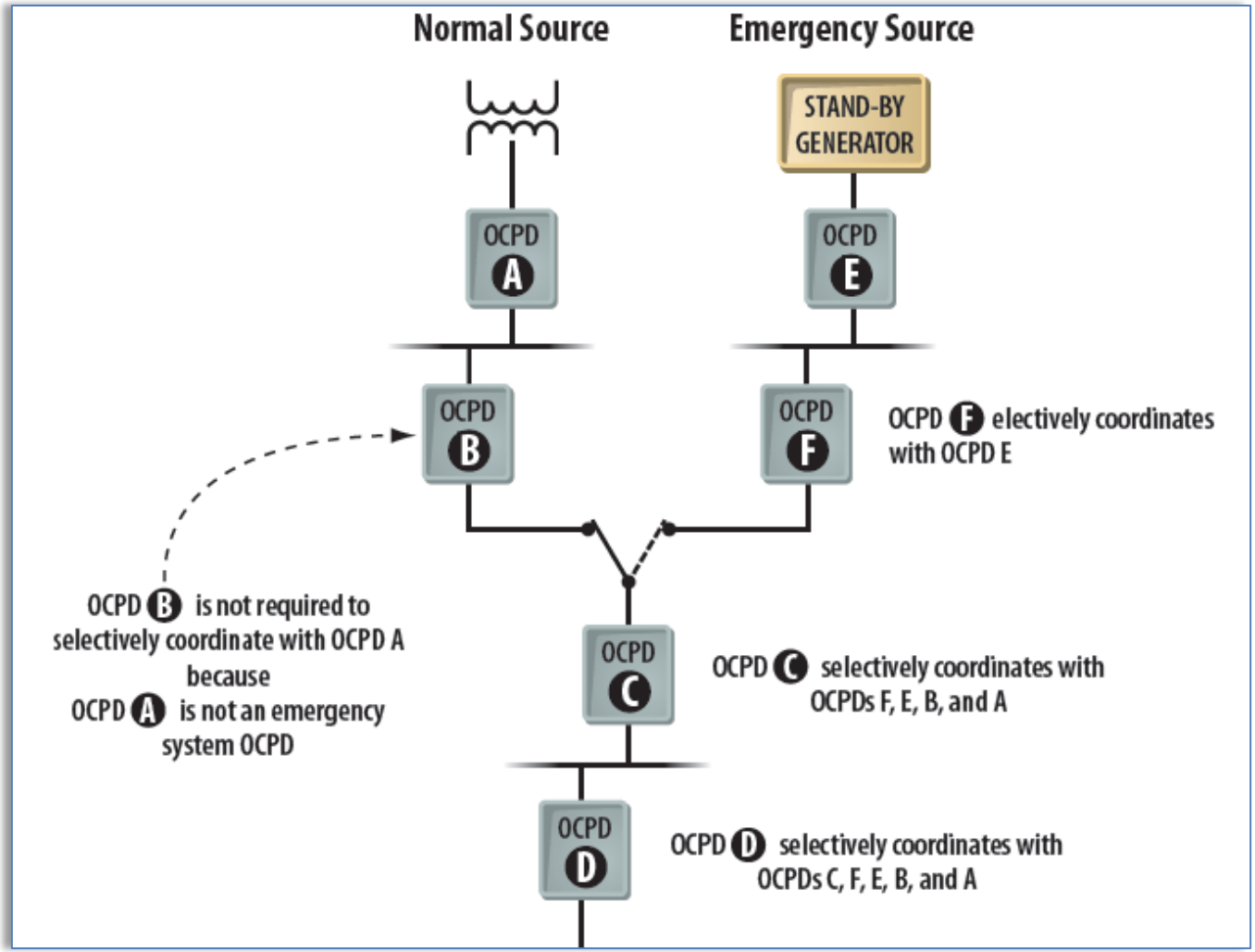
700.32

NEW



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705.5

REVISION

Parallel Operation

Change Summary

- Section 705.14 has been relocated to become 705.5.
- The title was changed from “Output Characteristics” to “Parallel Operation.”
- The previous first sentence of 705.14 has become 705.5(A).
- The marking requirements from 705.14 were deleted because listed equipment is required, which addresses the marking requirements.
- The last sentence of 705.14 has become 705.5(B).

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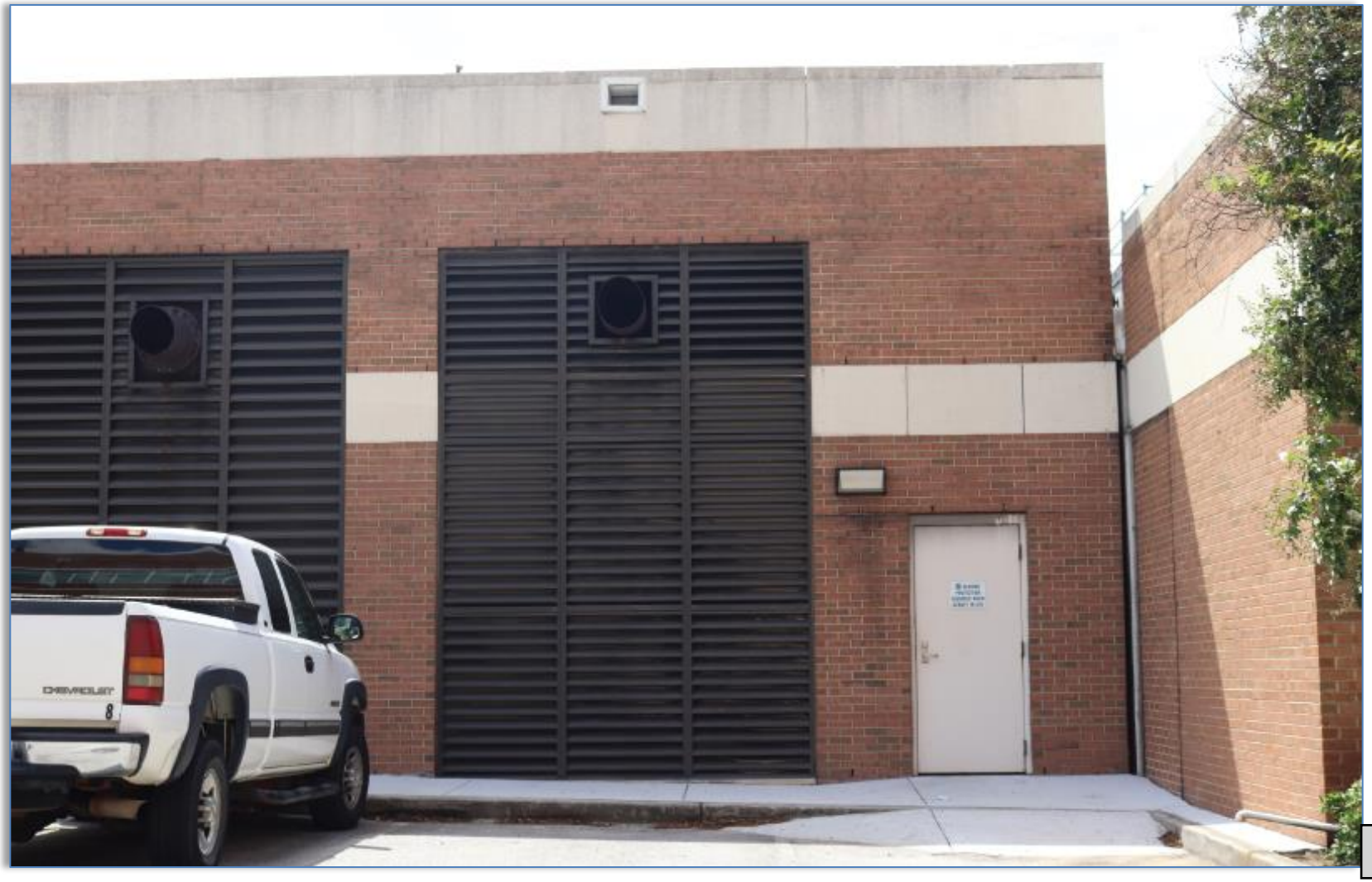
705.5

REVISION



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705.10

NEW

Identification of Power Sources

Change Summary

- The identification requirements have been reorganized into list format.
- The plaques, labels, or directories are now required to indicate the emergency telephone numbers of off-site entities that service the installation.
- A reference was added to *NFPA 1: Fire Prevention Code*, which provides installer information.

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705.10

NEW

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Courtesy of Michael J. Johnston

705.11

REVISION

Source Connections to a Service

Change Summary

- The title of 705.11 was revised to make it clear that it refers to any connection of an interconnected source to a service.
- The requirements for service conductors were moved to 705.11(B).
- The former 705.11(D) was relocated to (C) and was completely rewritten.
- The new 705.11(E) was added to provide requirements for bonding and grounding.

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705.11

REVISION

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Courtesy of the National Renewable Energy Laboratory

705.12

REVISION

Load-Side Source Connections

Change Summary

- The first paragraph was revised for clarity by deleting unnecessary words.
- 705.12(A) was deleted because disconnecting requirements are covered in 705.20 and overcurrent protection is covered in 705.30.
- Requirements were revised for ampere ratings of busbars for connection to distribution equipment with no specific listing and instructions for combining multiple loads.

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705.12

REVISION

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705.20

NEW

Source Disconnecting Means

Change Summary

- Section 705.20 provides requirements for disconnecting means for interconnected electric power production sources.
- Most articles that cover power sources also include disconnecting means requirements.
- If an installation complies with 705.20, a single disconnecting means is permitted to disconnect multiple sources.

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705.20

NEW

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705.80 through 705.82

NEW

Interconnected Systems Operating in Island Mode

Change Summary

- A new Part III has been added to provide requirements for operating an interconnected electric power production source in island mode.
- The three categories of operation are automatic load management, manual load management, and no-load management.
- Operation in island mode requires voltage and frequency to be controlled within limits.

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705.80 through 705.82

NEW

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706.1 & 706.8

REVISION

Scope

Change Summary

- Informational Note No. 1 points out that Article 480 covers installation of stationary-standby batteries.
- Other battery applications that are not stationary standby batteries are covered by Article 706.
- *NFPA 1* and *NFPA 855* were added to the list of reference standards because some battery chemistries require special fire protection precautions.

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706.1 & 706.8

REVISION

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Courtesy of Tesla Energy

706.7

REVISION

Commissioning and Maintenance

Change Summary

- Section 706.7 has been expanded to require that energy storage systems be commissioned before being placed into service.
- This does not apply to ESS installations in one- and two-family dwellings.
- An informational note was added to point to *NFPA 855* for information on commissioning of energy storage systems.

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706.7

REVISION

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Courtesy of Michael J. Johnston

706.15

REVISION

Disconnecting Means

Change Summary

- Requirements for disconnecting means for energy storage systems have been expanded.
- For one- and two-family dwellings, an emergency shutdown function must cease export of power from the ESS to the premises wiring of other systems.
- New requirements have been added for disconnecting means for batteries where the battery is separate from the ESS electronics and is subject to field servicing.

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706.15

REVISION

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Courtesy of Tesla Energy

Article 722

NEW

Cables for Power-Limited Circuits

Change Summary

- A new Article 722 has been created to cover cable requirements for Class 2 and 3 power-limited circuits, power-limited fire alarm circuits, and Class 4 fault-managed power systems.
- Many of the installation requirements for these types of cables were repeated in Articles 725 and 760.
- Part I provides general requirements for power-limited circuit conductors and cables.
- Part II covers listing requirements for conductors and cables.
- The requirements for Class 4 circuits are new for this cycle.

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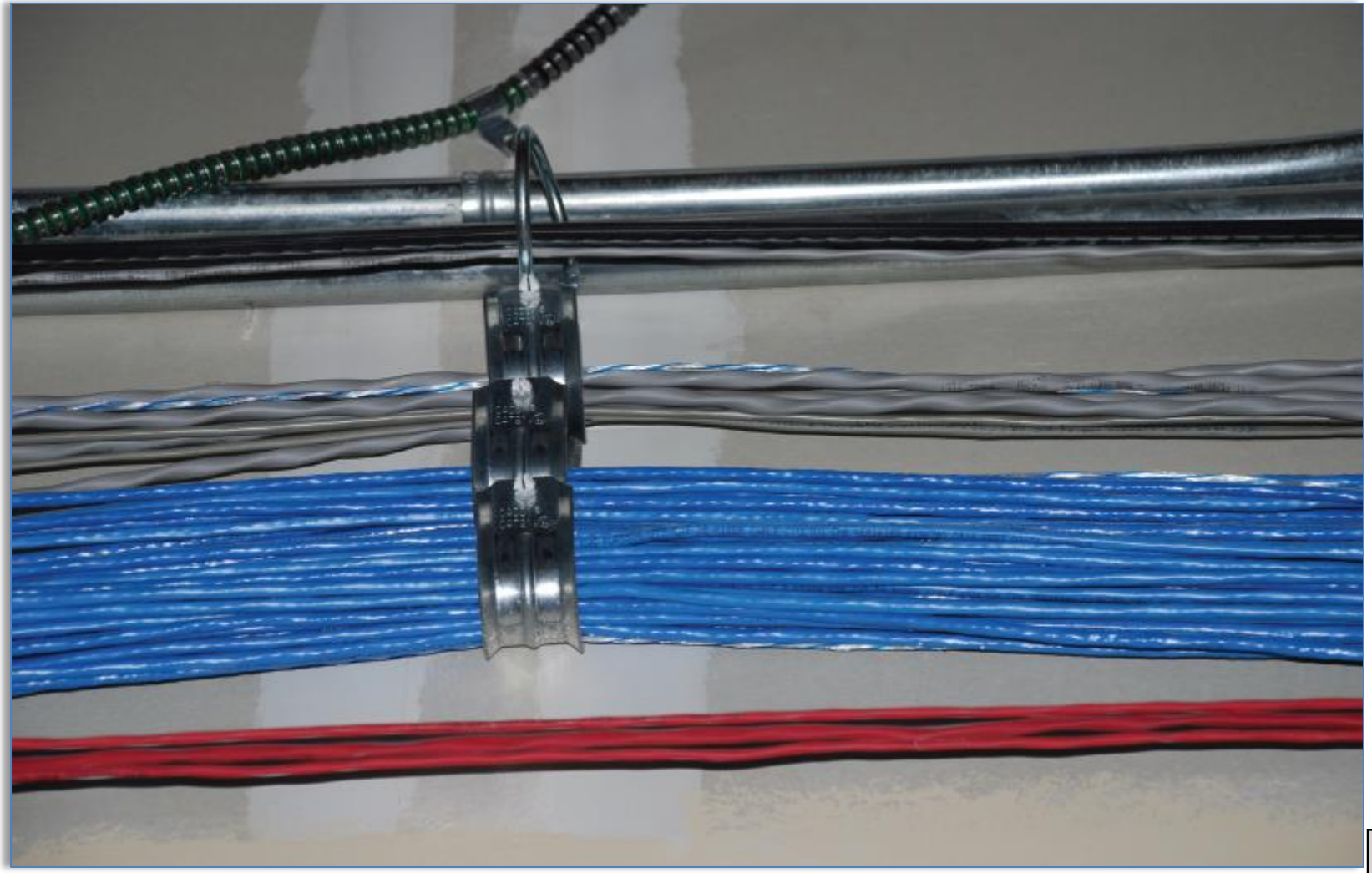
Article 722

NEW



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Courtesy of Michael J. Johnston

722.10

NEW

Hazardous (Classified) Locations

Change Summary

- Class 4 cables are permitted in hazardous (classified) locations where specifically permitted in the applicable article elsewhere in the *Code*.
- Similar language permitting wiring and applicable equipment has also been added to 725.10, 726.10, and 760.10 to provide a consistent approach in each of these articles.
- All of these sections have been rewritten into positive language by the *NEC* Correlating Committee.

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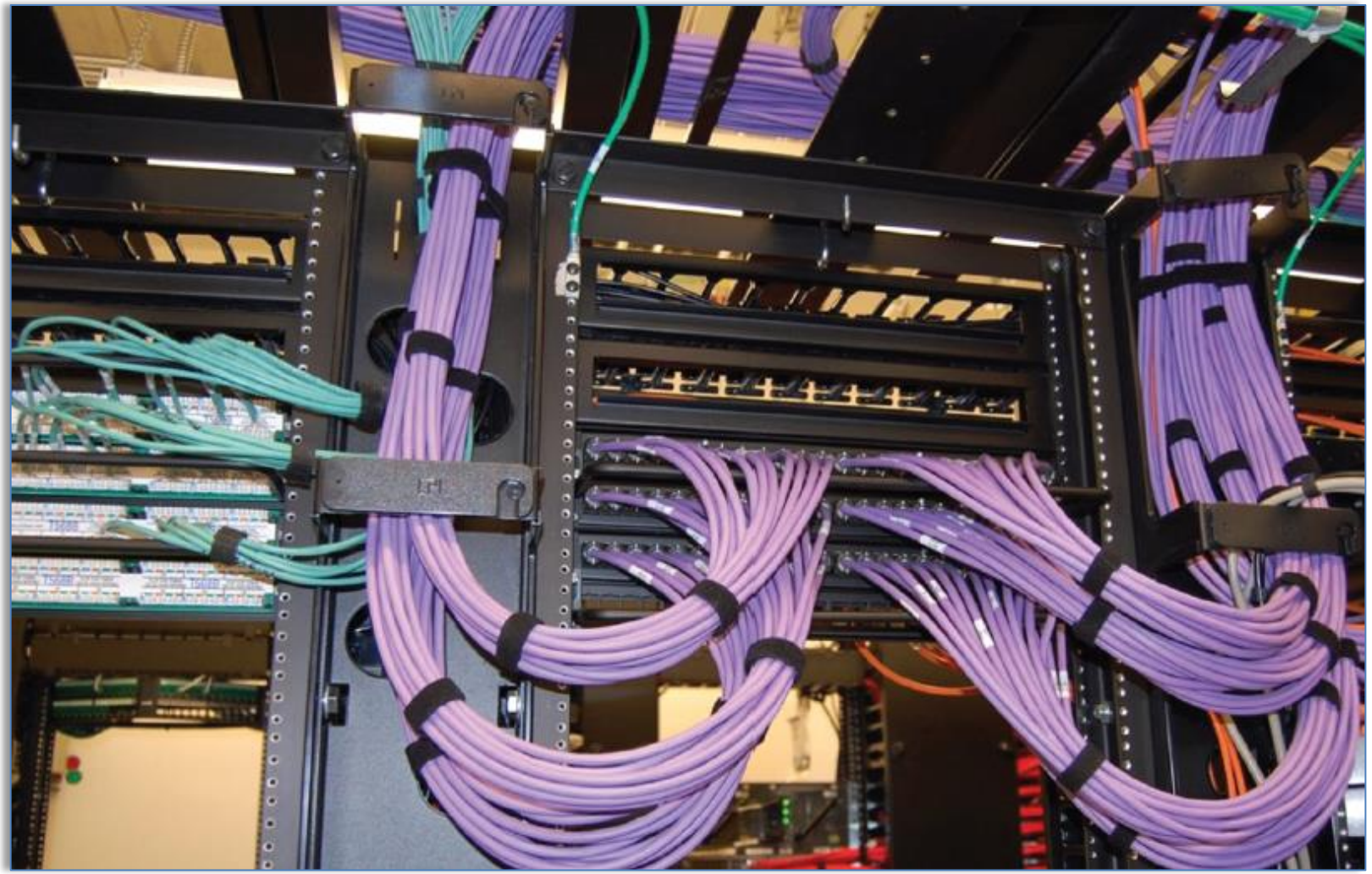
722.10

NEW



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Courtesy of Cisco

Article 724

NEW

Class 1 Power-Limited Circuits

Change Summary

- Class 1 circuit requirements have been moved from Article 725 to the new Article 724.
- Class 1 circuits are now limited to not more than 30 volts and 1,000 volt-amperes.
- The remote control and signaling circuits that are not power-limited are no longer considered to be Class 1 circuits. They are now covered by the first four chapters of the *Code*.

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Article 724

NEW

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Article 725

NEW

Class 2 and 3 Power-Limited Circuits

Change Summary

- Requirements for Class 1 circuits have been removed from Article 725, which now only applies to Class 2 and 3 power-limited remote control and signaling circuits.
- General requirements for wiring of Class 2 and 3 circuits have been relocated to new Article 722, Cables for Power-Limited Circuits.
- The relocated material includes substitution tables, abandoned cables, mechanical execution of work, and other requirements that are common to Articles 725, 760, and 770.

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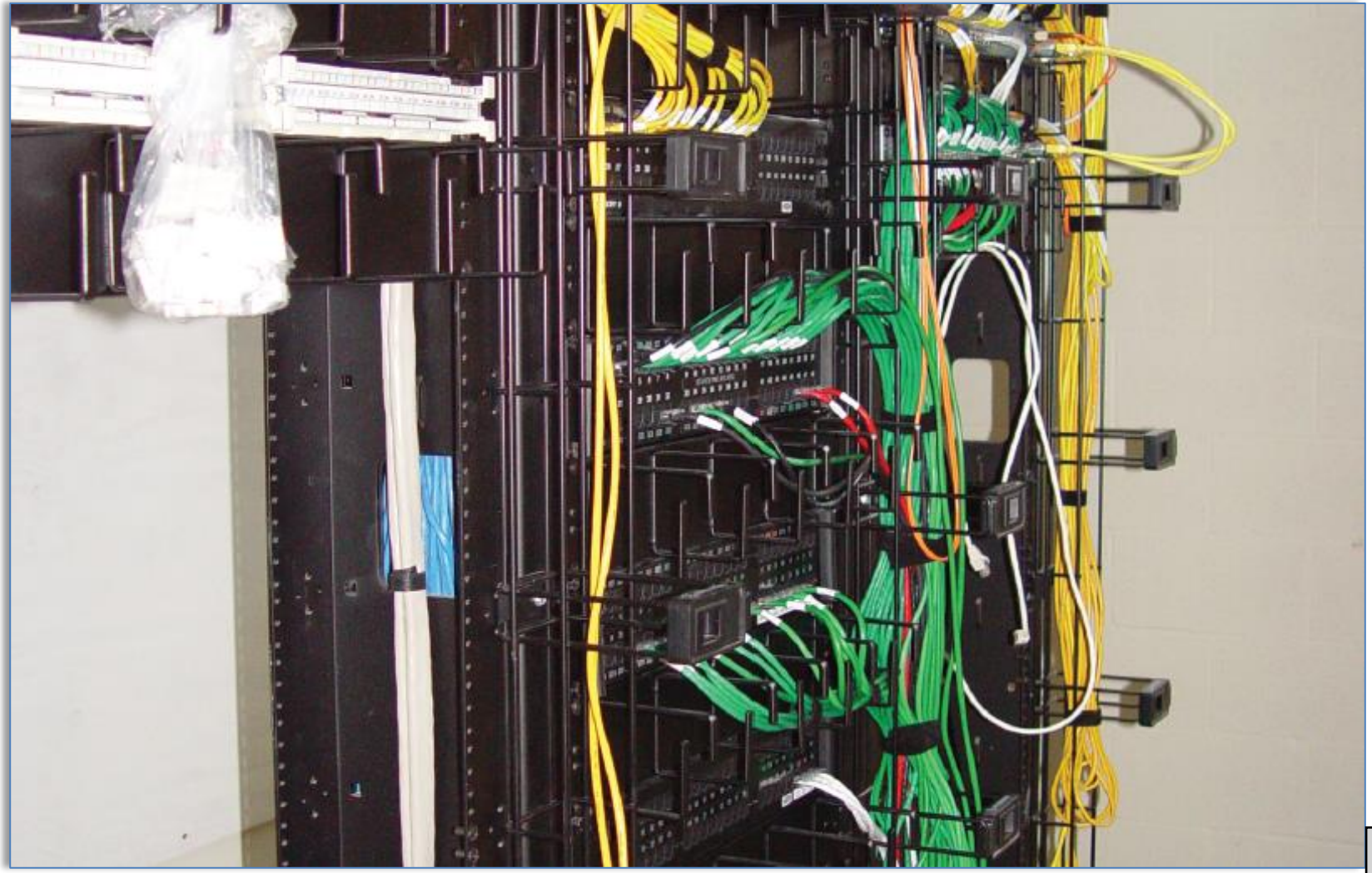
Article 725

NEW



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725.31

REVISION

Safety-Control Equipment

Change Summary

- If damage to Class 2 and 3 power-limited safety-control equipment can result in a direct fire or life safety hazard, the power-limited circuit must be installed in accordance with 724.31.
- Such circuits are no longer permitted to be reclassified as Class 1, but are required to be installed using Class 1 wiring methods.
- Reclassifying the wiring as Class 1 would require recertification of the source and load equipment as Class 1 equipment.

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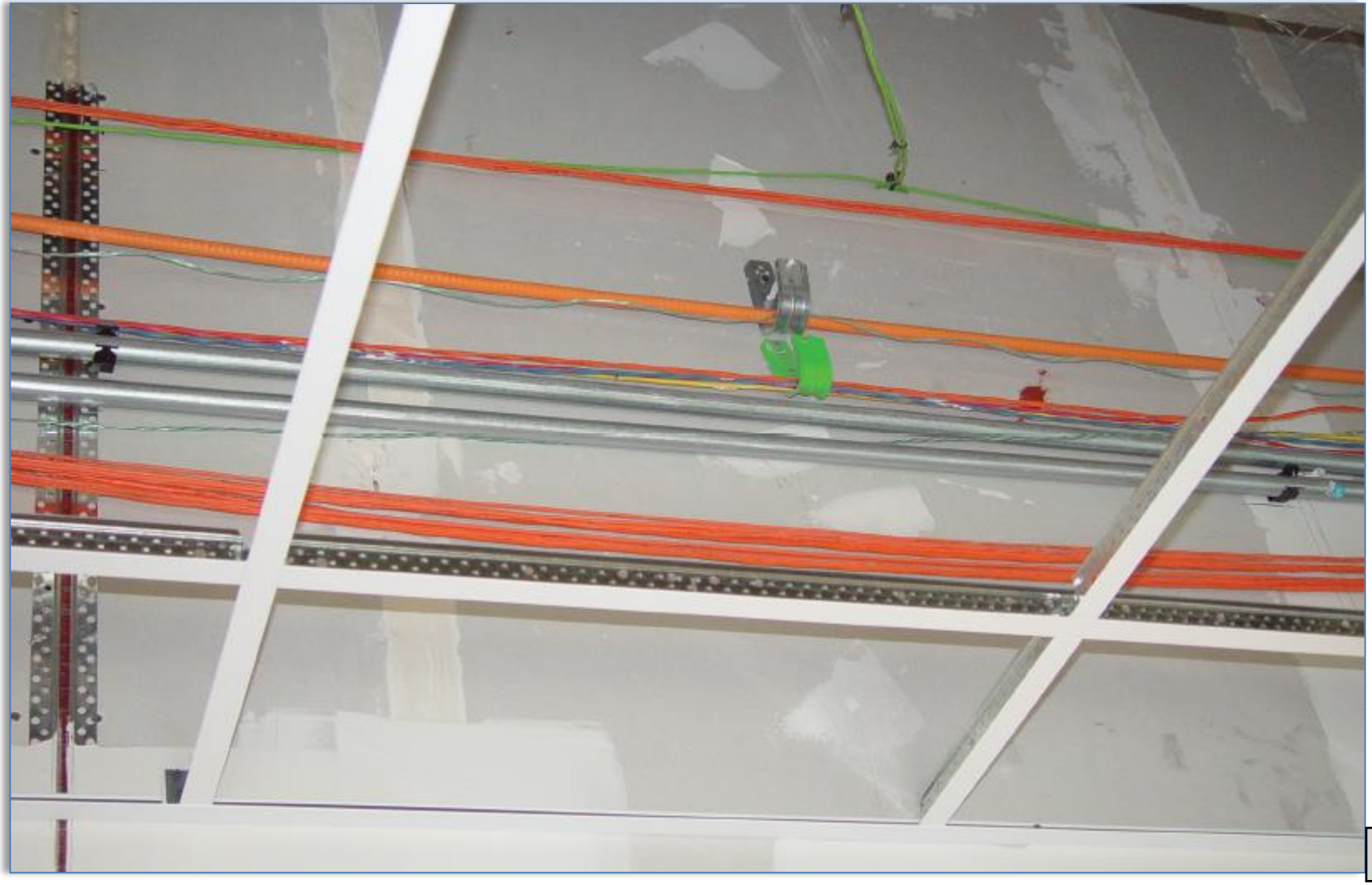
725.31

REVISION



778

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Courtesy of Michael J. Johnston

Article 726

NEW

Class 4 Power Systems

Change Summary

- A new Article 726, Class 4 Power-Limited Circuits, has been created to provide requirements for fault-managed power systems.
- Fault-managed power systems monitor the circuit for faults and control power delivery to ensure that fault energy is limited.
- Class 4 circuits can have a peak output voltage of 450 volts dc line-to-line or 225 volts line-to-ground.

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Article 726

NEW

780

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Courtesy of Michael J. Johnston

Article 750

REVISION

Energy Management Systems

Change Summary

- Energy management systems are required to be listed.
- Three options are provided for listing, including a complete listed system, a field installation kit, or listed components assembled as a system.
- 750.30(C) was expanded to provide requirements for current set point, system malfunction, settings, and marking requirements.

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Article 750

REVISION

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760.24

REVISION

Mechanical Execution of Work

Change Summary

- Fire alarm circuit cables and conductors must be supported by hardware, including straps, hangers, and cable ties, that are listed and identified for securement and support.
- This correlates with requirements in 320.30, 330.30, 334.30, and 337.30, which all require mounting hardware that is listed for securement and support.
- A similar requirement in 722.24 covers Class 2, 3, and 4 wiring.

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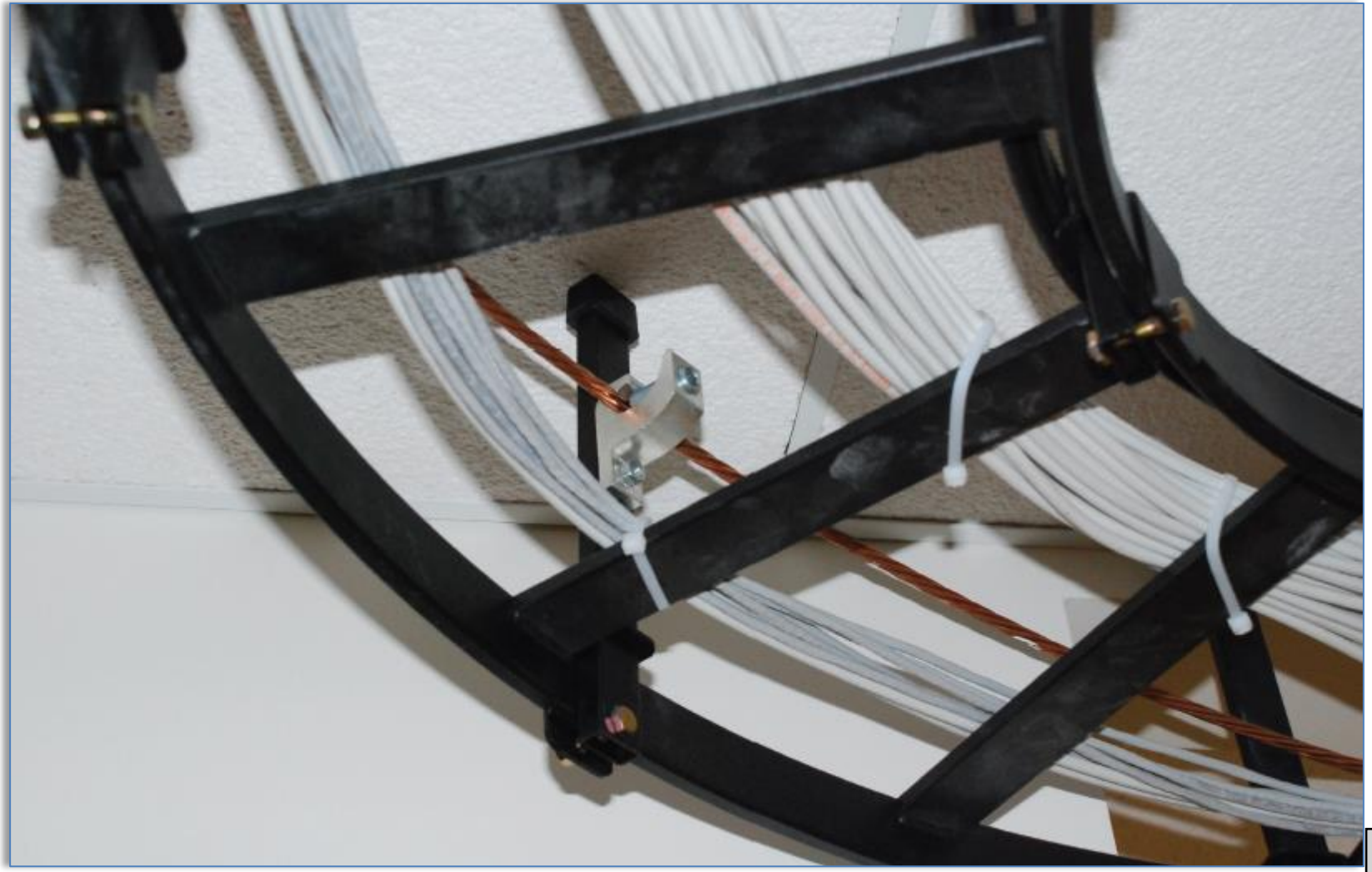
760.24

REVISION



784

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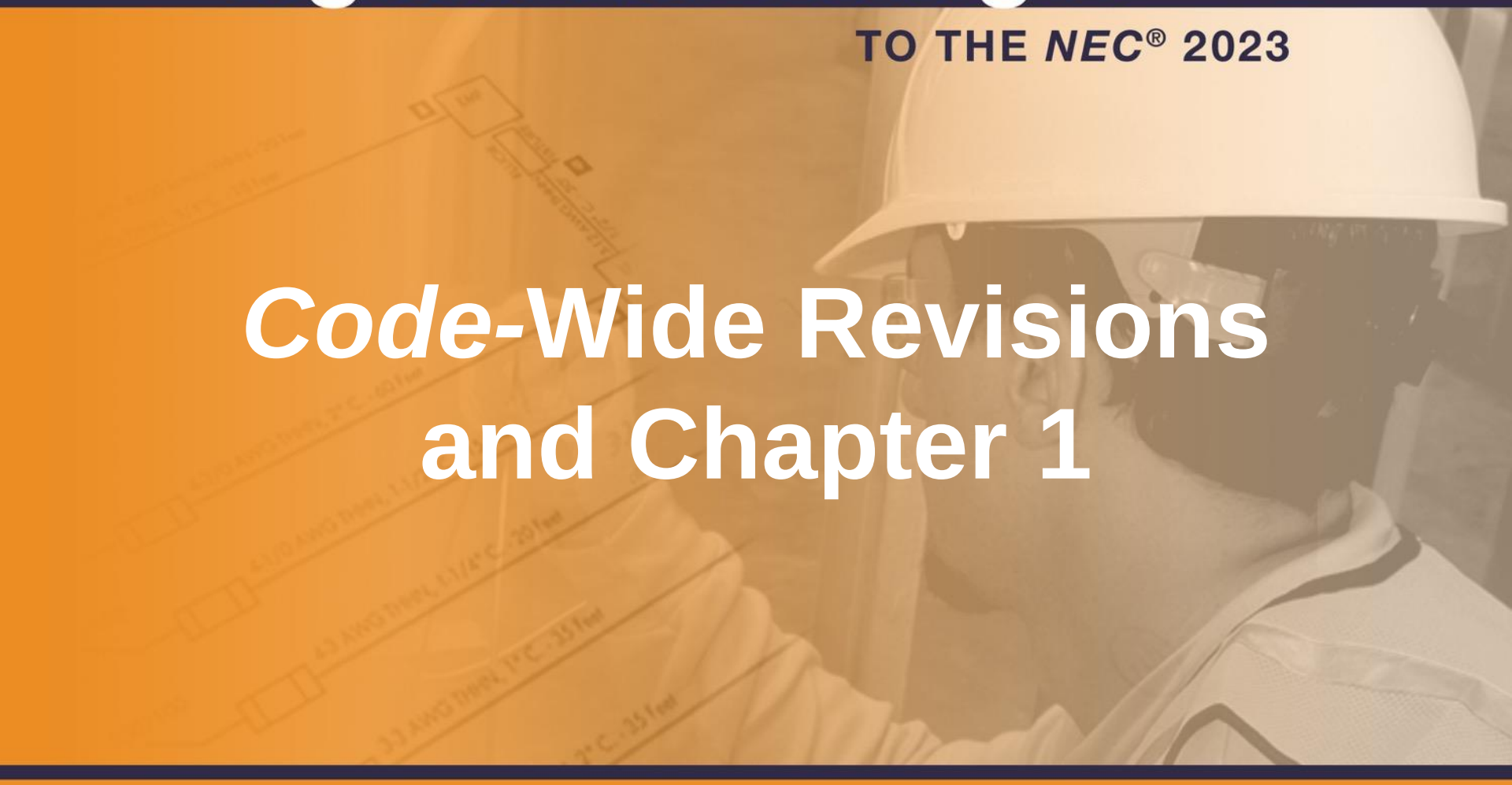
Significant Changes

TO THE *NEC*® 2023



Code-Wide Revisions and Chapter 1

electrical training ALLIANCE IBEW - NECA IN COLLABORATION WITH NECA NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION

Code-Wide Revisions

Reconditioned Equipment

Change Summary

- There are now several reconditioned equipment requirements in the *NEC*.
- The second section of some articles (XXX.2) is now reserved for any requirements that either permit or prohibit reconditioning of equipment that is covered by the article.

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Code-Wide Revisions

Definitions

Change Summary

- Article 100 now contains all definitions. No definitions will be in the other articles of the *Code*.
- Article 100 will no longer be divided into parts.
- Definitions are assigned to code-making panels based on the articles assigned to the panel and how closely the panel aligns with the definition. The responsible panel is indicated in each definition.
- Some definitions only apply to a single article. Where that is the case, the article number appears toward the end of the definition.
- In a few cases, multiple definitions continue to be required.

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Code-Wide Revisions

New, Deleted, and Relocated Articles and Revised Article Titles for the 2023 NEC

Change Summary

- Some Articles are new, three were deleted, some had title revisions, and others were relocated.
  - 110 General Requirements for Electrical Installations (Revised title)
  - 210 Branch Circuits, Not Over 1000 Volts ac, 1500 Volts dc, Nominal (Revised title)
  - 235 Branch Circuits, Feeders, and Services Over 1000 Volts ac, 1500 Volts dc, Nominal (New)
  - 245 Overcurrent and Overvoltage Protection for Systems Rated Over 1000 Volts ac, 1500 Volts dc, Nominal (New)
  - 305 General Requirements for Wiring Methods and Materials for Systems Rated Over 1000 Volts ac, 1500 Volts dc, Nominal (New)

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Code-Wide Revisions

New, Deleted, and Relocated Articles and Revised Article Titles for the 2023 NEC (continued)

Change Summary

- 315 Medium Voltage Conductors, Cable, Cable Joints, and Cable Terminations (Revised title and relocated)
- 335 Instrument Tray Cable: Type ITC (Relocated)
- 369 Insulated Bus Pipe (IBP)/Tubular Covered Conductors (TCC) Systems (New)
- 371 Flexible Bus Systems (New)
- 395 Outdoor Overhead Conductors over 1000 Volts (Relocated)
- 480 Stationary Standby Batteries (Revised title)
- 495 Equipment Over 1000 Volts ac, 1500 Volts dc, Nominal (Revised title and Relocated)
- 510 Hazardous (Classified) Locations-Specific (Deleted)

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Code-Wide Revisions

New, Deleted, and Relocated Articles and Revised Article Titles for the 2023 NEC (continued)

Change Summary

- 512 Cannabis Oil Equipment and Cannabis Oil Systems Using Flammable Materials (New)
- 712 Direct Current Microgrids (Deleted)
- 720 Circuits and Equipment Operating at Less Than 50 Volts (Deleted)
- 722 Cables for Power-Limited Circuits and Fault-Managed Power Circuits (New)
- 724 Class 1 Power-Limited Circuits and Class 1 Power-Limited Remote Control and Signaling Circuits (New)
- 725 Class 2 and Class 3 Power-Limited Circuits (Revised title)
- 726 Class 4 Fault-Managed Power Systems (New)
- 810 Antenna Systems (Revised title)

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Code-Wide Revisions

NEC Style Manual Changes

Change Summary

- A new version of the style manual was issued in 2020.
- Text was simplified to avoid long paragraphs and long sentences by placing complex requirements into a list format.
- Many of the changes improved readability, and those changes are not covered in this book.

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Code-Wide Revisions

Medium- and High-Voltage Requirements

Change Summary

- Many medium- and high-voltage requirements were removed from existing articles and moved to an article ending in number 5.
- For example, Article 235 now covers medium- and high-voltage services.
- New articles:
  - 235 Branch Circuits, Feeders, and Services Over 1000 Volts ac, 1500 Volts dc, Nominal
  - 245 Overcurrent and Overvoltage Protection for Systems Rated Over 1000 Volts ac, 1500 Volts dc, Nominal
  - 305 General Requirements for Wiring Methods and Materials for Systems Rated Over 1000 Volts ac, 1500 Volts dc, Nominal

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Code-Wide Revisions

Medium- and High-Voltage Requirements (continued)

Change Summary

- 315 Medium Voltage Conductors, Cable, Cable Joints, and Cable Terminations
- 395 Outdoor Overhead Conductors over 1000 Volts
- 495 Equipment Over 1000 Volts ac, 1500 Volts dc, Nominal

- Articles 395 and 495 were relocated from 399 and 490, respectively, for consistency with the numbering scheme for medium- and high-voltage articles.

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Code-Wide Revisions

Not a Change?

Change Summary

- Prior to the 2002 *Code*, NM cable was limited to buildings of three stories or less.
- Section 334.10 permitted NM cable in buildings of Types III, IV, and V construction, but the cables had to be concealed within walls, floors, or ceilings that provided a thermal barrier of material that provided at least a 15-minute finish rating.
- Limitations in 334.12 provided some applications and occupancies where NM cable was not permitted to be used.
- *International Building Code* and *NFPA 5000* limited Type IV heavy timber construction to five stories above grade.
- The *NEC* requirements were based on these limitations for 20 years.

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Code-Wide Revisions

Not a Change? (continued)

Change Summary

- The *International Building Code* changed its definition of Class IV construction to permit a heavy timber constructed building of up to 18 stories.
- *NFPA 5000* permits a Type IV heavy timber constructed building of up to 24 stories.
- These changes resulted in a significant change to the *NEC* that was not processed through the *NEC.*
- CMP 6 did not change the language.
- Significant changes took place in other codes outside of the *NEC* but affect the *NEC*.

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90.1

NEW

Scope

Change Summary

- Article 90 now has a scope that provides the scope of Article 90, rather than the scope of the *Code*.
- The material previously found in 90.1 has been combined with 90.2, which is now titled “Use and Application.”
- This change provides consistency and clarity but does not make any technical change to the *Code*.

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90.1

NEW

Article 90 Introduction

90.1 Scope

This article covers use and application, arrangement, and enforcement of this *Code*. It also covers the expression of mandatory, permissive, and nonmandatory text, provides guidance on the examination of equipment and on wiring, planning, and specifies the use and expression of measurements.

~~90.1 Purpose.~~

~~(A) Practical Safeguarding.~~

~~The purpose of this *Code* is the practical safeguarding or persons and property from hazards arising from the user of electricity. This *Code* is not intended as a design specification or an instruction manual for untrained persons.~~

~~(B) Adequacy.~~

...

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90.2

RELOCATE REORGANIZE

Use and Application

Change Summary

- Section 90.2 has a new title: Use and Application.
- All previous text in Section 90.1 has been blended into a reorganized 90.2
- The titles of 90.2(C) and (D) have been changed to accommodate the reorganization.

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90.2

RELOCATE REORGANIZE

90.2 ~~Scope~~ Use and Application

(A) Practical Safeguarding (Formerly 90.1(A))

(B) Adequacy (Formerly 90.1(B))

(C) Installations Covered (Formerly 90.2(A))

(D) Installations Not Covered (Formerly 90.2(B))

(E) Relation to Other International Standards (Formerly 90.1(C))

(F) Special Permission (Formerly 90.1(D))

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90.4

REORGANIZE

Enforcement

Change Summary

- This section was reorganized for clarity.
- A list format is used to make this section clearer.
- A new reference was added to Informative Annex H to comply with the *NEC Style Manual*.

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90.4

REORGANIZE

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90.5(C)

REVISION

Explanatory Material

Change Summary

- If a referenced standard does not have an edition date, the latest edition can be assumed.
- Newer editions of standards could have been released after the *Code* committee considered the latest edition.
- Since references are not mandatory, there is no prohibition against using an updated edition.
- Standards references are for convenience only. Most installations can be completed without referring to the referenced standards.

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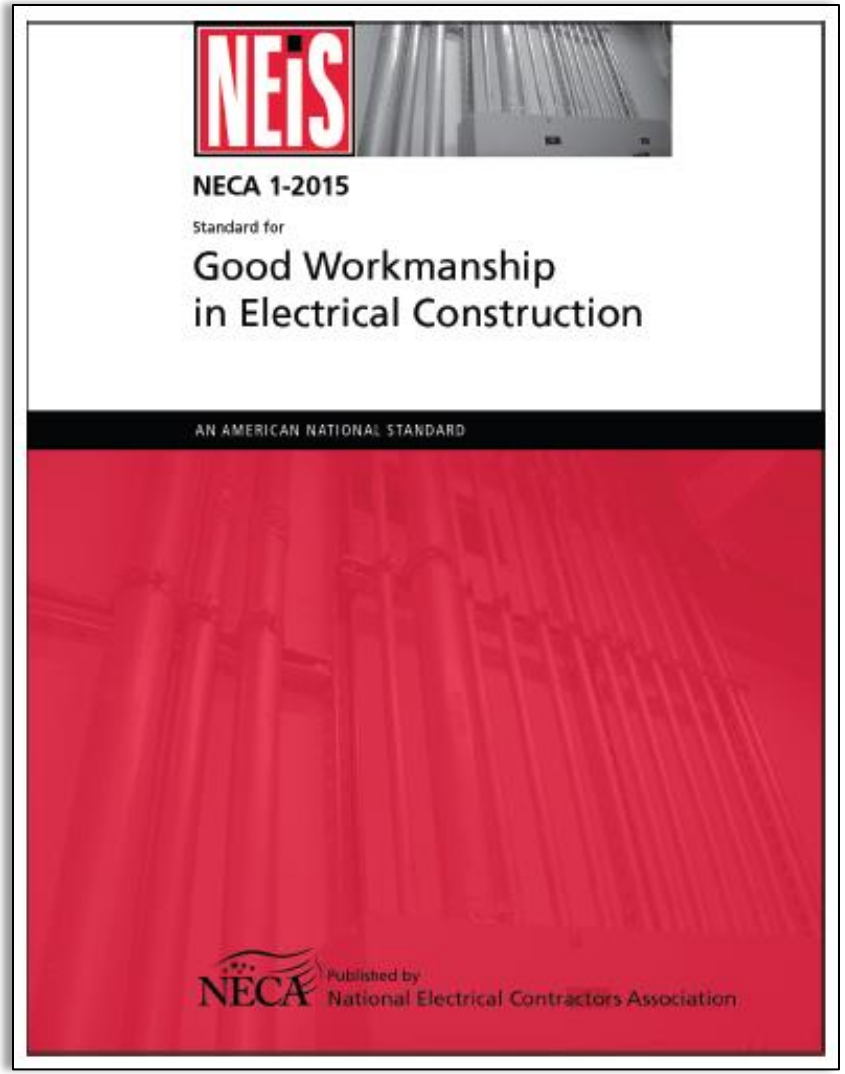
90.5(C)

REVISION



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Article 100

REORGANIZE

Article 100 Reorganization

Change Summary

- Article 100 has been consolidated into an article that is not divided into parts.
- All of the definitions from other articles have been relocated into Article 100.
- The XXX.2 sections of various articles no longer contain definitions.
- If a term had multiple uses, it has been modified to facilitate each use. In many cases, terms were modified to cover all appropriate applications.

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Article 100

REORGANIZE

Article 100 Definitions

~~Part I-General~~
~~Part II. Over 1000 Volts, Nominal~~
~~Part III. Hazardous (Classified) Locations~~

This definition is extracted from the definitions chapter of *NFPA 99* (3.3.30). In most other NFPA documents, definitions are numbered.

Equipment Branch.
A system of feeders and branch circuits arranged for delayed, automatic, or manual connection to the alternate power source and that serves primarily 3-phase power equipment. [99:3.3.30] (517) (CMP-15)

This definition only applies within Article 517.

Assigned Code-Making Panel

The format of many defined terms were edited to comply with the new *NEC Style Manual*. To assist in electronic searching, some defined terms appear in parentheses as it would be found in the document.

Overcurrent Protective Device, Branch-Circuit. (Branch-Circuit Overcurrent Protective Device)
A device capable of providing protection for service, feeder, and branch circuits and equipment over the full range of overcurrents between its rated current and its interrupting rating. (CMP-10)

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Article 100

REVISION

Definition of Accessible (as applied to wiring methods)

Change Summary

- For a wiring method to be considered accessible, it must not be closed in or blocked by the structure.
- Accessible wiring methods must also not be blocked by other electrical equipment.
- Coordination with other trades is often needed to ensure that accessible wiring methods are not blocked by building mechanical or plumbing systems.

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Article 100

REVISION

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Article 100

REVISION

Definition of Attachment Fitting, Weight Supporting

Change Summary

- This definition was revised to better describe the function of WSAF.
- The WSAF is a recognized component that is part of a listed luminaire or paddle fan.
- The combination of the WSAF and WSCR facilitate the modular replacement of luminaires and paddle fans in one- and two-family dwellings.
- Note also at the end of the definition the notation (CMP-18). This indicates the code-making panel that is responsible for the definition.
- NEMA WD6 recognizes WSAF configurations.

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Article 100

REVISION

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Courtesy of SKYX Platforms

Article 100

NEW

Definition of Motor Branch Circuit

Change Summary

- A new definition was added to differentiate between a branch circuit and a motor branch circuit.
- Branch circuits originate at the last overcurrent protective device supplying the circuit.
- Motor branch circuits include controllers and adjustable speed drives.

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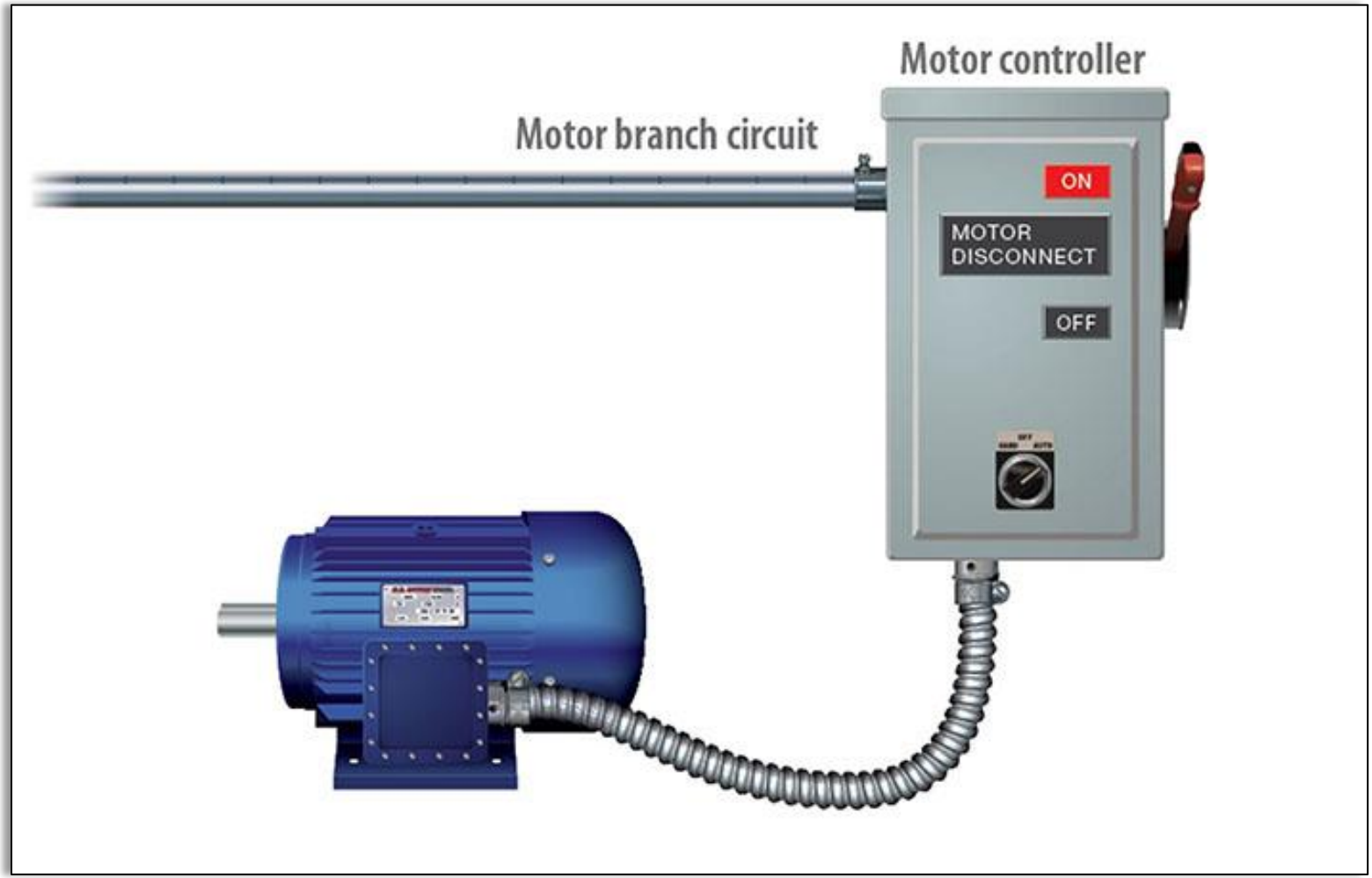
Article 100

NEW



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Article 100

NEW

Definition of Class 4 Definitions

Change Summary

- These definitions are for terms used in new Article 726, Class 4 (CL4) Power Systems.
- Class 4 power systems will be used with equipment used in 5G Internet communications systems.
- A Class 4 Power System is a fault-managed system that relies on a continuous electronic handshake to ensure proper operation.
- Faults in Class 4 Power Systems result in immediate termination of output power.

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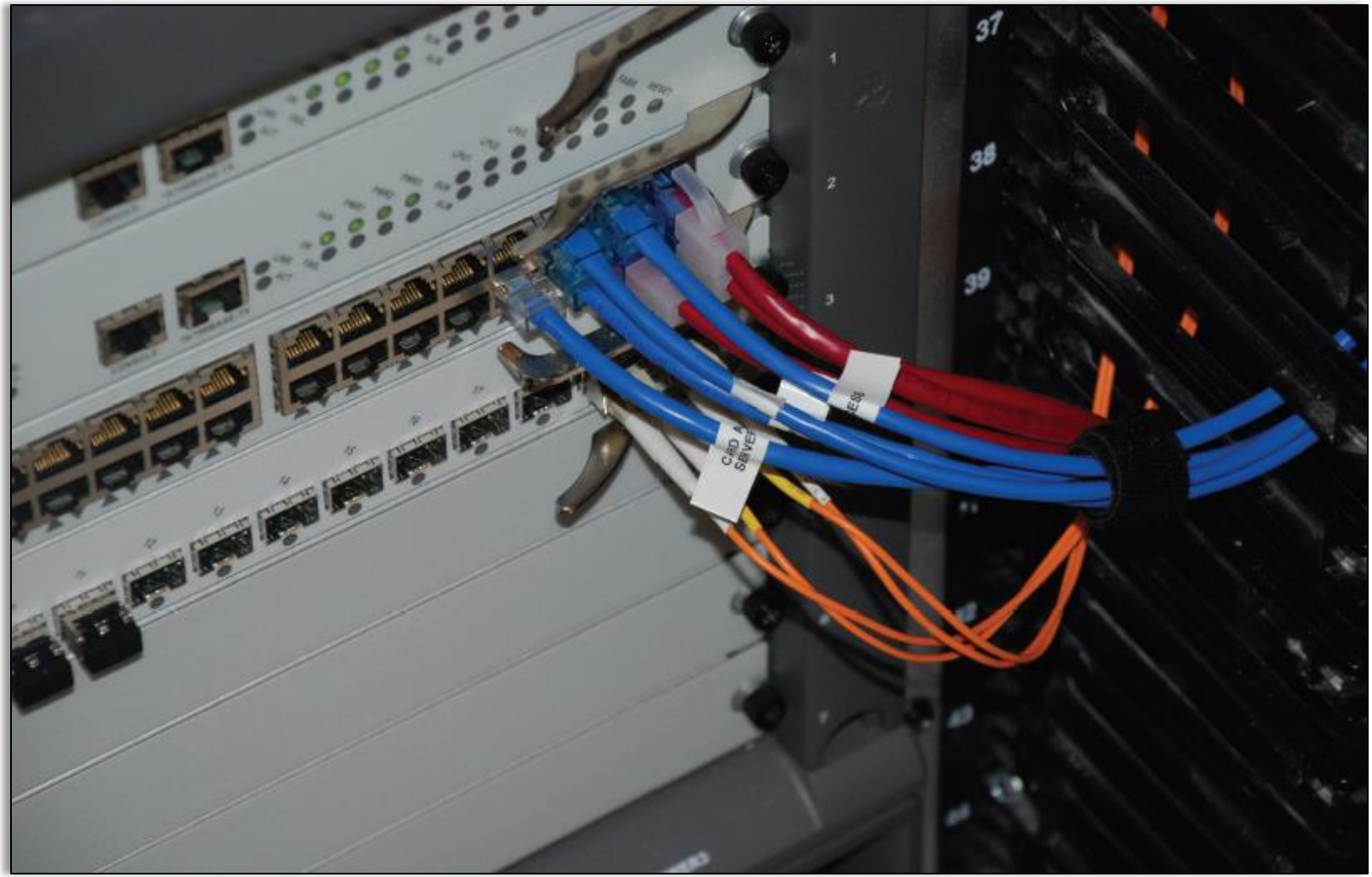
Article 100

NEW



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Courtesy of Michael J. Johnston

Article 100

NEW

Definition of Clothes Closet Storage Space

Change Summary

- A new simplified definition for clothes closet storage space has been added to Article 100.
- A clothes closet storage space is the area within a clothes closet in which combustible materials may be kept.
- The requirements for installation of luminaires remains in 410.16.

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Article 100

NEW

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Article 100

REVISION

Definition of Commissioning

Change Summary

- Revised definition to provide consistency in a commissioning process.
- Commissioning was previously covered only in Article 708, Critical Operations Power Systems.
- New commissioning requirements are found in 700.3, 701.3, and 706.7.
- Commissioning documentation should include as-built drawings and test results.

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Article 100

REVISION

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Courtesy of PDE Total Energy Solutions

Article 100

REVISION

Definition of Corrosive Environment

Change Summary

- Pool chemicals can cause corrosion of electrical equipment.
- Corrosive locations are those where pool sanitizing chemicals are present, and there is inadequate ventilation.
- Reference to *NFPA 400* was removed because it was not helpful for pool electrical equipment installers.
- The reference to the EPA website was removed, as a direct reference to the appropriate publications is more helpful.

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Article 100

REVISION

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Article 100

NEW

Definition of Counter (Countertop)

Change Summary

- A new definition was added for “counter (countertop)” to distinguish it from other work surfaces.
- An informational note reference was added for UL standards for receptacles and attachment plugs and GFCI devices.
- A second informational note references requirements for receptacles in countertops and work surfaces.

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Article 100

NEW

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Article 100

NEW

Definition of Energized, Likely to Become

Change Summary

- There is a new definition of the term *likely to become energized*.
- The term is used in 25 places in the 2020 *NEC*.
- *Likely to become energized* has been on a list of standard terms used in the *NEC Style Manual*, where it meant “failure of insulation on.” The new definition adds electrical spacing failure as an additional consideration.

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Article 100

NEW

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Courtesy of Michael J. Johnston

Article 100

REVISION

Definitions of Equipotential Plane

Change Summary

- There are now two definitions in Article 100 for Equipotential plane.
- The general definition is “Conductive elements that are connected together to minimize the voltage differences.” This definition is not limited to a single article.
- The second definition applies to natural and man-made bodies of water. This definition applies only to Article 682.

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Article 100

REVISION

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Article 100

NEW

Definition of Fault Managed Power

Change Summary

- Fault-managed power is one of the key definitions for new Article 726. Class 4 power systems are fault-managed power systems.
- Class 4 power systems provide a pulsed power output that relies on a continuous handshake to provide fault detection and ensure proper operation.
- Class 4 power systems can supply up to 450 volts dc line-to-line or 225 volts dc to ground to provide power and control of electronic equipment.

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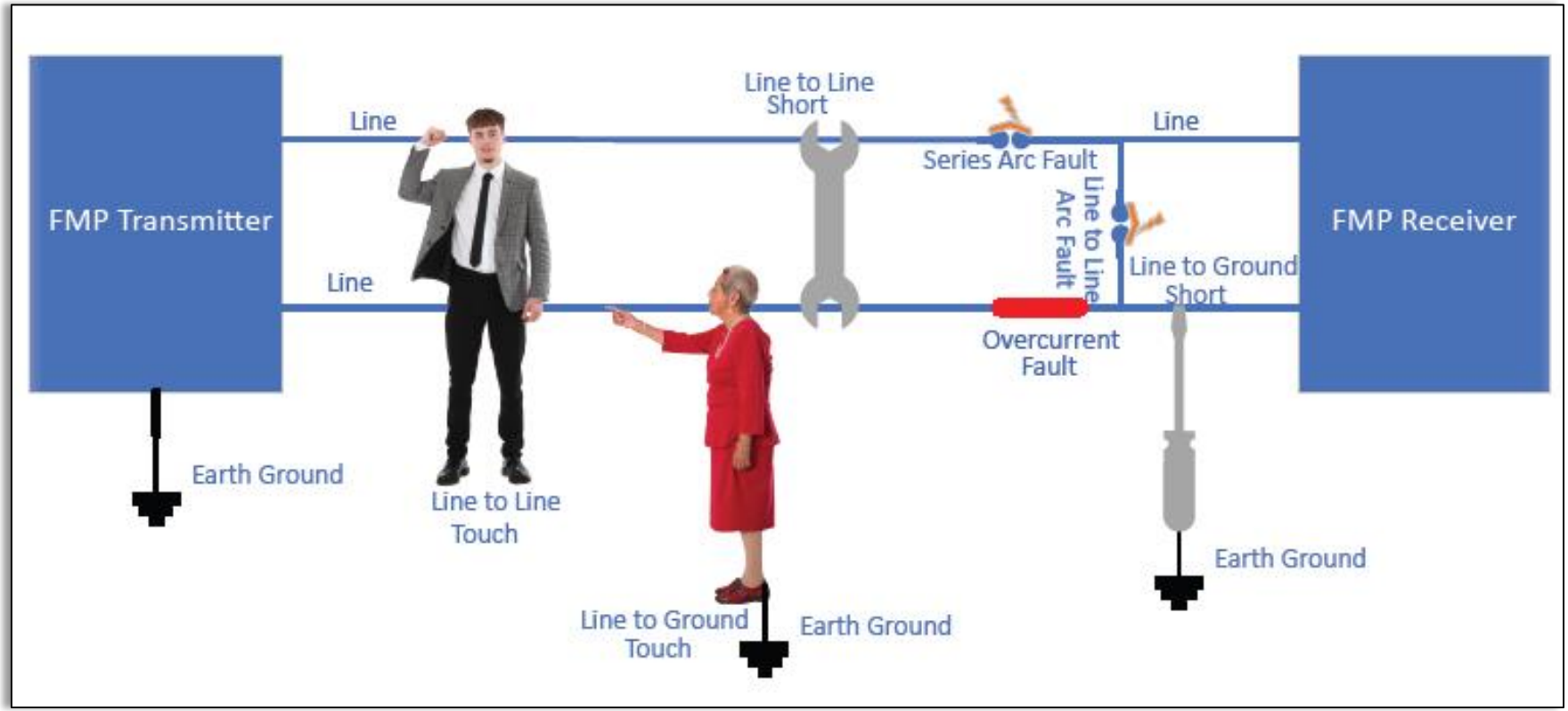
Article 100

NEW



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Courtesy of Cisco

Article 100

NEW

Definition of Fibers/Flyings, Combustible

Change Summary

- A new definition was added for combustible fibers/flyings.
- Combustible fibers/flyings consist of solid particles greater than 500 µm in size that can form an explosible mixture when suspended in air at standard atmospheric pressure and temperature.
- In contrast, combustible dusts consist of solid particles that are 500 µm or smaller that can form an explosible mixture.

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Article 100

NEW

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Article 100

NEW

Definition of GFCI, Special Purpose

Change Summary

- A new definition was added for Special Purpose Ground-Fault Circuit-Interrupter.
- SPGFCIs are used on circuits with voltage greater than 150 volts to ground.
- Traditional GFCIs are also known as Class A GFCIs. Special purpose GFCIs are either Class C, D, or E GFCIs.

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Article 100

NEW

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Article 100

NEW

Definition of Ground-Fault Detector-Interrupter

Change Summary

- GFDI protection is designed to provide ground-fault protection of photovoltaic dc circuits.
- As noted in 690.41(B), equipment that does not have ground-fault protection will often have a warning in the manual that indicates that the unit does not have a GFDI device.
- GFDIs are equipment protection, not personnel protection.

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Article 100

NEW

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Article 100

NEW

Definition of Industrial Installation, Supervised

Change Summary

- The term *Supervised Industrial Installation* is used in Articles 240 and 702, but it has been undefined until now.
- Industrial installations typically have a relaxation of some rules of the *Code*, as industrial installations are usually designed, installed, monitored, and maintained by qualified personnel.
- The definition was initially developed by CMP 10 and was revised by a task group including CMPs 1, 10, and 14; it remains limited to Article 240.

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Article 100

NEW

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Article 100

REVISION

Definition of Inverter, Multimode

Change Summary

- Multimode inverters can operate in both interactive mode and island mode.
- In the interactive mode, an inverter operates in parallel with the utility and can supply power back to the utility.
- In the island mode, it will separate from the utility to supply power to the premises through an energy storage system.

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Article 100

REVISION

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Article 100

REVISION

Definition of Location, Wet

Change Summary

- The definition of “wet location” has been rewritten into a list format.
- The previous format consisted of a sentence with commas, which made it more difficult to interpret.
- An informational note was added that gives an example of a wet location.
- The definitions of damp location and dry location were much shorter and clearer, so no changes to them were necessary.

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Article 100

REVISION

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Article 100

NEW

Definition of Locations, Hazardous (Classified)

Change Summary

- A new general definition has been added for Hazardous (Classified) Locations.
- Article 500 defines Classes I, II, and III, as well as the divisions and groups.
- Article 505 provides the classification system for gases, vapors, and liquids using the IEC Zone system.
- Article 506 provides the classification system for dusts and combustible fibers and flyings using the IEC Zone System.
- IEC uses the same zone system for dusts that is uses for fibers and flyings.

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Article 100

NEW

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Article 100

NEW

Definition of Microgrid, Health Care

Change Summary

- A health care microgrid is now permitted to be used as the normal power source.
- If a health care microgrid is used as the normal source, it is not permitted to be used as the alternate source.
- Essential electrical systems are permitted to be supplied by a health care microgrid that also supplies non-essential loads.
- Note the nomenclature at the end of the definition that indicates that the source of this definition is *NFPA 99*, the *Health Care Facilities Code.*

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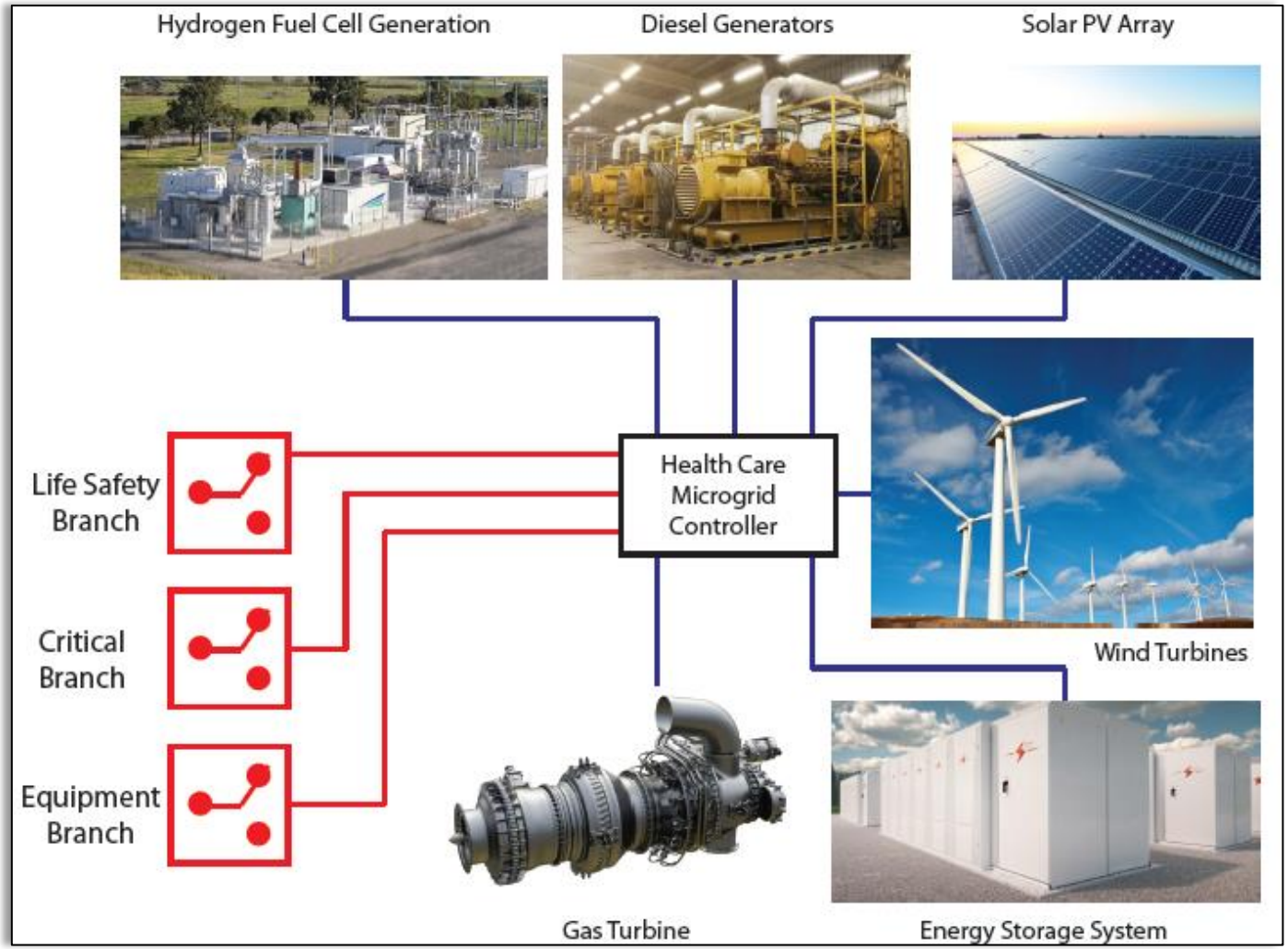
Article 100

NEW



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Article 100

NEW

Definitions of Panelboard and Panelboard, Enclosed

Change Summary

- The definition of “panelboard” was revised to recognize panelboards that are installed in an enclosure other than a cabinet or cutout box.
- A new definition was added for an “enclosed panelboard,” which is installed in a cabinet, cutout box, or enclosure suitable for a panelboard application.
- Sections 110.16(A) and 110.26(D) are among the requirements that apply to enclosed panelboards.

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Article 100

NEW

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Article 100

NEW

Definition of Receptacle, Weight-Supporting Ceiling

Change Summary

- This is a new definition of a receptacle that was introduced in the 2017 *Code*.
- Weight-supporting ceiling receptacles (WSCR) are contact devices that are designed to mate with a weight-supporting attachment fitting (WSAF) to make an electrical connection and to support the weight of luminaires or paddle fans.
- A WSCR that is listed for fan support can also support luminaires without fans, while a WSCR that is listed for luminaire support will reject a paddle fan.

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Article 100

NEW

847

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Courtesy of SKYX Platforms

Article 100

NEW

Definition of Servicing

Change Summary

- “Servicing” is defined as: The process of following a manufacturer’s set of instructions or applicable industry standards to analyze, adjust, or perform prescribed actions upon equipment with the intention to preserve or restore the operational performance of the equipment.
- “Reconditioned” is defined as: Electromechanical systems, equipment, apparatus, or components that are restored to operating conditions. This process differs from normal servicing of equipment that remains within a facility, or replacement of listed equipment on a one-to-one basis.
- The informational note points out that servicing includes maintenance and repair.

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Article 100

NEW

849

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Courtesy of Michael J. Johnston

Article 100

NEW

Definition of Stranding (Compact and Compressed)

Change Summary

- New stranding definitions have been provided.
- Compact stranding: each layer is pressed together to minimize gaps between strands, reducing the overall diameter.
- Compressed stranding: conductors are pressed together, result is an overall diameter that is less than a concentric stranded conductor but greater than a compact stranded conductor.

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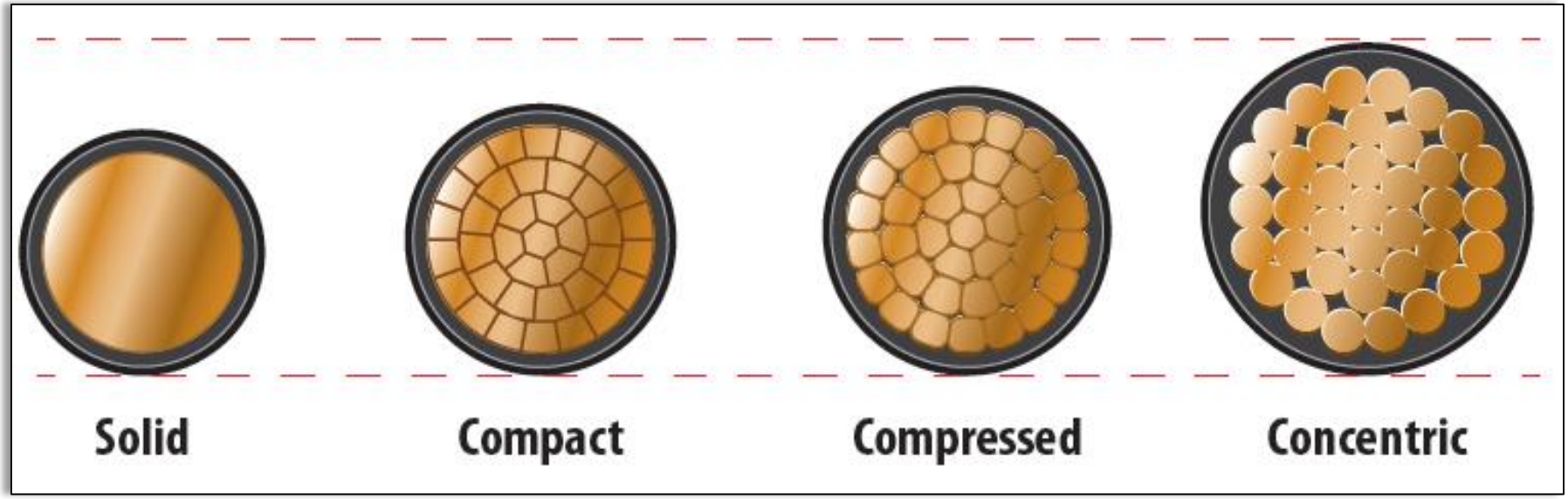
Article 100

NEW



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Article 100

REVISION

Definition of Type P Cable

Change Summary

- Type P Cable has been used on drilling rigs for four decades.
- Type P Cable is limited to industrial locations where maintenance and supervision ensure that qualified personnel monitor and service the installation.
- Type P Cable is permitted in hazardous locations, where permitted in the article covering the location.

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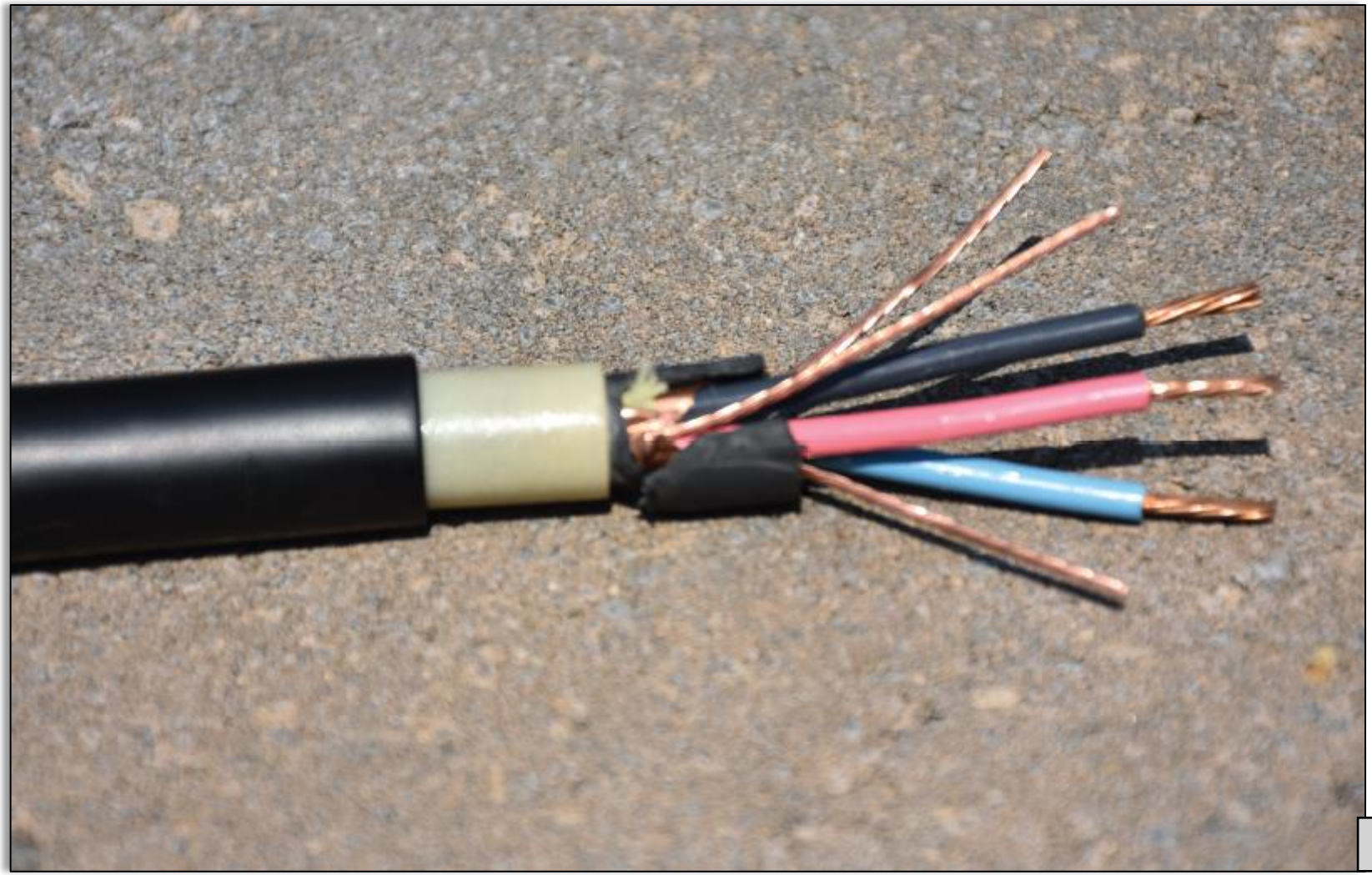
Article 100

REVISION



853

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110.3(A)

REVISION

Examination

Change Summary

- Cyber attacks on network connected electronic equipment are an increasing threat.
- Section 110.3(A)(8) now requires the evaluation of cyber security for network-connected life-safety equipment.
- An informational note was added that references standards for including the IEC 62443 series of standards on Industrial Automation and Control Systems and UL standards on cyber security, including UL 2900 and UL 5500.

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110.3(A)

REVISION

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110.3(B)

NEW

Installation and Use

Change Summary

- Listed or labeled equipment is required to be installed and used in accordance with any instructions included in the listing or labeling. The same now applies to equipment that is identified for a use.
- Installation instructions are often misplaced after installation. This informational note points out that QR codes on products or information on manufacturer websites can provide installation instructions.
- Online product information is often easier to access after the product is installed.

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110.3(B)

NEW

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110.8

REVISION

Wiring Methods

Change Summary

- Section 90.2(C) indicates that if the installation is covered by the *Code*, the wiring methods recognized by the *Code* are permitted to be installed in any building, occupancy, or premises wiring system.
- The definition of premises wiring in Article 100 includes interior and exterior wiring and associated hardware.
- Premises wiring does not include the internal wiring of appliances, luminaires, motor controllers, motor control centers, and similar equipment.

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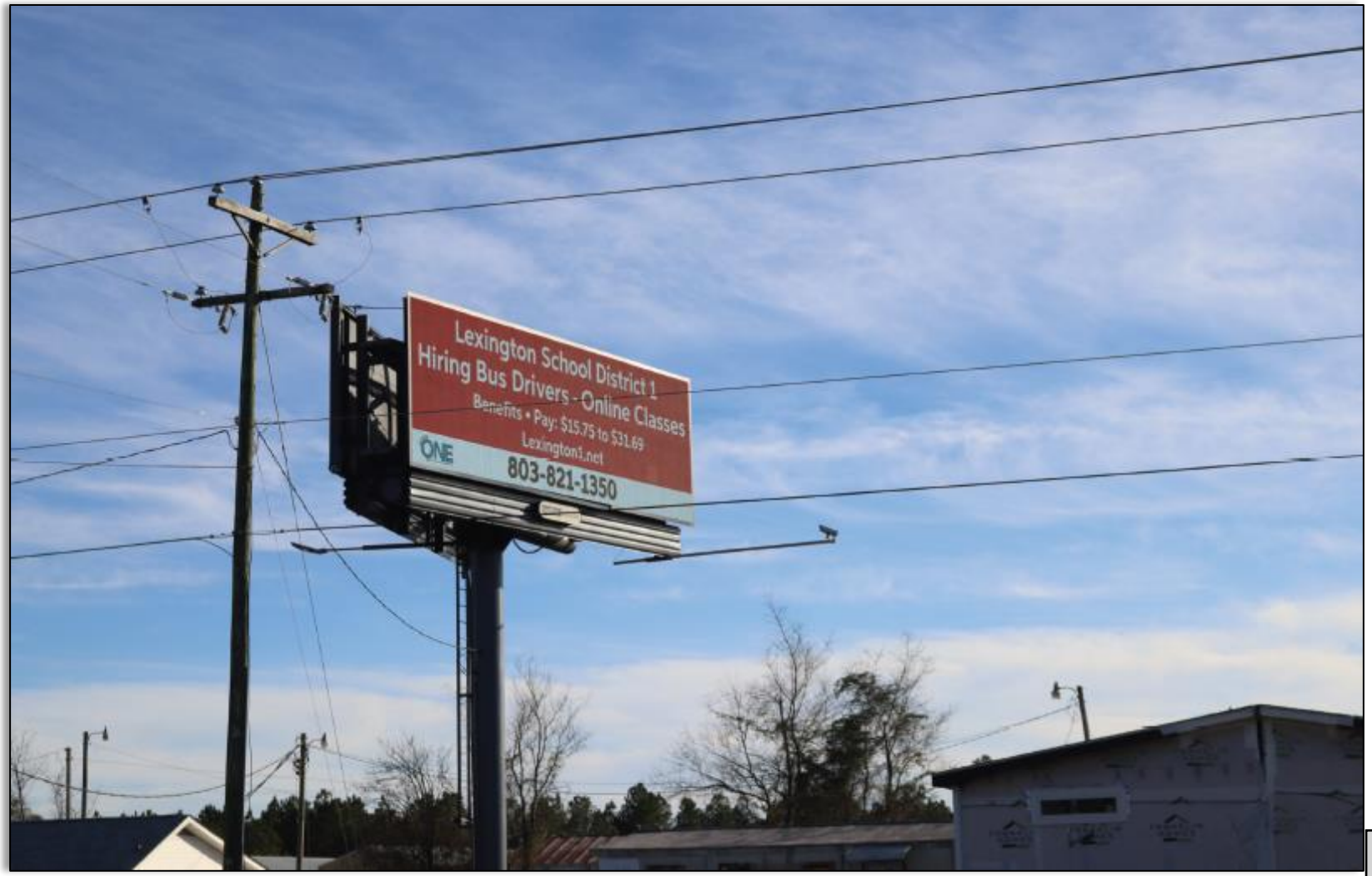
110.8

REVISION



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110.12

REVISION

Mechanical Execution of Work

Change Summary

- The terms *neat* and *workmanlike* were replaced with *professional* and *skillful*.
- This editorial change uses more descriptive and gender-neutral terms.
- The informational note change is simply editorial.
- Informational Note No. 1 to 110.12(C) was deleted because this section applies to cables and conductors; it does not apply to fiber optic cables.

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110.12

REVISION

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110.14(A)

REVISION

Terminals

Change Summary

- The requirement that terminal connections be “thoroughly good” has been replaced with the term *mechanically secure* to replace vague and unenforceable terminology.
- The text was revised to clarify that terminal connections must provide a good electrical connection.
- Requirements for connection methods for certain equipment, such as receptacles (covered by CMP 18), are the responsibility of the panel that covers that equipment.

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110.14(A)

REVISION

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110.16(B)

REVISION

Service Equipment and Feeder Equipment

Change Summary

- Section 110.16(B) is expanded to apply to feeder supplied equipment, as well as service equipment.
- The requirement has been modified to make it clear that the required label is an arc flash warning label.
- The threshold for a required label has been lowered from 1,200 amperes to 1,000 amperes.
- The requirements for the content of the label have been deleted because they are included in 110.21(B).

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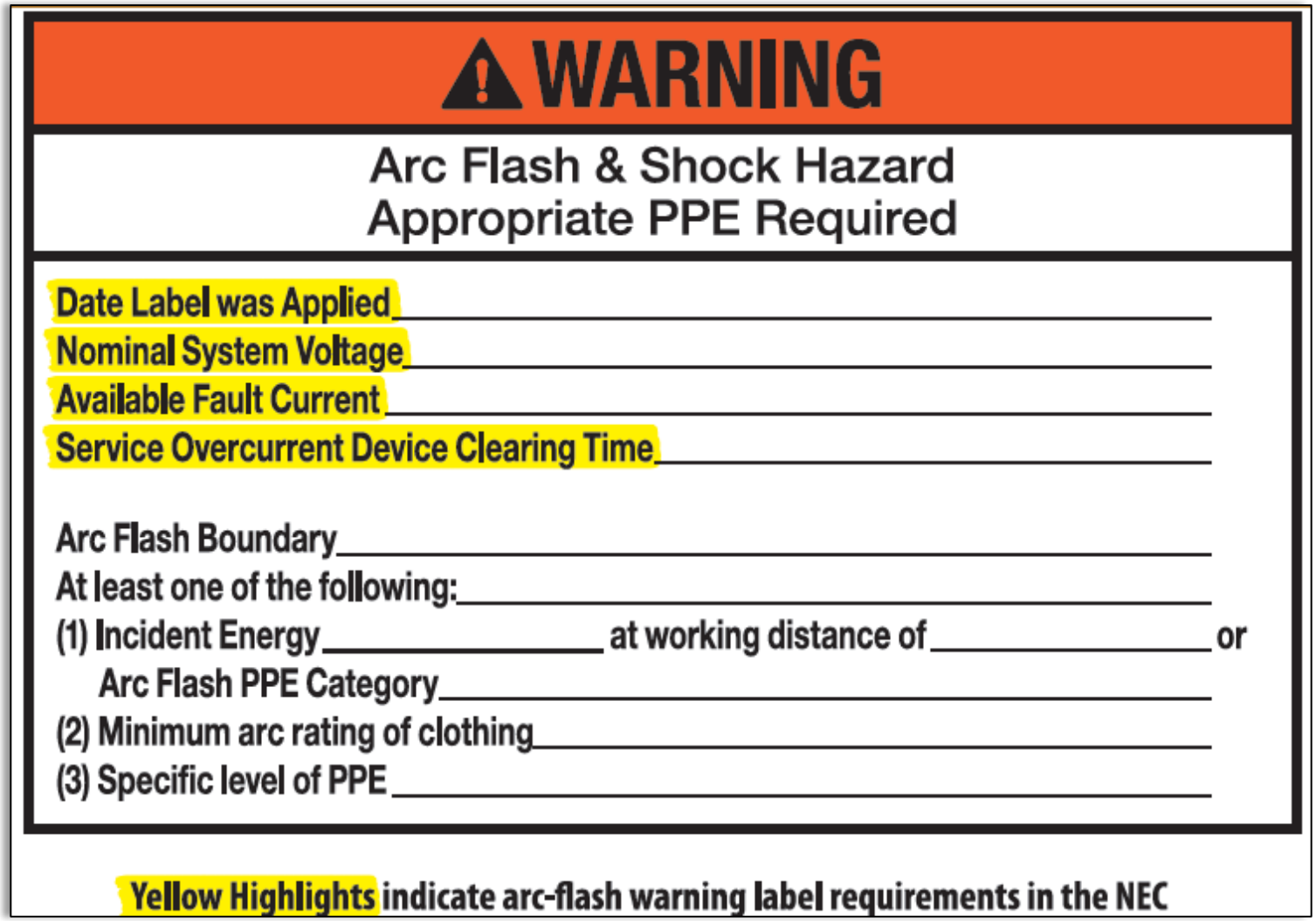
110.16(B)

REVISION



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110.17

NEW

Servicing and Maintenance of Equipment

Change Summary

- This addition is significant because in addition to requiring a *qualified person* (a defined term), the individual must be a qualified person trained in servicing and maintenance of equipment.
- Servicing and maintenance must be performed in accordance with the manufacturer's instructions and applicable industry standards or as approved by the AHJ.
- Identified replacement parts must be verified under applicable product standards.

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110.17

NEW

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Courtesy of Burlington Electrical Testing

110.20

NEW

Reconditioned Equipment

Change Summary

- Equipment is generally permitted to be reconditioned, unless prohibited elsewhere in the *Code*.
- Requirements are provided for parts and sources of information.
- If listing is required, the equipment must be listed or field-labeled as reconditioned.
- If listing is not required, it must be listed or field-labeled as reconditioned or reconditioned in accordance with the manufacturer's instructions.

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110.20

NEW

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110.21(A)

REVISION

Reconditioned Equipment, Marking Requirements

Change Summary

- The marking requirements for reconditioned equipment have been reorganized into list format.
- The original listing mark must be removed or made permanently illegible.
- The original equipment nameplate can remain, but the listing mark must be removed.
- The exception for industrial facilities still applies.

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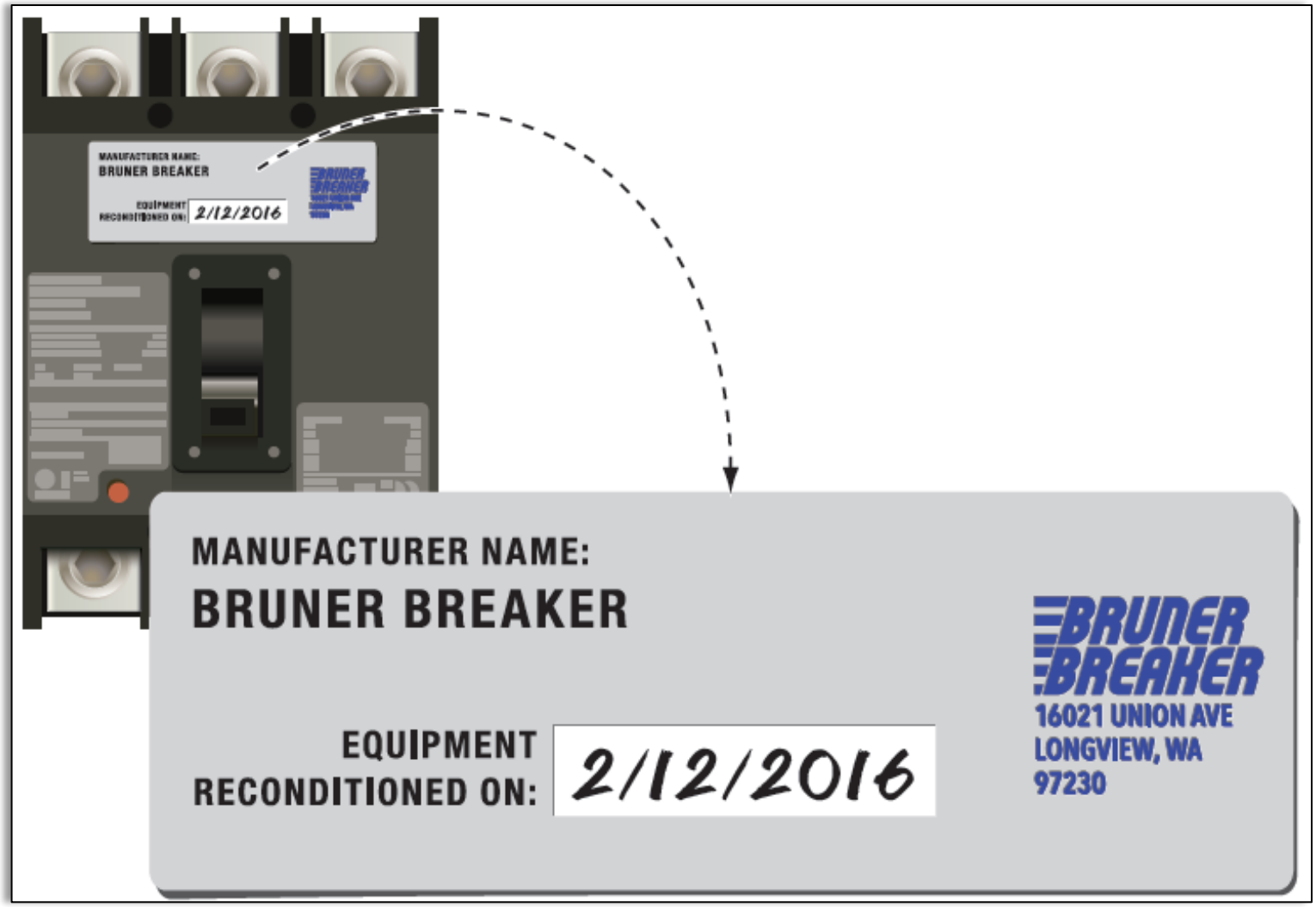
110.21(A)

REVISION



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110.22(A)

REVISION

Identification of Disconnecting Means, General

Change Summary

- Disconnecting means are required to be legibly marked to indicate their purpose, unless located and arranged to make the purpose evident.
- The marking must include the identification and location of the circuit source that supplies the disconnecting means, unless located and arranged to make the identification of the circuit source evident.
- This change is intended to make it easier for service personnel to quickly locate the power source. This is especially important in large and high-rise buildings.

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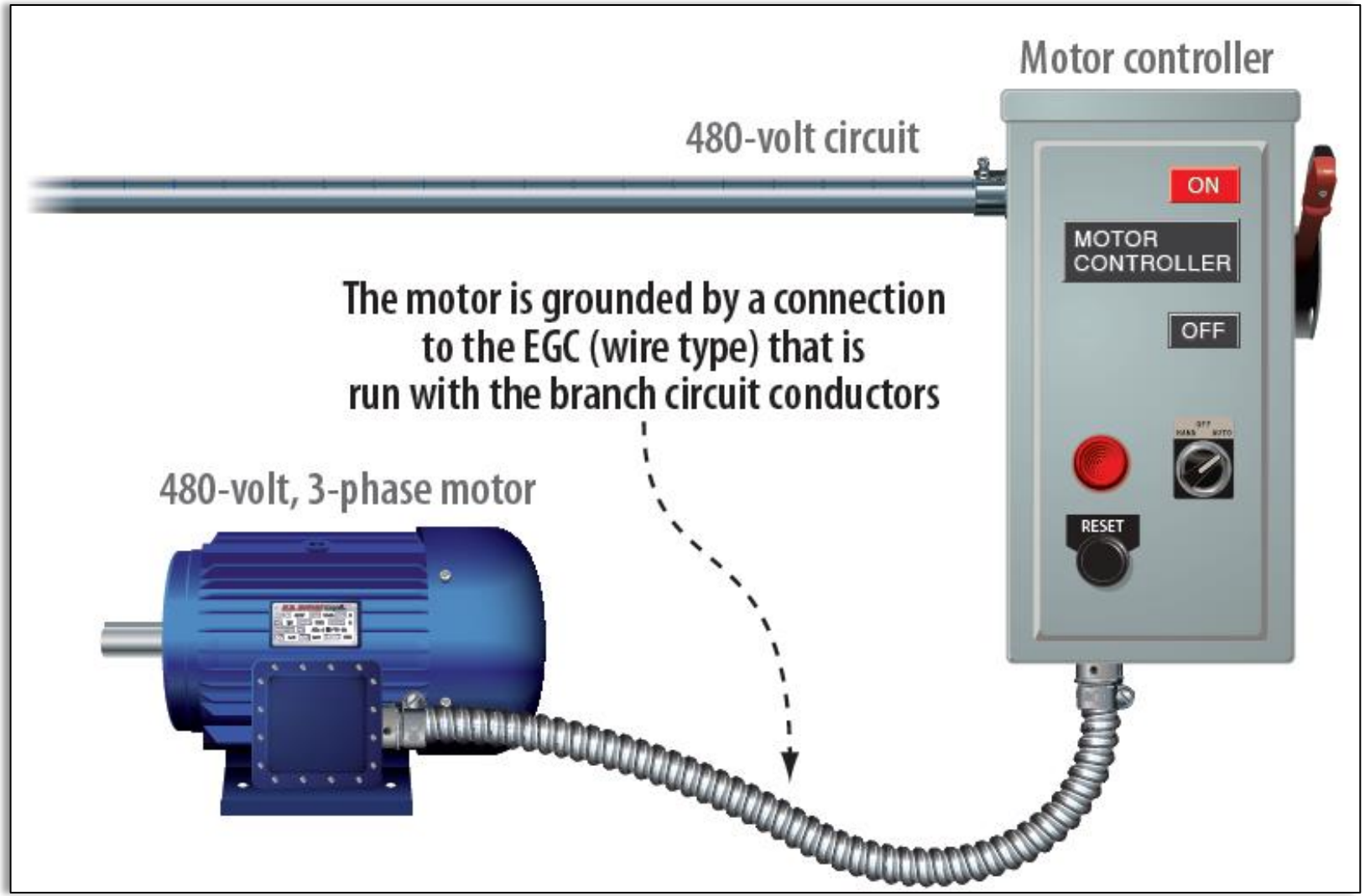
110.22(A)

REVISION



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110.26

REORGANIZE

Depth and Width of Working Space

Change Summary

- The requirement that open equipment doors must not impede entry or egress to the working space was relocated from 110.26(C)(2) to 110.26.
- Relocation of the open equipment door requirement to 110.26 means that it now applies to all equipment, not just large equipment.
- Access or egress is impeded if one or more simultaneously-opened equipment doors restricts access to less than 24 inches wide or 6 ½ feet high.

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110.26

REORGANIZE

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110.26(A)(4)

REVISION

Limited Workspace Requirements

Change Summary

- The limited access workspace requirements were modified to provide requirements for workspaces in front of duct heaters installed above partitions.
- The workspace must be unobstructed to the floor by fixed cabinets, walls, or partitions.
- A horizontal ceiling structural member or access panel is permitted in the space if the location of weight-bearing structural members does not result in a side reach of more than 6 inches to work inside the enclosure.

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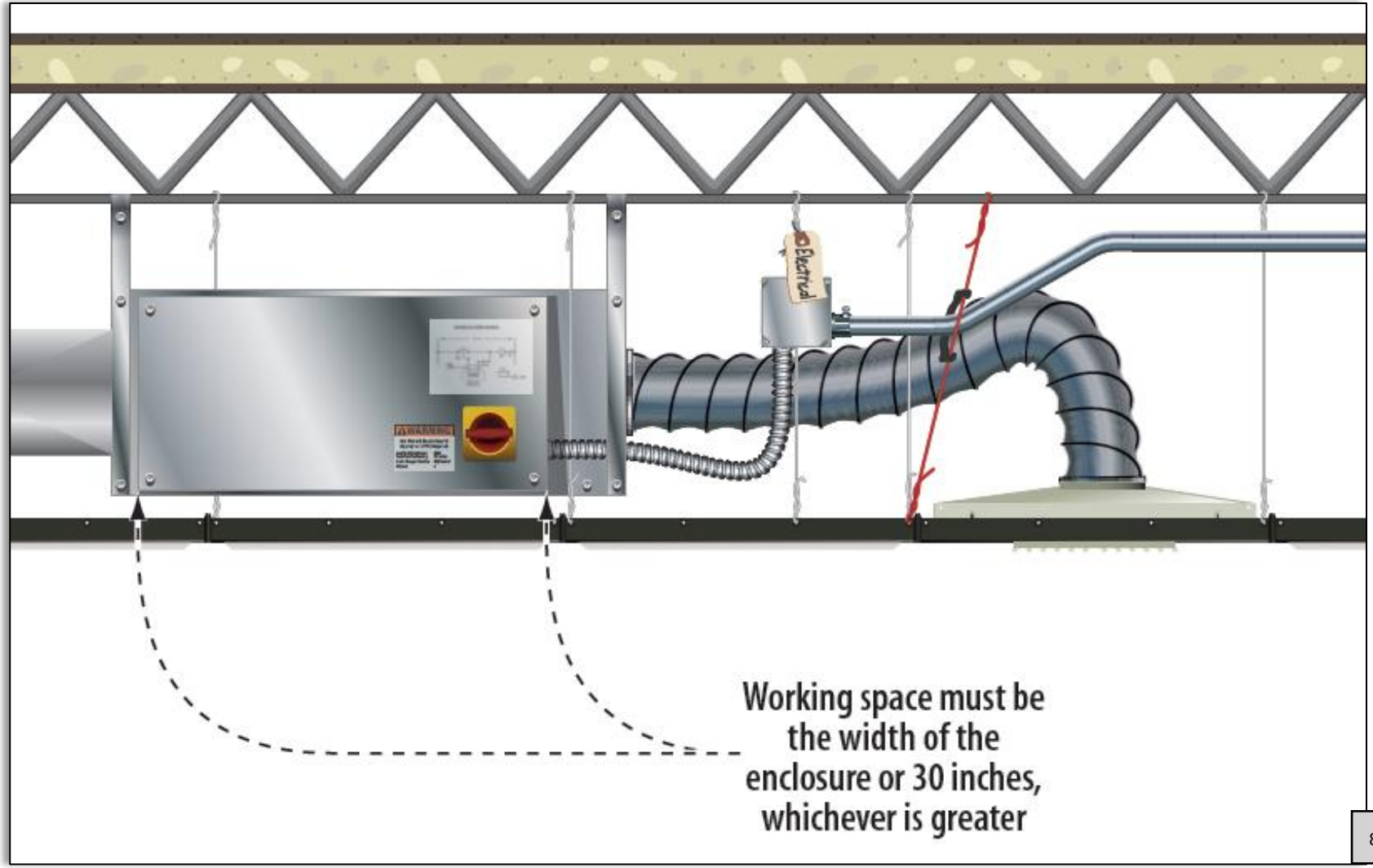
110.26(A)(4)

REVISION



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110.26(A)(6)

NEW

Grade, Floor, or Working Platform

Change Summary

- Section 110.26 requires access and workspace around all electrical equipment to permit ready and safe operation and to permit maintenance.
- The grade, floor, or platform in the workspace must be clear of obstructions and tripping hazards.
- The grade, floor, or platform in the workspace must be as level and flat as possible.
- Similar requirements have been added to 110.34(A) for equipment operating over 1,000 volts.

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110.26(A)(6)

NEW

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110.26(E)

REVISION

Dedicated Equipment Space

Change Summary

- The requirement for dedicated equipment space in 110.26(E) has been expanded to include all service equipment rated 1,000 volts or less.
- The requirement will now include service equipment for one- and two-family dwellings, including the emergency disconnects now required in 230.85
- A service rated disconnect will now have the same equipment space requirements as service rated switchgear and service rated panelboards for 1,000 volts or less.

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110.26(E)

REVISION

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Table 110.28

REVISION

Table 110.28 Enclosure Types, Informational Notes

Change Summary

- Informational Note No. 3 was revised to add a reference to 502.10(A)(2) for Class II, Division 1 locations.
- Informational Note No. 5 notes that some Type 4X enclosures are marked “for indoor use only.”
- Informational Note No. 6 notes that some Type 4, 4X, and 12 enclosures are ventilated, but still provide the required ingress protection.
- Informational Note No. 7 references the NEMA Standard for enclosure type ratings.

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Table 110.28

REVISION

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Courtesy of Michael J. Johnston

110.29

NEW

In Sight From (Within Sight From, Within Sight)

Change Summary

- A new requirement has been added that establishes that “in sight from” means that the equipment must be visible and not more than 50 feet from the other equipment.
- This requirement was created to comply with the *NEC Style Manual*.
- Definitions are not permitted to contain requirements. The establishment of limits constitutes a requirement.
- The definition with the requirement still exists.

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110.29

NEW

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110.31(A)(4)

REVISION

Locks, Personnel Doors

Change Summary

- Personnel doors for electrical vaults containing equipment rated over 1,000 volts are now required to open at least 90 degrees. These doors are required to be equipped with listed panic hardware or listed fire exit hardware.
- There is a similar requirement in 110.26(C)(3) for equipment rated 1,000 volts and less.
- An informational note was added to reference two UL Standards: UL 305, Standard for Panic Hardware; and UL 10C, Standard for Safety for Positive Pressure Fire Tests of Door Assemblies.

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110.31(A)(4)

REVISION

887

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Significant Changes

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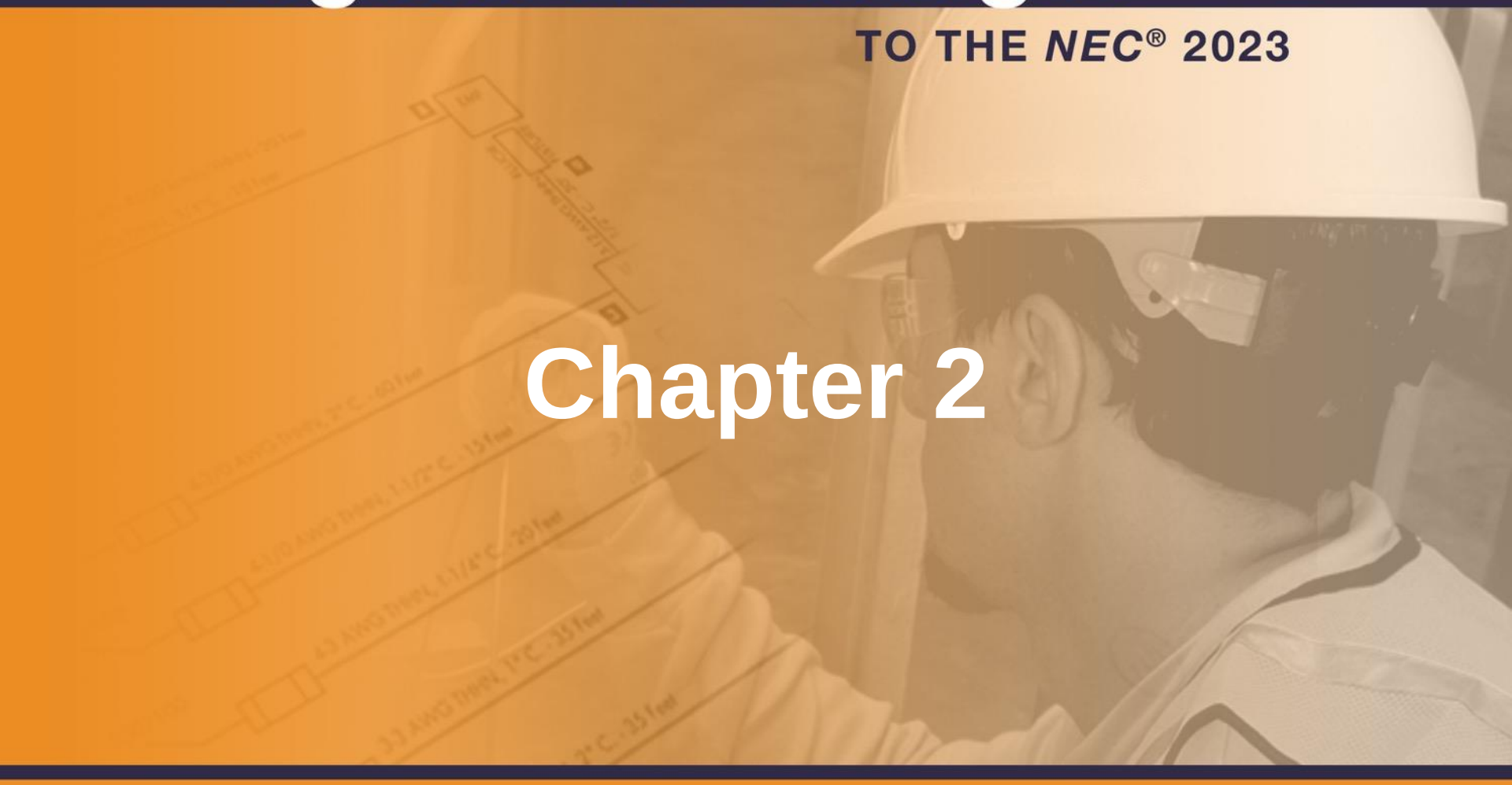

Chapter 2

electrical training ALLIANCE IBEW - NECA IN COLLABORATION WITH NECA NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION

200.2(A)

REVISION

General

Change Summary

- This section was revised to correlate with the change in 250.36.
- “High-impedance grounded systems” are now referred to as “impedance grounded systems.”
- The grounded system conductor of impedance grounded systems is now referred to as the “impedance grounded conductor.” This section does not apply to the impedance grounded conductor.
- This section was changed from paragraph to list format.

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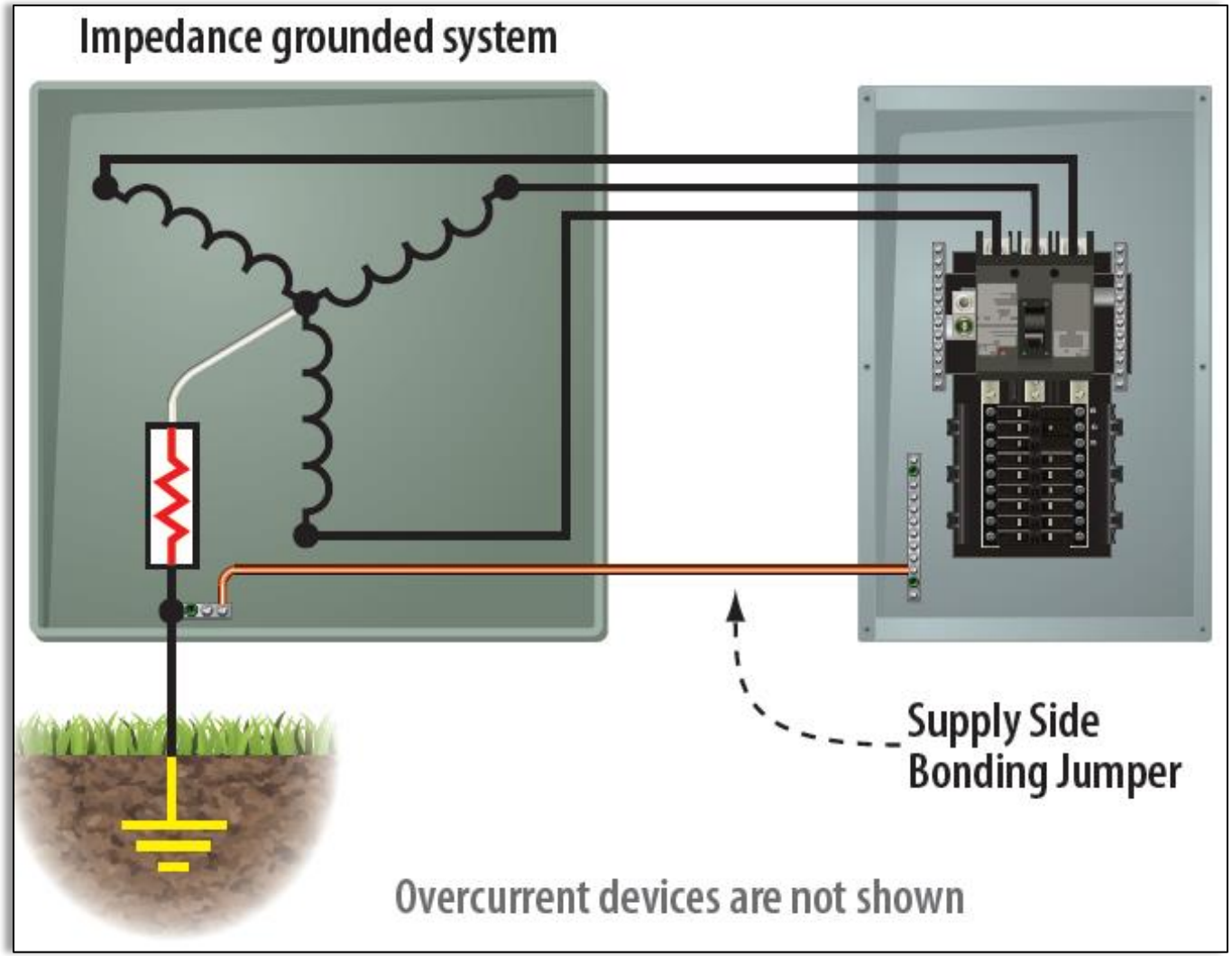
200.2(A)

REVISION



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210.6(D) & (E)

REVISION RELOCATE

Branch Circuit Voltage Limitations

Change Summary

- The voltage limit in Section 210.6(D) was increased from 600 volts between conductors to 1,000 volts between conductors for consistency with other voltage limitations across the *Code*.
- The section has also been revised to reference a limit of 1,500 volts dc between conductors.
- Section 210.6(E) has been deleted.
- A new Article 235 has been created that will contain requirements for medium and high-voltage branch circuits, feeders, and services.

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210.6(D) & (E)

REVISION RELOCATE

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210.8

REVISION

GFCI Protection for Personnel

Change Summary

- The term *ground-fault circuit-interrupter protection for personnel* in the first sentence is replaced with the term *listed Class A GFCI*.
- Elsewhere in the section, the acronym GFCI is used to comply with the *NEC Style Manual*, which requires the use of acronyms where practical.
- The definition of “Ground-fault Circuit Interrupter (GFCI)” in Article 100 makes it clear that the term is used to describe a device that is intended to protect personnel. The informational note makes it clear that the device referred to is a Class A GFCI.

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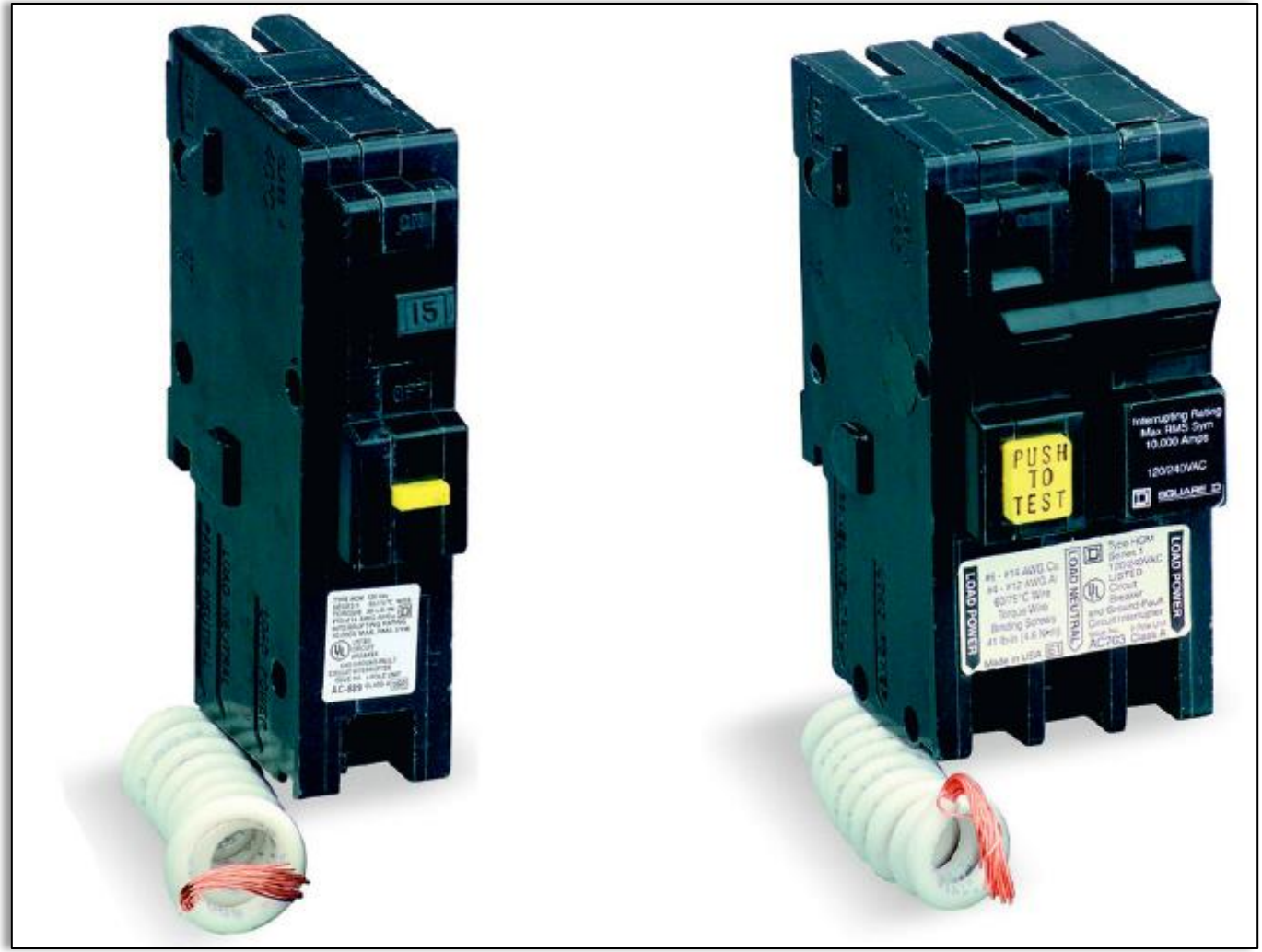
210.8

REVISION



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Courtesy of Schneider Electric

210.8(A)

REVISION

Dwelling Units

Change Summary

- The reference to fire alarm systems in an informational note to list item (5) has been deleted because it is covered in Article 760.
- GFCI requirements for kitchens now apply to all kitchen receptacles.
- GFCI requirements apply to any area of a dwelling unit with permanent provisions for food preparation, drink preparation, or cooking.
- Receptacles in bathroom exhaust fan assemblies that are not readily accessible do not require GFCI protection.

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210.8(A)

REVISION

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210.8(B)

REVISION

Other Than Dwelling Units

Change Summary

- The GFCI requirements for other than dwelling units have been revised and clarified.
- List items (3) through (5) have been revised to clarify GFCI requirement for kitchens, food and beverage preparation and food serving areas, and any other preparation or food/beverage serving area where there is also cooking.
- A new requirement for GFCI protection of cord-and plug-connected fixed or stationary appliances has been added.
- A new GFCI requirement for receptacles within 6 feet of aquariums, bait wells, and similar open aquatic vessels or containers has been added.

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210.8(B)

REVISION

© 2022 *electrical training ALLIANCE*

210.8(D)

REVISION

GFCI Protection for Personnel-Specific Appliances

Change Summary

- In the 2020 *Code*, the determination of which appliances required GFCI protection was assigned to CMP 17, who placed them in 422.5.
- Section 422.5(A) specified several appliances that require GFCI protection. They could be protected via a branch circuit device, or they could be protected by a device in the cord.
- This section contained convoluted cross references to 422.5(A) for the list of appliances and 422.5(B) for the protection method.
- This revision brings back the list of appliances to 210.8, and it now requires GFCI protection of the branch circuit or the outlet.

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210.8(D)

REVISION

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210.8(F)

REVISION

GFCI Protection for Personnel-Outdoor Outlets

Change Summary

- The requirements of 210.8(F) have been revised to indicate that it applies to all outdoor outlets other than those covered by 210.8(A), Exception No. 1, rated 150 volts or less to ground, and 50 amperes or less.
- A list of four locations has been added to clarify which locations are included.
- If equipment supplied by one of the specified outlets is replaced, the outlet will now be required to be GFCI protected.
- Exception No. 2 does not require GFCI protection for listed HVAC equipment installed prior to September 1, 2026.

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210.8(F)

REVISION

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210.11(C)(4)

REVISION

Garage Branch Circuits

Change Summary

- Section 210.11(C)(4) was revised to clarify that garages must be supplied by at least one 20-ampere branch circuit for each vehicle bay. The circuits are NOT permitted to supply other garage receptacles.
- In a single-vehicle bay garage, the circuit is permitted to supply other outlets.
- The 20-ampere branch circuit was previously permitted to supply only readily accessible outdoor receptacle outlets. Exception No. 1 was revised to permit it to supply outdoor receptacle outlets.
- Additional branch circuits rated 15 amperes are permitted to supply other receptacle outlets.

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210.11(C)(4)

REVISION

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210.12

REVISION

Arc-Fault Circuit-Interrupter Protection

Change Summary

- The main rule of 210.12 was rewritten to align with changes made to the subsections of 210.12, including a new requirement that all AFCIs be listed.
- The title of 210.12(A) was changed to “means of protection.” Information regarding the specific areas of the dwelling unit requiring AFCI protection has been moved into 210.12(B).
- Section 210.12(B), (C), and (D) have been changed into lists.
- Section 210.12(D)(3) has been added to require AFCI protection of 120-volt, single-phase 15- and 20-ampere branch circuits in areas designed exclusively for sleeping in fire stations, stations for rescue squads, and police stations.

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210.12

REVISION

© 2022 *electrical training ALLIANCE*

210.18

REVISION

Rating

Change Summary

- Section 210.18 now recognizes 10-ampere individual branch circuits.
- Exception No. 1 has been revised to permit individual branch circuits greater than 50 amperes that supply non-lighting loads in locations with conditions of maintenance to ensure that only qualified persons service the installations. This had previously been limited to industrial locations.
- A new Exception No. 2 was added that prohibits 10-ampere branch circuits from serving receptacle outlets.

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210.18

REVISION

© 2022 *electrical training ALLIANCE*

210.19

REVISION RELOCATE

Conductors – Minimum Ampacity and Size

Change Summary

- New branch circuit voltage limits have been added for ac and dc circuits.
- Section 210.19 now applies to branch circuits not exceeding 1,000 volts ac and 1,500 volts dc.
- The requirements for branch circuits exceeding 1,000 volts ac and 1,500 volts dc have been removed from this section and relocated to Article 235.
- There are several minor editorial changes to comply with the *NEC Style Manual*.

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210.19

REVISION RELOCATE

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Courtesy of Bill McGovern, City of Plano, TX

210.23

REVISION

Permissible Loads, Multiple-Outlet Branch Circuits

Change Summary

- New requirements have been added to 210.23(A) for 10-ampere branch circuits.
- This section contains an ascending list from the smallest sized branch circuit to the largest. Therefore, the 10-ampere branch circuits appear first.
- 210.23(A)(1) lists the types of loads that are permitted to be supplied by a 10-ampere branch circuit, while 210.23(A)(2) lists the loads that are not permitted to be supplied by a 10-ampere branch circuit.

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210.23

REVISION

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210.52(A)(2)

REVISION

Wall Space

Change Summary

- The criteria for what is considered wall space that requires receptacles in dwelling units has been revised.
- Since there are wall spaces where receptacle installation is impractical, Section 210.52(A)(2) spells out which spaces must be considered wall space for receptacles.
- The space behind stationary appliances has been added to 210.52(A)(2)(1) to indicate that the wall space behind stationary appliances need not be considered as wall space that requires receptacles.

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210.52(A)(2)

REVISION

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210.52(C)

REVISION

Countertops and Work Surfaces

Change Summary

- A new exception was added to 210.52(C)(1) for countertops with wall space where a receptacle cannot be installed in the required wall space to permit installation as near as practicable.
- Receptacles are no longer required in 210.52(C)(2) for island and peninsular counter tops. If not installed, provision is required for a future installation.
- Receptacles are permitted to be in or on but not below countertops.

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210.52(C)

REVISION

Courtesy of ABB Inc.

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210.70

REVISION

Lighting Outlets Required

Change Summary

- Section 210.70 has been revised to make it clear that switches of control devices are not permitted to rely only on battery power unless the lighting outlets are energized upon battery failure.
- A lighting outlet that is controlled by a listed wall-mounted control device is now required in laundry areas of dwelling units.
- A lighting outlet is required for exterior illumination of exits or entrances of dwelling units, attached garages, and detached garages with power. This does not apply to doors for vehicles.
- Dimmer control of lighting in accordance with 210.70(A)(3) is not permitted, unless the listed control devices can provide dimming control that can provide maximum brightness at each location for stairway illumination.

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210.70

REVISION

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215.15

NEW

Barriers

Change Summary

- The widespread acceptance of *NFPA 70E, Electrical Safety in the Workplace*, has brought attention to the need to prevent electrical hazards that can exist while trying to establish an electrically-safe work condition.
- In the 2020 *Code*, the requirements for barriers in panelboards, switchboards, and switchgear were relocated from 408.3(A)(2) to 230.62(C), where they only applied to services.
- A similar hazard exists for panelboards, switchboards, switchgear, and motor control centers that are supplied by feeders or transformer secondary conductors.

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215.15

NEW

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215.18

NEW

Surge Protection

Change Summary

- During the 2020 *Code* cycle, a new surge protection requirement was added for dwelling unit services in 230.67 (expanded for 2023).
- Surge protection is now required for feeders that supply dwelling units, dormitory units, guest rooms and guest suites of hotels and motels, and patient sleeping rooms of nursing homes and limited care facilities.
- The use of sensitive electronic equipment in these newly added areas, supplied by services, is identical to its usage in dwelling units.
- A similar requirement was adopted in 225.42 for outside feeders.

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215.18

NEW

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Article 220

REORGANIZE

Article 220 Reorganization

Change Summary

- Article 220 has been rewritten to improve its usability. This change covers the reorganization only.
- Requirements that were in 220.11 and 220.10 were moved from Part II, Branch-Circuit Load Calculations, to Part I, General.
- Section 220.12 was relocated to Part III because it addresses feeder and service load calculations.
- Sections 220.14(J), (K), and (M) were relocated to 220.41, 220.43, and 220.44, respectively, because they deal with loads.

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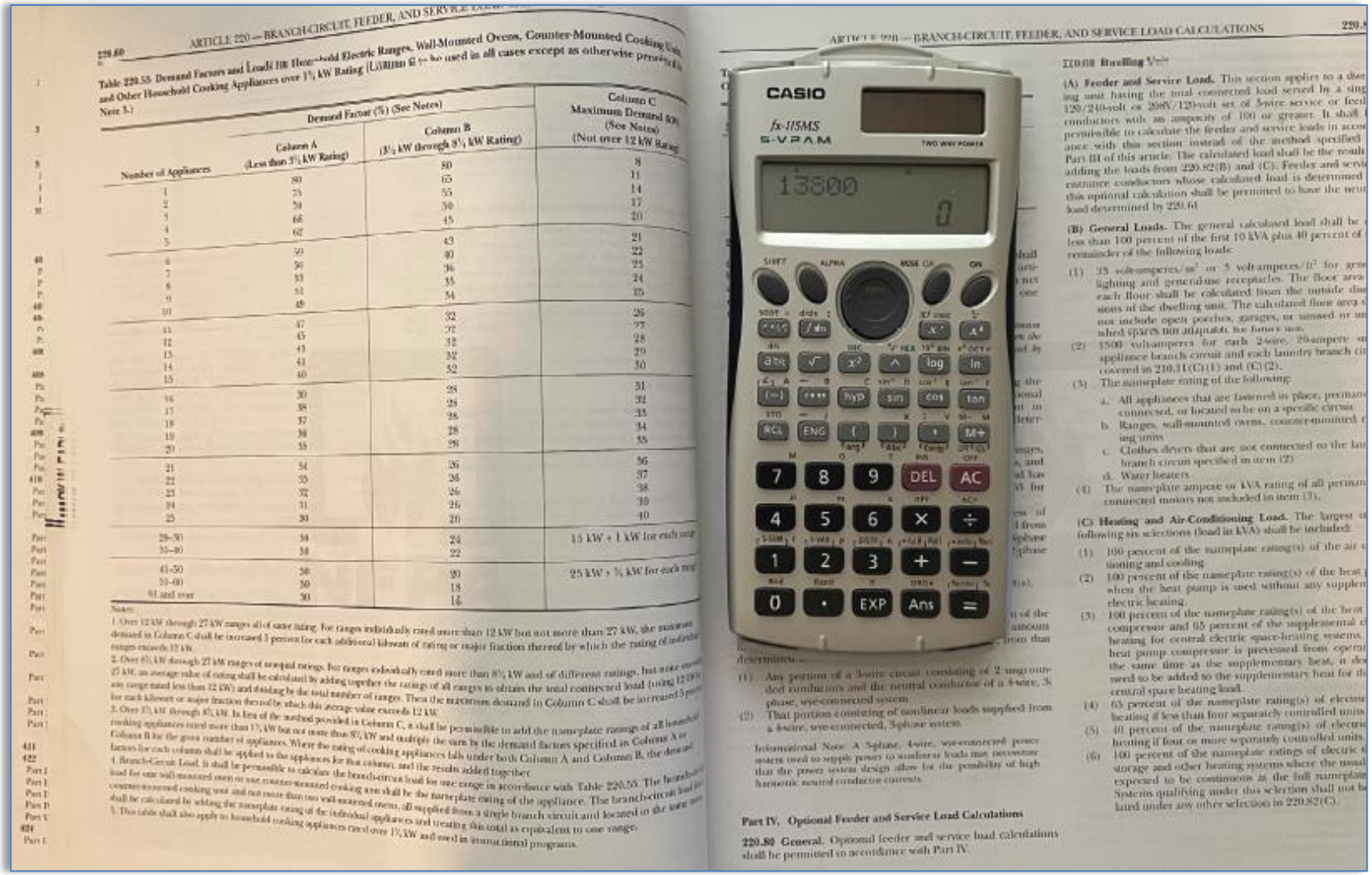
Article 220

REORGANIZE



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220.5(C)

REVISION

Floor Area

Change Summary

- Section 220.11 has been relocated from Part II of Article 220 to become 220.5(C).
- Garages and unfinished spaces, as well as unused spaces, are now included in the floor area calculations.
- Open porches continue to not be included in the floor area calculation if they cannot be adapted for future use as a habitable room or occupiable space.

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220.5(C)

REVISION

© 2022 *electrical training ALLIANCE*

220.42

REVISION

Lighting Load for Non-Dwelling Occupancies

Change Summary

- The lighting load requirements for non-dwelling occupancies have been moved from Part II to Part III, Feeder and Service Load Calculations.
- The informational note to 200.42(A) points out that unit load conditions of the table are now based on minimum load conditions and 80% power factor, not 100%, as previously indicated. These values might not provide sufficient capacity.
- The note to the table has been revised to make it clear that no additional multiplier is required for the unit loads.

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220.42

REVISION

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220.50

REVISION

Motors and Air-Conditioning Equipment

Change Summary

- The title of Section 220.50 has been changed to “Motors and Air-Conditioning Equipment” to reflect the fact that it also provides a reference to the requirements for hermetic refrigerant motor-compressors.
- The section has been reformatted to clearly delineate the requirements for motors from those for air-conditioning equipment.
- The air-conditioning requirements now reference all of Part IV of Article 440 for sizing of the branch circuit conductors.

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220.50

REVISION

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220.53

REVISION

Appliance Load – Dwelling Units

Change Summary

- Section 220.53 permits a demand factor of 75% to be applied to the nameplate rating of four or more appliances fastened in place rated at least ¼ horsepower or 500 watts.
- Electric vehicle supply equipment has been added to the list of loads that are not permitted to have a reduced demand factor.
- Section 625.41 requires that the EVSE branch circuit be sized for continuous duty loads.

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220.53

REVISION

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220.57

NEW

Electric Vehicle Supply Equipment (EVSE) Load

Change Summary

- A new requirement has been added for sizing the load for electric vehicle supply equipment.
- The load must be sized at 7,200 volt-amperes or the nameplate rating of the equipment, whichever is larger.
- An informational note was added to reference 625.42, which provides the requirement for sizing an EVSE circuit.

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220.57

NEW

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220.60

REVISION

Noncoincident Loads

Change Summary

- This section covers requirements for calculating noncoincident loads on feeders and services. Noncoincident loads are loads that are unlikely to be used simultaneously, such as heating and air conditioning.
- The largest of the loads is permitted to be used for calculating the size of the feeder or service.
- Where a motor or air-conditioning load is part of the noncoincident load and is not the largest of the noncoincident loads, 125% of the larger of the motor load or the air-conditioning load must be used.

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220.60

REVISION

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220.70

NEW

Energy Management Systems (EMSs)

Change Summary

- Section 220.70 will allow listed energy management systems to be used to limit the load on feeders or services.
- Upon malfunction, the EMS must disconnect the loads.
- Access to the settings must be restricted to authorized personnel in accordance with 750.30(C)(3).
- There are field marking requirements indicating the maximum current setting, the date of the calculation and setting, and identification of current-limited loads and sources.

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220.70

NEW

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220.110

NEW

Receptacle Loads – Health Care Facilities

Change Summary

- Demand factors for receptacle loads in health care facilities have been added in 220.110, which is located in the new Part VI, Health Care Facilities.
- These new requirements are based on receptacle load data from health care facilities.
- Since load calculations and demand factors are found in Article 220, the demand factors are referenced in 517.22.

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220.110

NEW

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220.120

REVISION

Receptacle Loads

Change Summary

- Table 555.6 has been relocated to 220.120.
- The relocation of demand factors is consistent with the decision to place requirements for demand factors in health care facilities into 220.110.
- Note No. 2 was revised to provide a method for shore power load calculations for slips using individual kilowatt-hour submeters.
- A new note has been added to the table that notes that if a circuit feeds a boat hoist and shore power for the same boat slip, only the load with the larger demand factor must be counted in the calculation because the loads are not coincident.

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220.120

REVISION

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225.41

NEW

Emergency Disconnects

Change Summary

- One- and two-family dwelling units that are supplied by a feeder now require an emergency disconnect that is installed in an outdoor, readily accessible location.
- If more than one disconnect is required, they must be grouped.
- The disconnecting means must be marked “EMERGENCY DISCONNECT.”
- The disconnect marking is required to be on the outside front of the enclosure. The label must be red with white lettering.

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225.41

NEW

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225.42

NEW

Surge Protection

Change Summary

- During the 2020 cycle, a new surge protection requirement was added for dwelling unit services in 230.67 (expanded for 2023).
- Surge protection is now required for outside feeders that supply dwelling units, dormitory units, guest rooms and guest suites of hotels and motels, and patient sleeping rooms of nursing homes and limited care facilities.
- A similar requirement is now located in 215.18 for feeders.
- There is no exception for outside feeder equipment for remotely-located SPD protection for upstream feeder or service equipment.

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225.42

NEW

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230.7

REVISION

Other Conductors

Change Summary

- Service conductors have been prohibited from being in the same cable or raceway with branch-circuit or feeder conductors.
- Service conductors are now also prohibited from being installed in underground boxes or handhole enclosures with branch-circuit or feeder conductors.
- Intermingling service conductors with other conductors is a hazard to workers and to connected equipment.
- Grounding electrode conductors and supply-side bonding jumpers are permitted in the same raceway or enclosure as the service conductors.

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230.7

REVISION

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230.24(A)

REVISION

Above Roofs

Change Summary

- The requirement for the minimum vertical clearance of overhead conductors above a roof surface has been increased from 2.5 meters (8 ft.) to 2.6 meters (8 ft. 6 in.)
- The vertical clearance extends 3 feet in every direction from the edge of the roof.
- The minimum clearance requirement for service conductors was less than for feeder conductors. Service conductors would be a greater hazard to workers on roofs than feeder conductors.
- The metric conversion in 225.19(A) was incorrect in the last edition of the *Code*.

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230.24(A)

REVISION

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230.43

REVISION

Wiring Methods for 1000 Volts, Nominal, or Less

Change Summary

- The list of permitted wiring methods for service entrance conductors has been revised.
- Type TC-ER cable is permitted where it is identified for use as service conductors.
- Flexible bus systems are a new wiring method that is now permitted for services.
- Article 371 provides installation requirements for flexible bus systems.

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230.43

REVISION

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230.62(C)

REVISION

Barriers

Change Summary

- Barriers are required in service equipment to minimize the likelihood of inadvertent contact with uninsulated, and ungrounded, service busbars and terminals.
- This requirement has been revised to make it clear that the requirement applies to protection from contact when the service disconnect is in the open position.
- The conductors and terminals being protected by barriers will remain energized when the service disconnect is in the open position.

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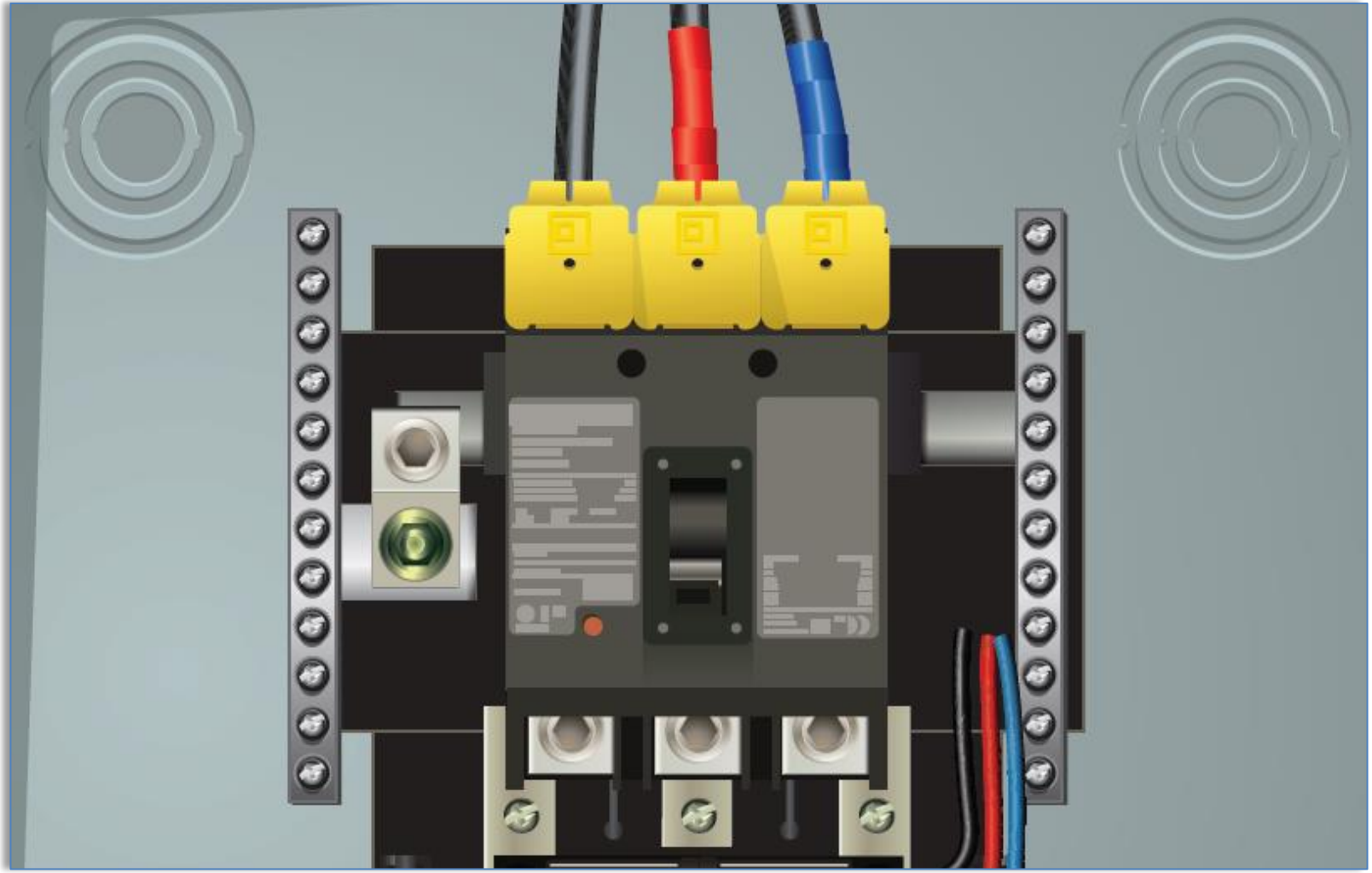
230.62(C)

REVISION



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230.67

REVISION

Surge Protection

Change Summary

- Surge protection will now be required to be provided in service equipment for dormitories, guest rooms and guest suites of hotels and motels, and sleeping areas of nursing homes and limited care facilities.
- With the expansion of the requirements, the section was reformatted into list format.
- Surge protective devices must have a nominal discharge current rating of not less than 10 kA.

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230.67

REVISION

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230.71(B)

REVISION

Two to Six Service Disconnecting Means

Change Summary

- The requirements for barriers in vertical sections of switchboards were clarified.
- Transfer switches in service equipment are now required to be in separate compartments.
- Barriers between a service disconnect for a motor control center and motor disconnects are now required.
- An exception was added that permits the addition of service disconnects (up to six) in a single enclosure in an existing installation that was installed in compliance with editions of the *Code* prior to 2020.

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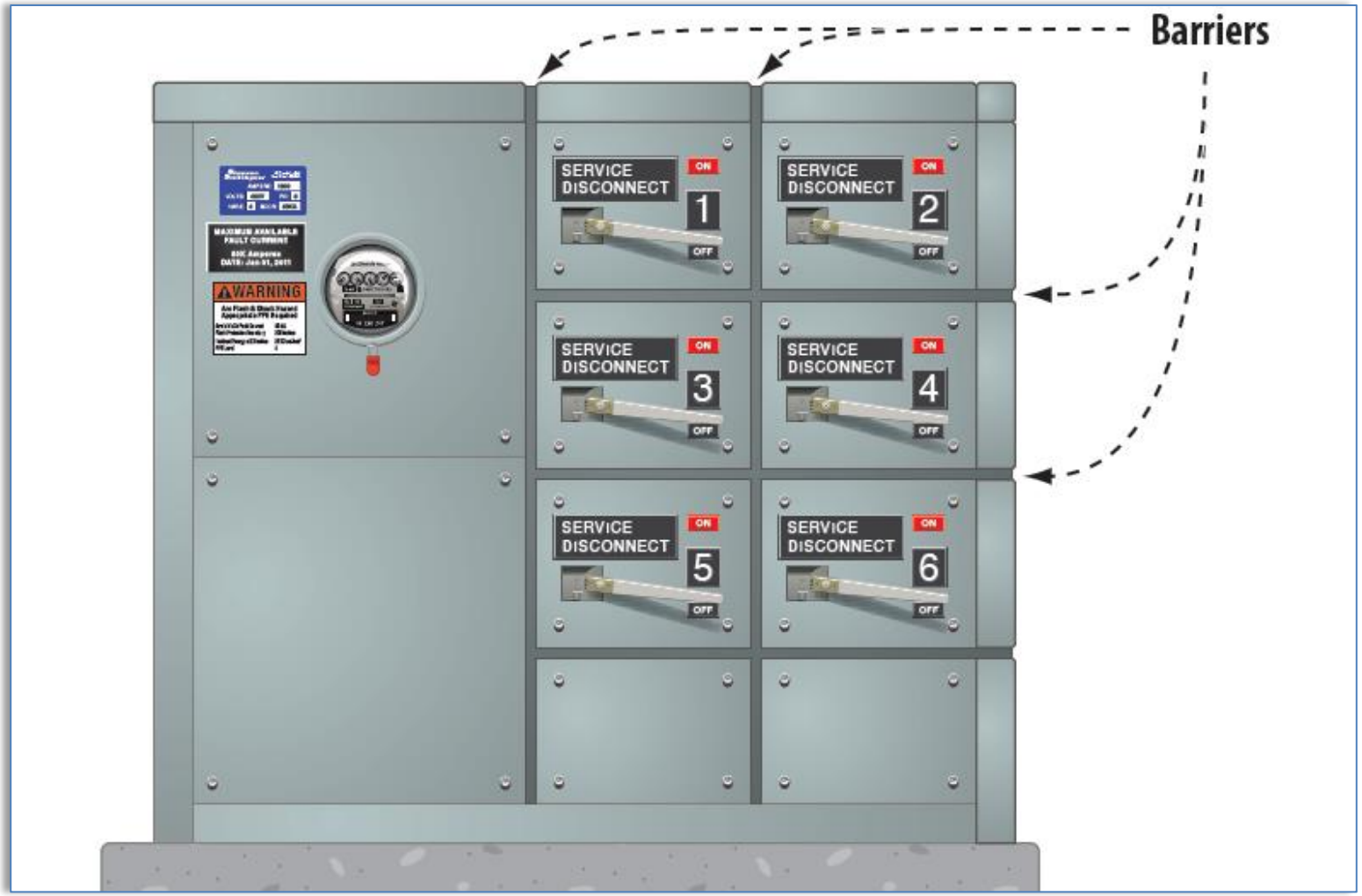
230.71(B)

REVISION



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230.85

REVISION

Emergency Disconnects

Change Summary

- Section 230.85 was rewritten into a list format and the language was clarified.
- An exception was added to not require an outdoor service disconnect to be readily accessible, where an outdoor feeder disconnect is installed in accordance with 225.41.
- If multiple disconnects are required, they must be grouped.
- If disconnects are replaced, all of the requirements of this section apply. However, the exception to (C) permits some repairs.

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230.85

REVISION

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Article 235

NEW

Branch Circuits, Feeders, and Services Over 1000 Vac…

Change Summary

- A new Article 235 has been created that covers requirements for branch circuits, feeders, and services over 1,000 volts ac or over 1,500 volts dc.
- This change is intended to locate the medium-voltage requirements to improve usability and clarity.
- Corresponding requirements have been deleted from Articles 210, 215, and 230.

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Article 235

NEW

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240.2

NEW

Reconditioned Equipment

Change Summary

- Section 240.2 has been created to indicate which equipment is permitted to be reconditioned.
- Equipment not permitted to be reconditioned includes GFPE, GFCI, low-voltage fuseholders, low-voltage nonrenewable fuses, molded-case circuit breakers, and low-voltage circuit breaker electronic trip units.
- Equipment permitted to be reconditioned includes low-voltage power circuit breakers, electromechanical relays, and current transformers.
- Reconditioned equipment covered by Article 240 must be listed.

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240.2

NEW

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Courtesy of Eaton

240.4(B)

REVISION

Overcurrent Devices Rated 800 Amperes or Less

Change Summary

- Conductors must be protected from overcurrent in accordance with their ampacity. Where the ampacity does not equal a standard OCPD rating, the next standard size (not to exceed 800 amperes) is permitted to be used in accordance with 240.4(B).
- An adjustable trip OCPD is permitted to be used as long as the setting does not exceed the next standard rating size above the conductor ampacity.
- The means to adjust the setting of the adjustable trip mechanism must have restricted access in accordance with 240.6(C).

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240.4(B)

REVISION

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Courtesy of Michael J. Johnston

240.6(D)

NEW

Remotely Adjustable Trip Circuit Breakers

Change Summary

- Remotely adjustable circuit breakers are permitted to have an ampere rating that is equal to the adjusted current setting (long-time pickup setting).
- Access can be achieved directly through a local nonnetworked interface or through a networked interface where the circuit breaker and software are identified as being evaluated for cybersecurity or the network has had a documented cybersecurity assessment.
- Two informational notes were added that reference cybersecurity standards and recognized methods of commissioning to identify cyber threats.
- A third informational note points out that continuous vigilance is necessary.

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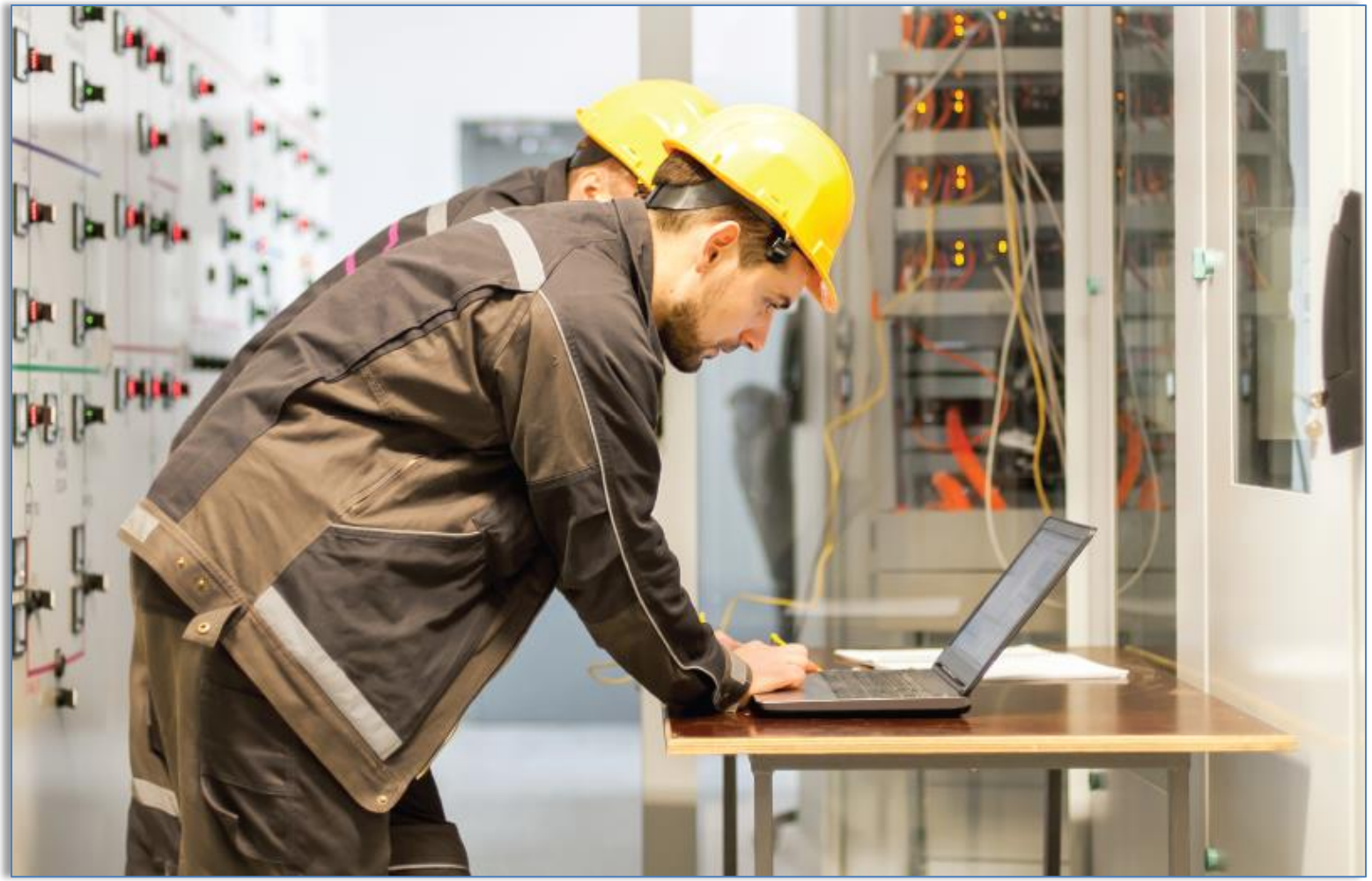
240.6(D)

NEW



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240.7

NEW

Listing Requirements

Change Summary

- Branch-circuit overcurrent protective devices are now required to be listed.
- The listing standards include *UL 499 Standard for Safety: Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures*, and *UL 1066 Standard for Safety: Low-Voltage AC and DC Power Circuit Breakers Used in Enclosures.*
- Products that are not listed must be evaluated for safety in accordance with 110.3(A) as the basis for approval by the AHJ. Jurisdictions do not have the facilities to properly evaluate circuit breakers.

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240.7

NEW

970

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Courtesy of Michael J. Johnston

240.11

NEW

Selective Coordination

Change Summary

- Selective coordination of overcurrent protective devices limits the extent of an outage without opening the service.
- If there are feeders connected to the service that have loads that are not required to be coordinated, the uncoordinated loads could be capable of opening the service OCPD.
- The 2023 *Code* requires that when feeders are connected to a service that has loads that are required to be selectively coordinated, the feeders are also required to be selectively coordinated.

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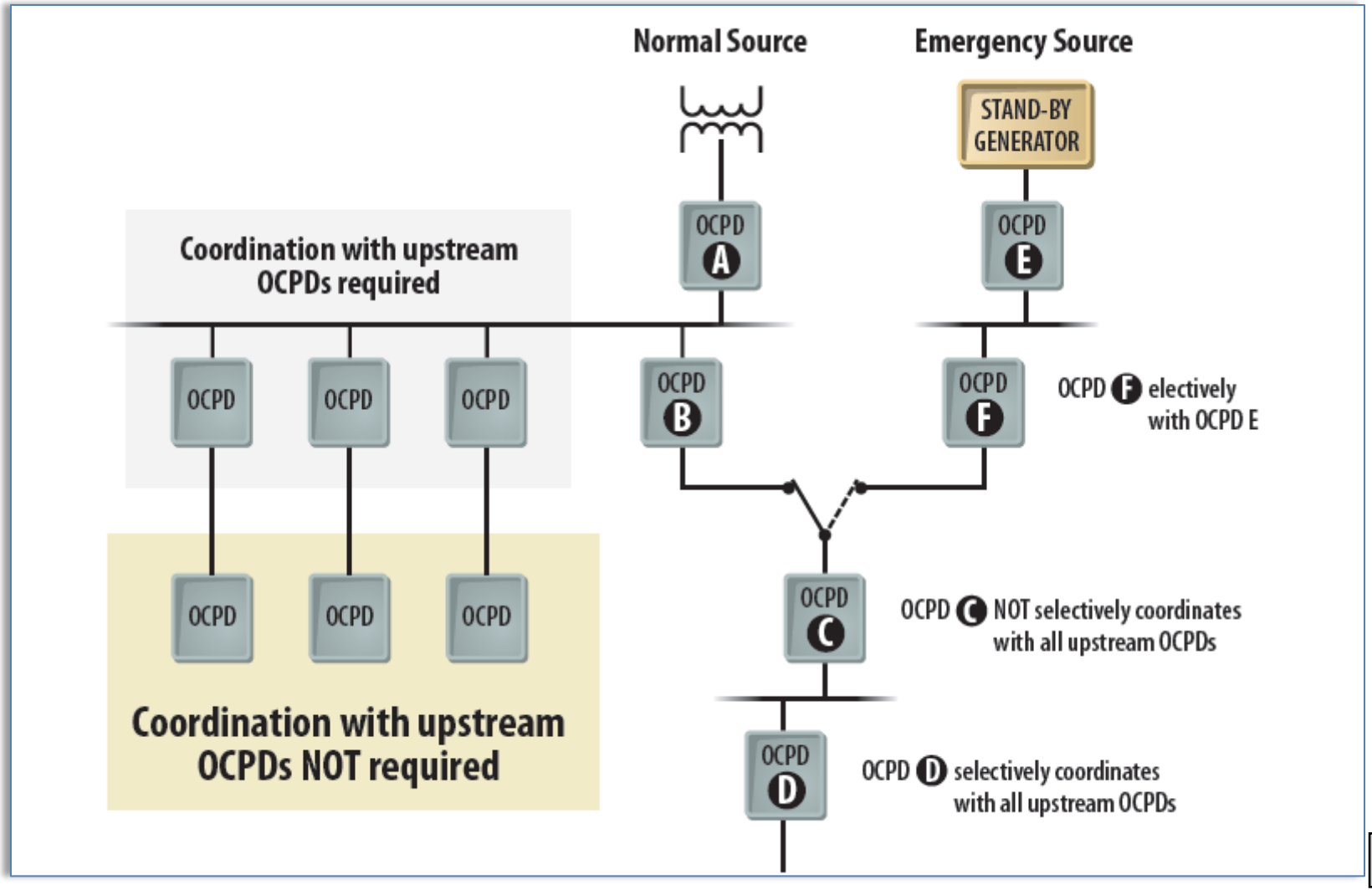
240.11

NEW



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240.24

REVISION

Location in or on Premises

Change Summary

- The use of a tool to access overcurrent protective devices will be permitted in enclosures designed for hazardous (classified) locations and for enclosures to protect against environmental conditions.
- Branch-circuit overcurrent protective devices will not have to be accessible to all residents in sleeping rooms in dormitory units.
- The prohibition against locating overcurrent protection in bathrooms of dwelling units, dormitory units, and guest rooms and guest suites has been expanded to include all bathrooms, showering facilities, and locker rooms with showering facilities.

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240.24

REVISION

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240.89

NEW

Replacement Trip Units

Change Summary

- Replacement trip units for circuit breakers must be listed for use in the specific circuit breaker type.
- The trip unit may be identical to the original, or it could provide additional features.
- Listing ensures that the new trip unit will not compromise the operation of the circuit breaker.
- This action correlates with the action taken during the 2020 cycle in 490.21(A)(5) for circuit breakers rated over 1,000 volts (245.21(A)(5) in this edition).

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240.89

NEW

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242.9

NEW

Indicating

Change Summary

- Surge protective devices are required to provide an indication that they are operating properly.
- A surge protective device can be damaged by a high-level surge, even if it has protected the equipment.
- Previously, the occupant may not have known that the SPD operation may have damaged it, precluding future protection.

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242.9

NEW

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242.42

REVISION

Surge Arrester Rating

Change Summary

- Previously, the rating of a surge arrester was required to be equal to or greater than the maximum continuous operating voltage at the point of application.
- The duty cycle is now required to be not less than 125% of the maximum continuous operating voltage available at the point of application.
- The reference to silicon-carbon type surge arresters was deleted because they are no longer manufactured.

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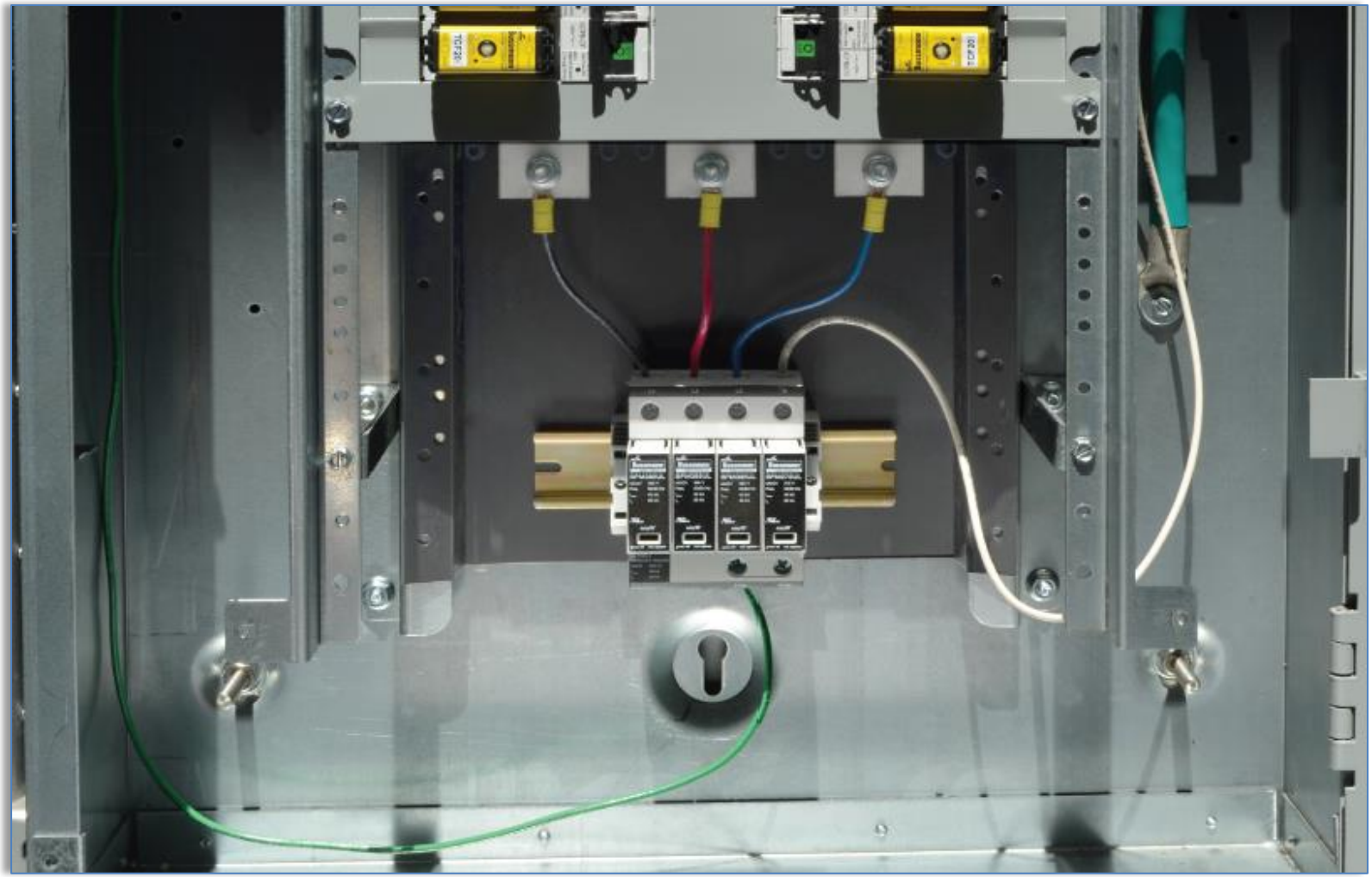
242.42

REVISION



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Article 245

NEW

Overcurrent Prot. Sys. Rated Over 1000 Vac, 1500 Vdc

Change Summary

- A new Article 245 has been created on overcurrent protection for systems rated over 1,000 volts ac and 1,500 volts dc.
- This new article will replace previous requirements for systems over 1,000 volts, which were located in Articles 240 and 490.
- This is one of several new articles that are intended to enhance the *NEC*'s coverage of medium- and high-voltage applications.

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Article 245

NEW

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Courtesy of Michael J. Johnston

245.2

REVISION

Reconditioned Equipment

Change Summary

- This section was revised, placed into list format, and relocated to become 245.2.
- Medium- and high-voltage circuit breakers are now permitted to be reconditioned.
- Electromechanical protective relays and current transformers are now permitted to be reconditioned.
- Medium-voltage fuseholders and medium-voltage nonrenewable fuseholders are not permitted to be reconditioned.

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245.2

REVISION

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250.6

REVISION

Objectionable Current

Change Summary

- This section was revised to recognize that bonding of various parts of electrical systems and equipment can also cause objectionable currents.
- 250.6(B) now provides remedies to objectionable currents resulting from bonding.
- 250.6(C) was revised to recognize that currents resulting from abnormal conditions may not be temporary and could also exist due to required grounding and bonding connections.

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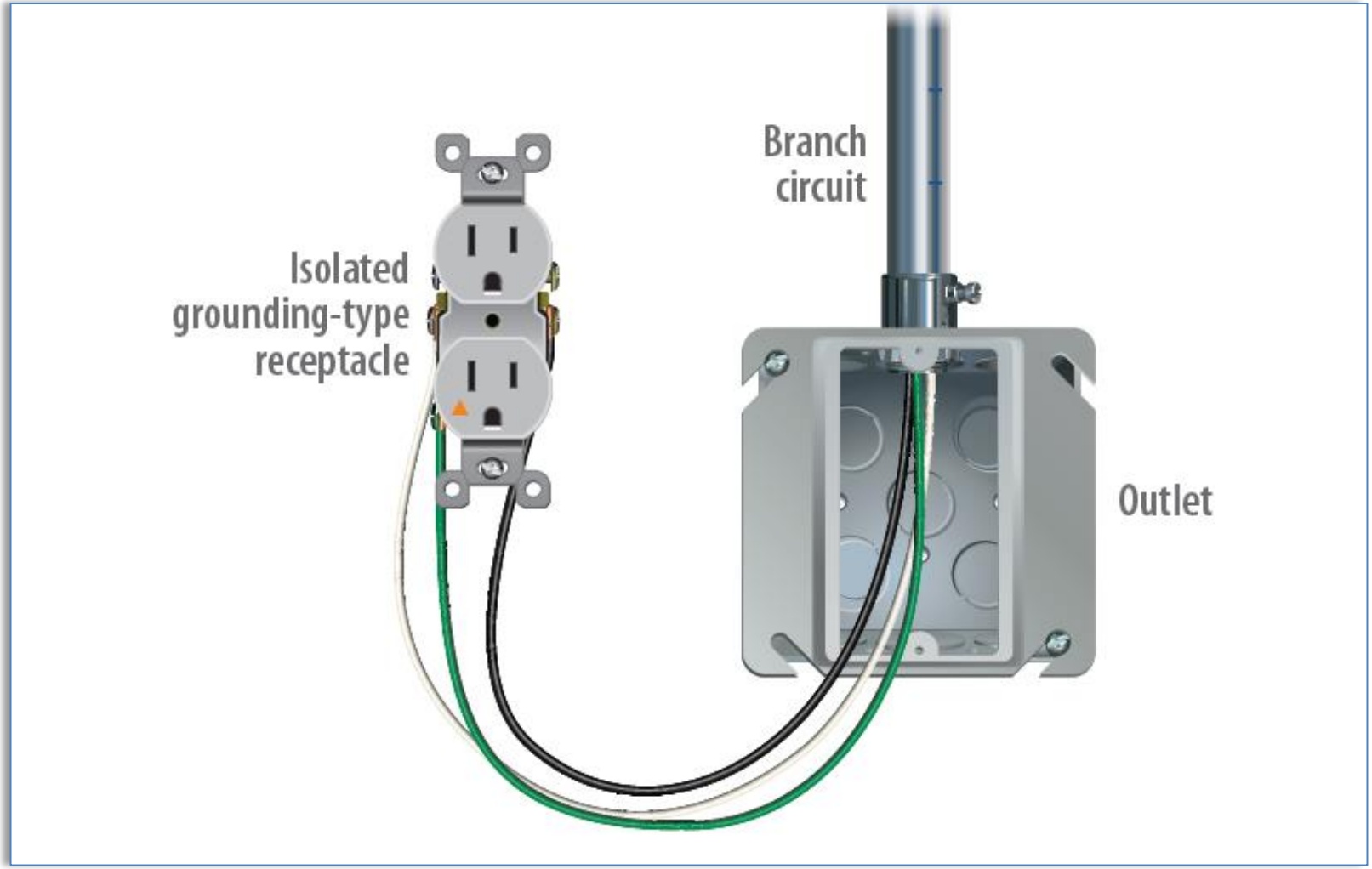
250.6

REVISION



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250.20

REVISION

Alternating-Current Systems to Be Grounded

Change Summary

- Alternating current systems are now required to be grounded in accordance with 250.20, unless prohibited elsewhere in the *Code.*
- A new informational note has been added to point to specific examples of applications where grounding is prohibited. In addition, 250.22 was deleted because it was a reference to some of these requirements elsewhere in the *Code*.
- 250.20(D) was revised to recognize that impedance grounded systems do not have a neutral conductor.

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250.20

REVISION

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250.24

REVISION

Grounding of Service-Supplied AC Systems

Change Summary

- The term *high impedance grounded system* is now changed to *impedance grounded system.*
- The conductor that connects to the neutral point through an impedance is not a grounded conductor – it is an impedance grounded conductor. Correlating changes were made in 250.36.
- Parallel grounded service conductors in two or more parallel raceways are required to be connected in parallel. The grounded conductor in each raceway is to be sized based on the conductor in the raceway.

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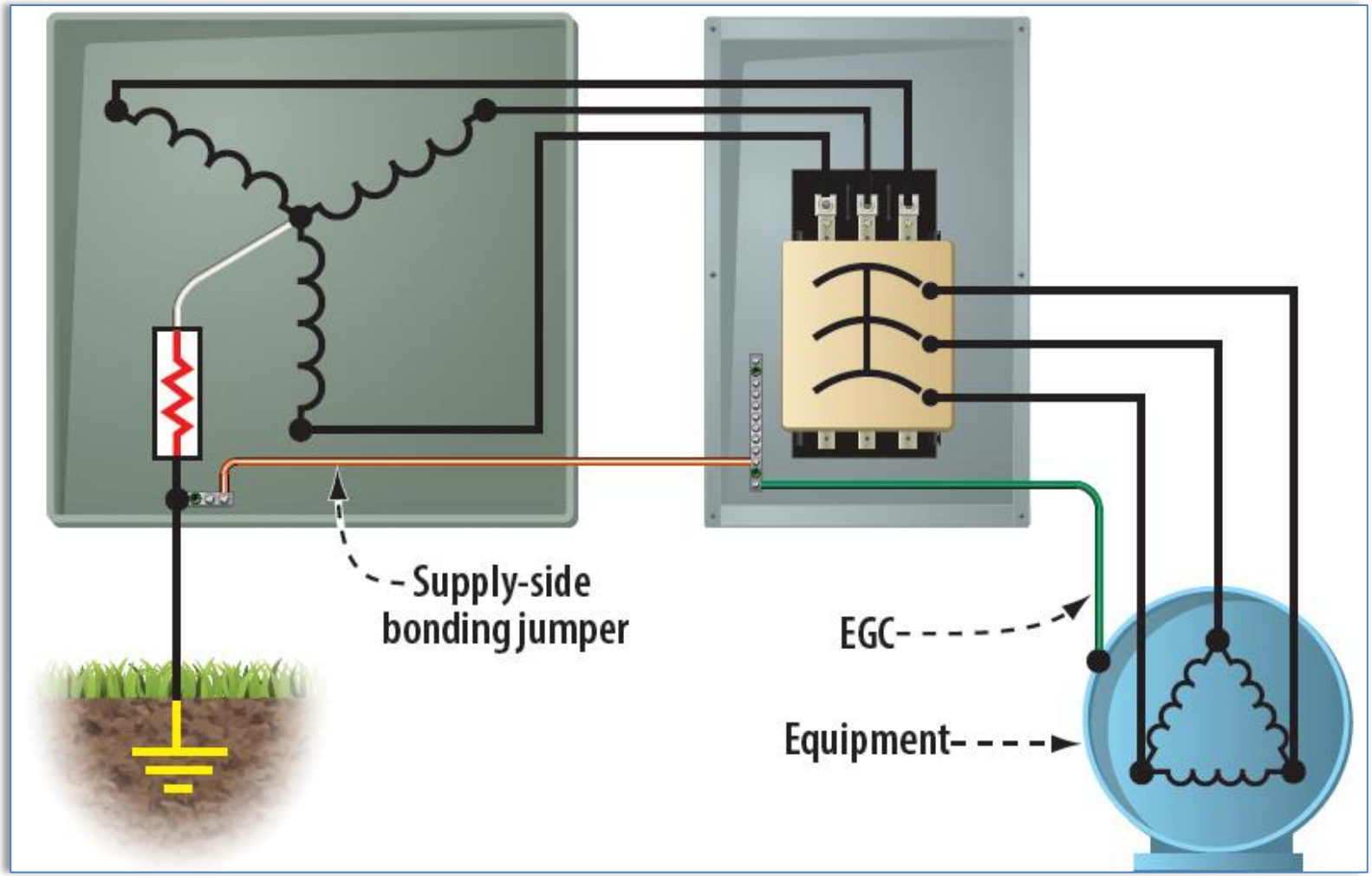
250.24

REVISION



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250.36

REVISION

Impedance Grounded Systems – 480 V to 1000 V

Change Summary

- The term *high impedance grounded neutral system* is now changed to *impedance grounded system.*
- The conductor that connects to the neutral point through an impedance is not a grounded conductor – it is an impedance grounded conductor.
- The conductor is also not a neutral conductor.

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250.36

REVISION

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250.64

REVISION

Grounding Electrode Conductor Installation

Change Summary

- Section 250.64(B) has been updated to include copper-clad aluminum conductors in the requirements for securing and supporting.
- Section 250.64(D)(2)(2) has been revised to recognize that some buildings are supplied by branch circuits, rather than by feeders or services. This removes a conflict with 250.24(A)(1).
- A new 250.64(G) was added to prohibit grounding electrode conductors from being run through the ventilation openings of equipment.
- There were several minor editorial corrections in this section.

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250.64

REVISION

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Courtesy of Copperweld Bimetallics LLC

250.68(C)

REVISION

Grounding Electrode Conductor Connections

Change Summary

- Interior metal piping that is electrically continuous with a metal underground water pipe electrode that is not more than 5 feet from the point of entrance is permitted to extend the grounding electrode.
- The measurement has been clarified in three places to make it clear that the measurement is along the water piping.
- In 250.68(C)(2) and (C)(3), there were references to “the usual steel tie wires” without explanation. The phrase “the usual” was deleted.

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250.68(C)

REVISION

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250.94(B)

REVISION

Bonding for Communications Systems-Other Means

Change Summary

- Section 250.94(B) was revised to clarify the requirement for the connection to a busbar, which is connected to the grounding electrode conductor. The conductor must be the larger of one of the following:
  - A conductor that is sized at least as large as the largest conductor connected to the busbar.
  - A 6 AWG conductor in accordance with 250.94(A)(4)

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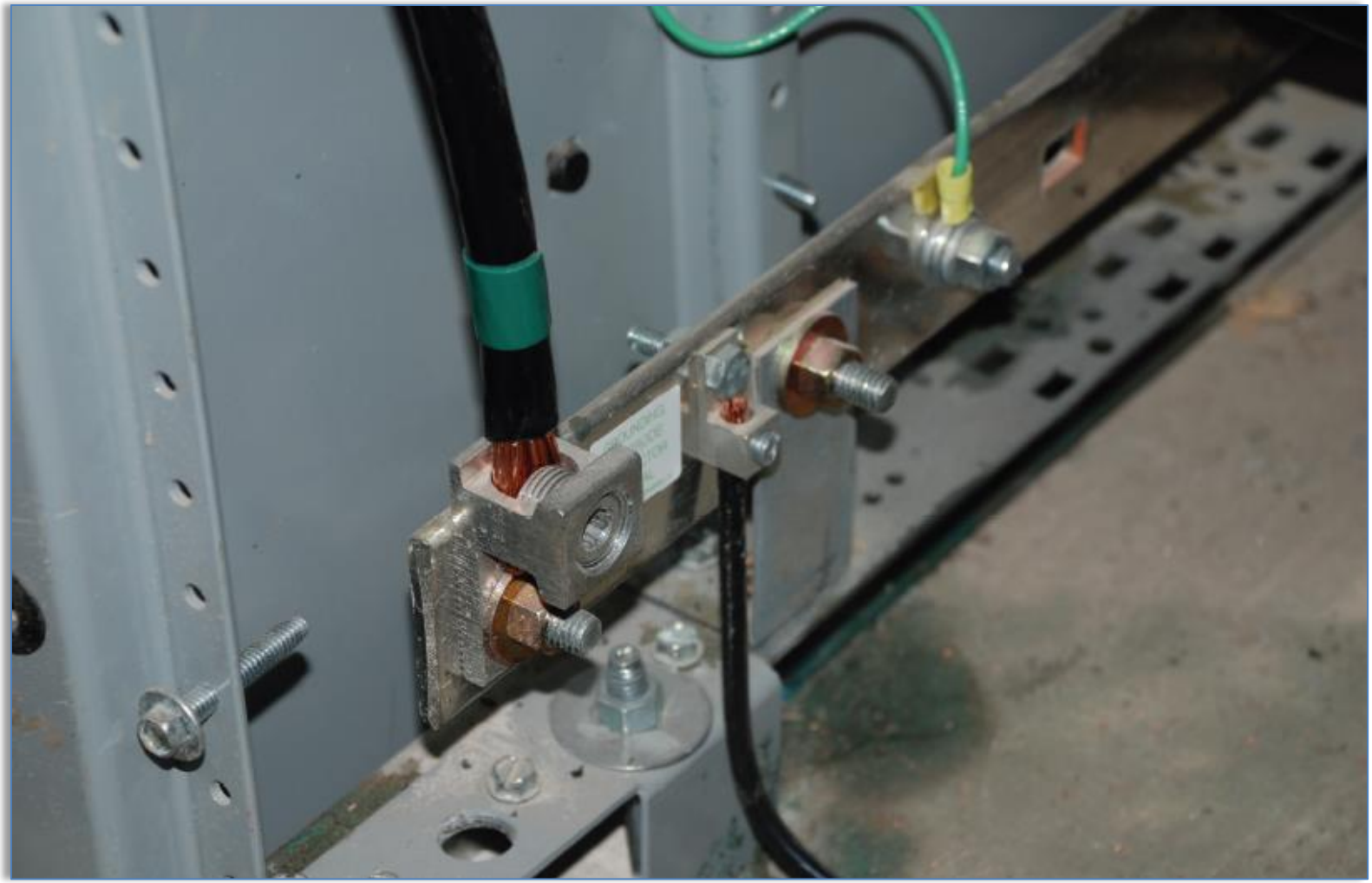
250.94(B)

REVISION



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250.104(C) & (D)

REVISION

Bonding of Piping Systems and Exposed Struct. Metal

Change Summary

- Changes were made in 250.104(C) to replace the vague language about conductors of “sufficient size” with a reference to Table 250.102(C)(1) to specify the size.
- Changes were made in 250.104(D)(3) to make it clear that the piping being referred to is metal water piping.
- Changes were also made to recognize that connections to grounding electrodes in the earth may be extended through portions of the pipe or structural electrodes that are above ground, provided the installation complies with 250.68(C).

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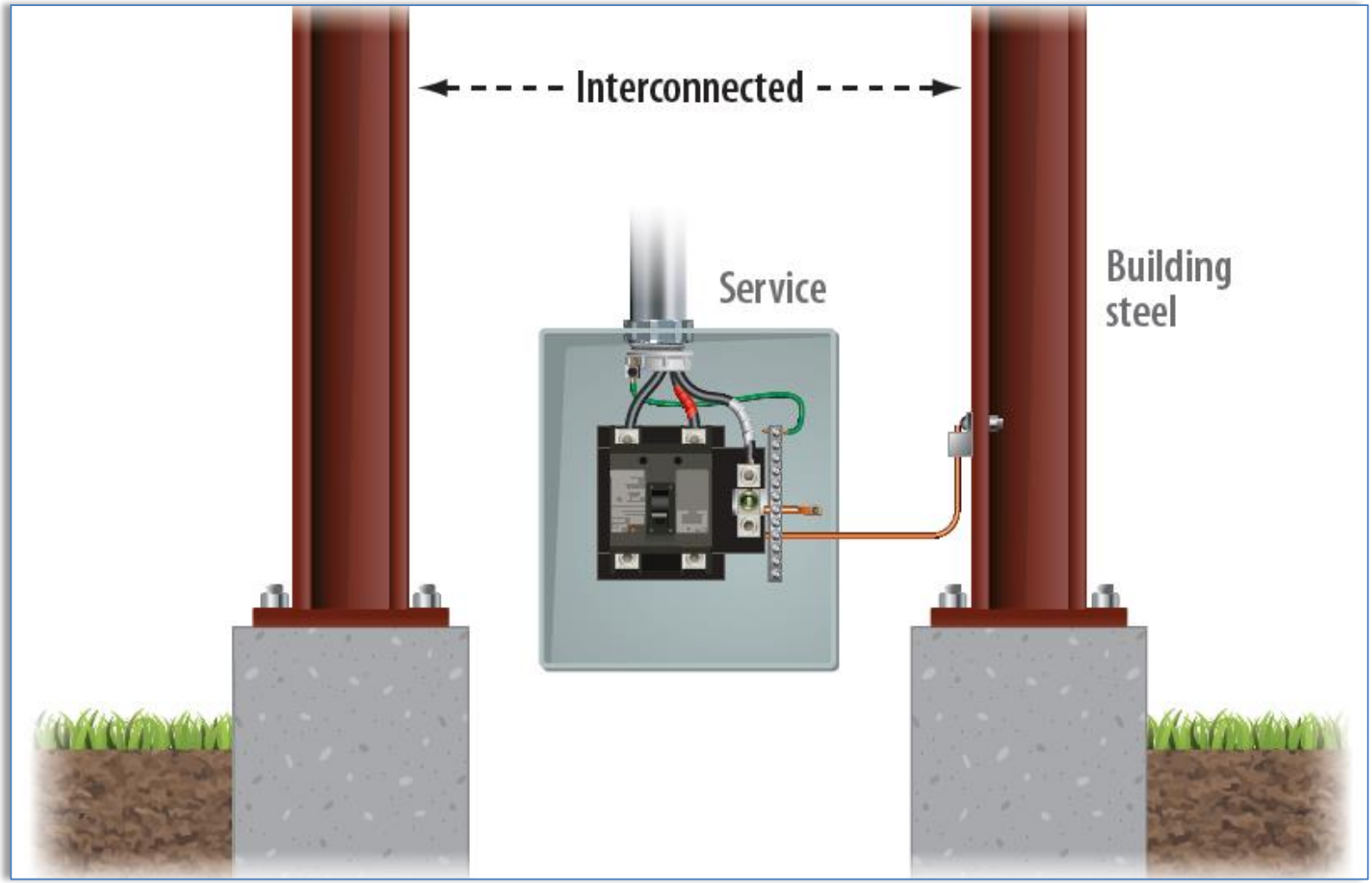
250.104(C) & (D)

REVISION



1000

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250.118

REVISION

Types of Equipment Grounding Conductors

Change Summary

- Section 250.118, Types of Equipment Grounding Conductors, was reformatted into two subdivisions: (A) Permitted, and (B) Not Permitted.
- Section 250.118(A)(5)(f) and (A)(6)(f) were added for locations where there is a need for high resistance to corrosion. A stainless-steel core has a higher electrical resistance than other metals used in the construction of liquidtight flexible metal conduit. The bonding jumper can be internal or external to the liquidtight flexible metal conduit.
- A requirement for a bonding jumper was also added to 250.118(A)(5)(e).

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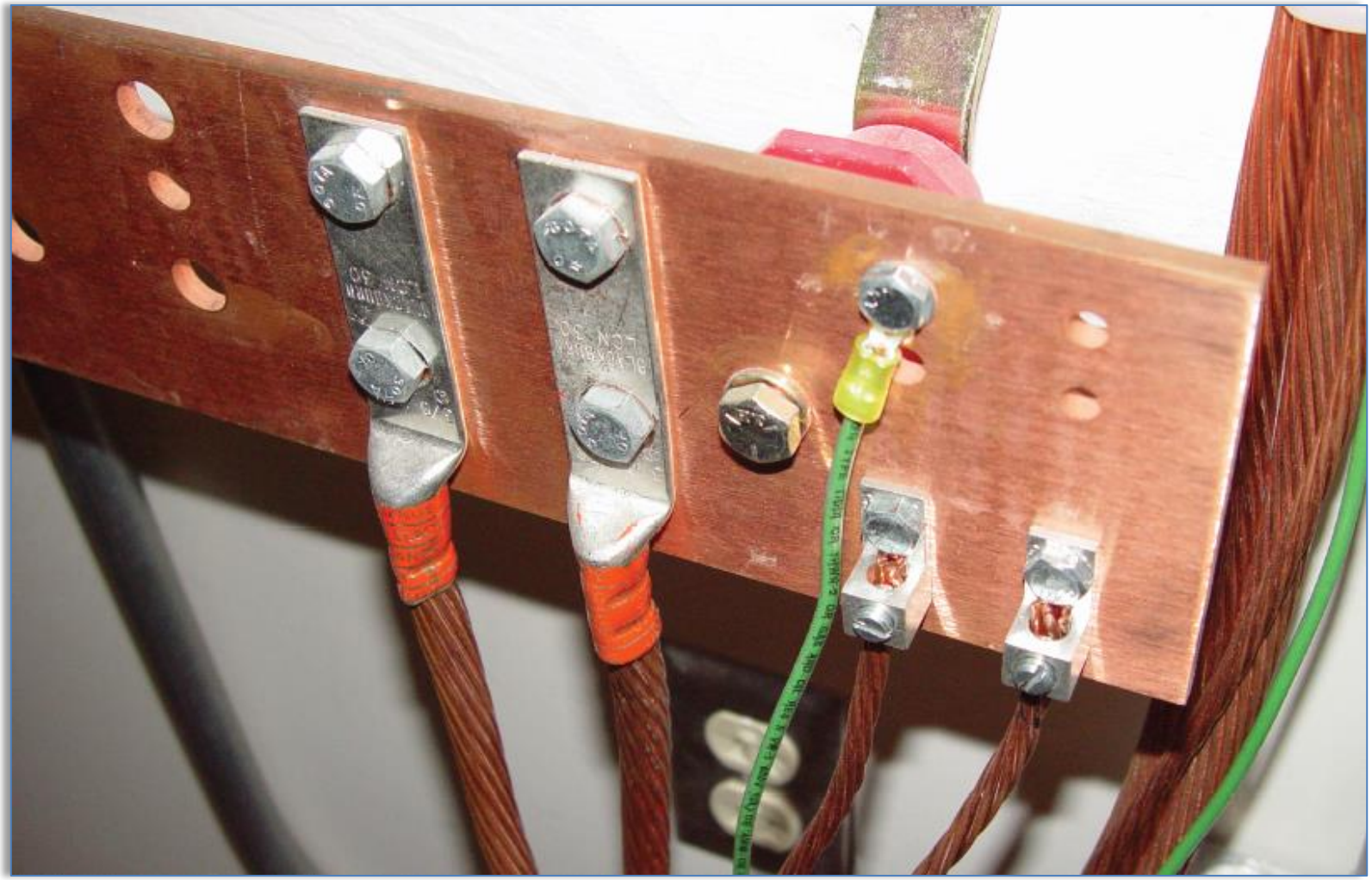
250.118

REVISION



1002

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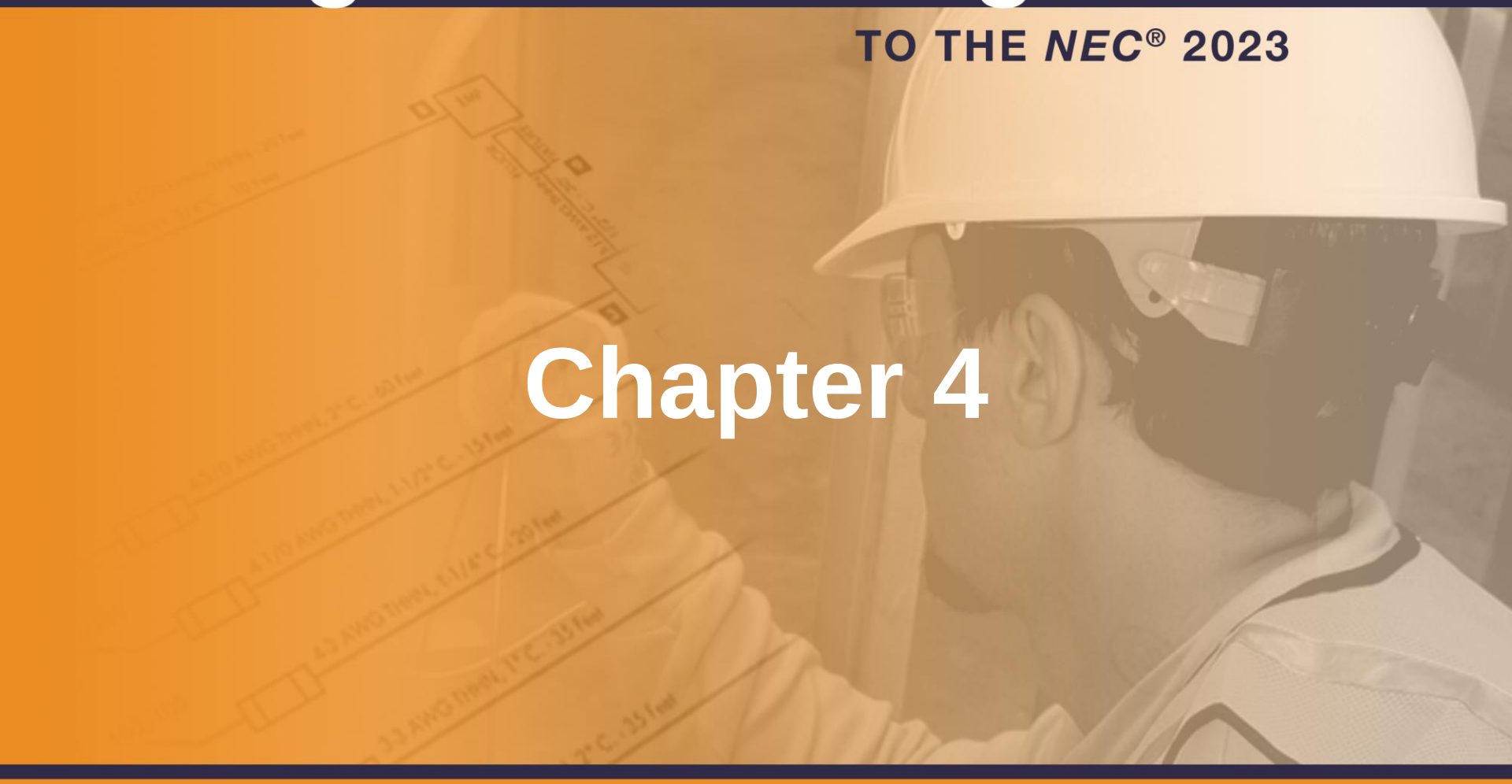
Courtesy of Michael J. Johnston

Significant Changes

TO THE *NEC*® 2023



Chapter 4

electrical training ALLIANCE IBEW - NECA IN COLLABORATION WITH NECA NATIONAL ELECTRICAL CONTRACTORS ASSOCIATION

400.40 through 400.52

NEW REVISION

Portable Power Feeder Cables Over 2000 V, Nominal

Change Summary

- Article 400, Part III has a title change. It now covers portable cables of over 600 volts up to 2,000 volts.
- A new Part IV was added on portable power feeder cables over 2,000 volts, nominal.
- Portable power feeder cables can be used for connection of portable equipment and machinery or for wiring of cranes and hoists. Portable power feeder cables can also be used for temporary services and other temporary installations.

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400.40 through 400.52

NEW REVISION

1005

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404.1

REVISION

Scope

Change Summary

- Article 404 applies to all switches, switching devices, and circuit breakers used as switches.
- Article 404 typically applies to switches operating at 1,000 volts or less but can apply to switches operating at higher voltages as specifically referenced elsewhere in the *Code*.
- There is a new generation of wireless control switches that are battery operated. These wireless switches are not covered by Article 404.
- An informational note was added that points to 210.70, which now has requirements that apply to wireless switches.

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404.1

REVISION

1007

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404.14 & 404.14(D)

NEW REVISION

Snap Switch Terminations

Change Summary

- Section 404.14 has been revised to require that switches be listed and marked with their ratings.
- New 404.14(D) was added to provide requirements for conductors used on the terminals of switches based on the markings of the switches.
- Section 404.14(D)(3) also addresses the limited use of push-in terminals, which are restricted to 14 AWG copper conductors only.

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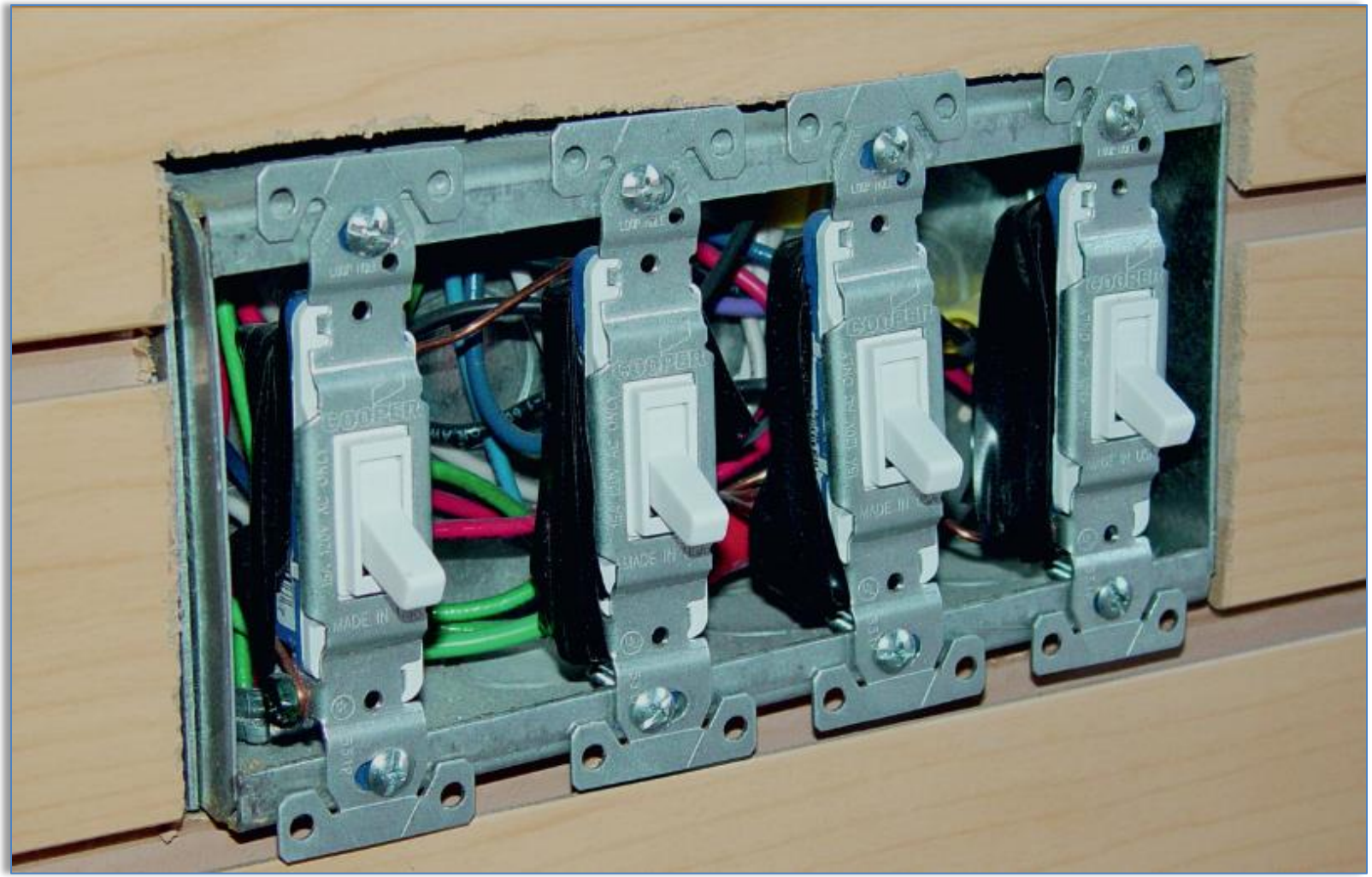
404.14 & 404.14(D)

NEW | REVISION



1009

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404.16

NEW

Reconditioned Equipment

Change Summary

- Lighting, dimmer, and electronic control switches are not permitted to be reconditioned.
- Snap switches are an inexpensive and easily-replaceable item. Therefore, they are not permitted to be reconditioned.
- Knife switches, switches with butt contacts, and bolted pressure switches are permitted to be reconditioned.

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404.16

NEW

1011

Courtesy of Leviton

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404.30

NEW

Switch Enclosures with Doors

Change Summary

- Doors of enclosures for switches that provide access to live parts when opened must be constructed so that either a tool or other approved means is necessary to open the door if the switch is in the closed position.
- A similar change was made in 690.13(A) and 690.15(A) during the 2020 cycle.
- This does not prohibit the use of a lock to prevent access.
- These changes are intended to restrict access by unqualified persons. The primary intent is to protect children.

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404.30

NEW

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Courtesy of Michael J. Johnston

406.3

REVISION

Receptacle Rating and Type

Change Summary

- The title of 406.3(C) has been changed to CO/ALR Receptacles.
- Section 406.3(D) has been added to cover requirements for termination of conductors to receptacles.
- Push-in terminals are only listed for 14 AWG copper conductors and can only be used to connect receptacles on 15-ampere branch circuits.

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406.3

REVISION

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406.4

REVISION

General Installation Requirements

Change Summary

- Section 406.4(D)(3) now requires replacement GFCI-type receptacles to be listed.
- Section 406.4(D)(5) provides requirements for replacement tamper-resistant receptacles. A tamper-resistant receptacle is not required if a non–grounding-type receptacle is replaced with another non–grounding-type receptacle. A tamper-resistant receptacle is also not required if a CO/ALR receptacle is replaced with another CO/ALR receptacle.
- Replacement receptacles must be provided with GFPE if required elsewhere in the *Code*.
- Floor receptacles must be protected in accordance with 406.4(G).

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406.4

REVISION

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406.9

REVISION

Receptacles in Damp or Wet Locations

Change Summary

- Hinged covers of outlet box hoods in damp locations must be able to open at least 90° from the open to the closed position.
- If not designed to open 90°, it must be able to open fully.
- All receptacles in wet locations must be listed and identified as weather resistant.
- Other receptacles in wet locations that are attended while in use must be weatherproof with the attachment plug removed.
- The bathtub and shower space zones have been revised.

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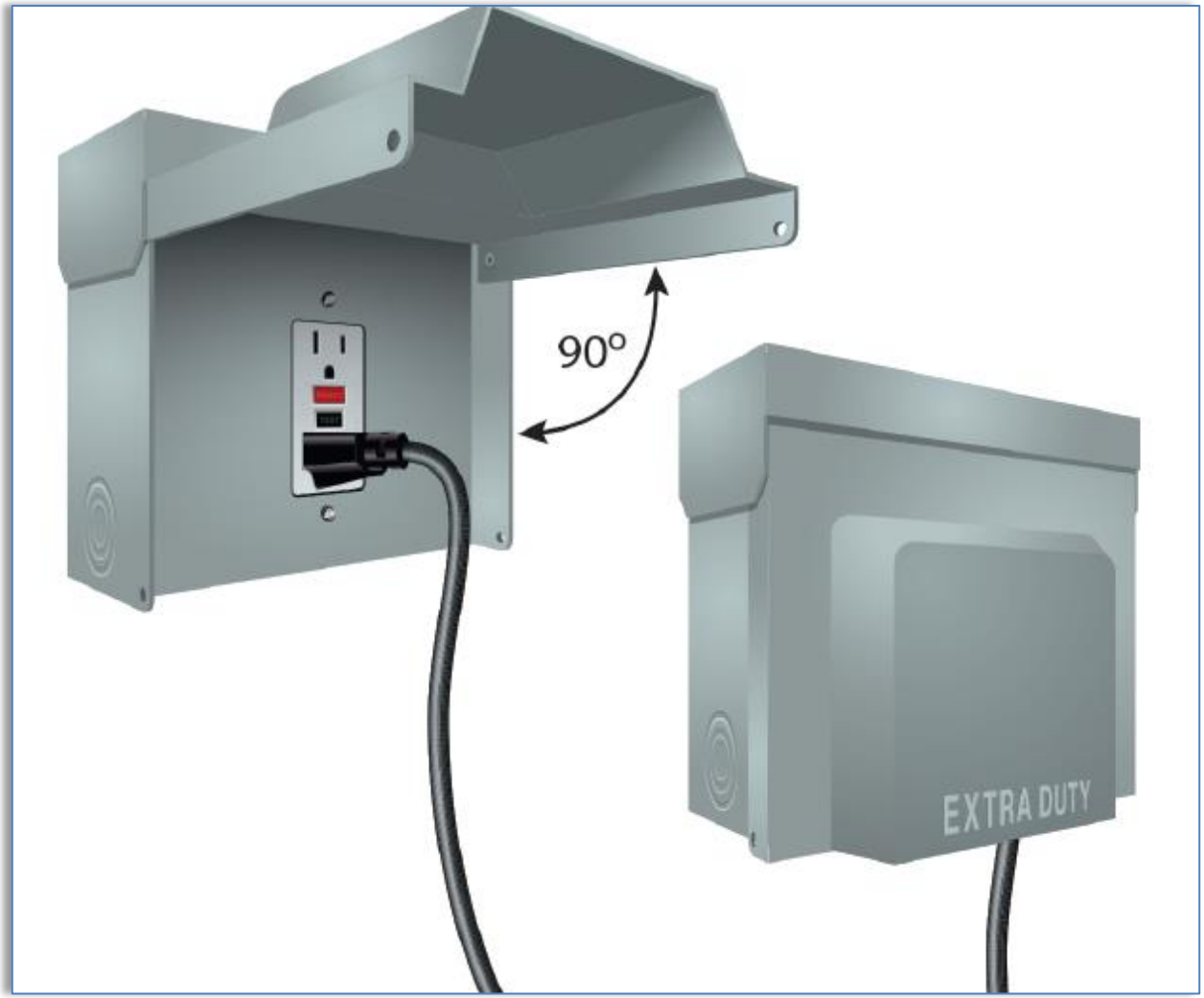
406.9

REVISION



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406.12

REVISION

Tamper-Resistant Receptacles

Change Summary

- Tamper-resistant receptacle requirements now include all dwelling units, boathouses, mobile homes, and manufactured homes, including their attached and detached garages.
- Requirements for tamper-resistant receptacles in medical facilities and other types of residential facilities have been revised and clarified.
- The exception has been clarified so that a tamper-resistant receptacle is not required for single receptacles that supply one appliance or duplex receptacles that are not readily accessible. The exception only applies if the receptacle is in the space designated for a specific appliance.

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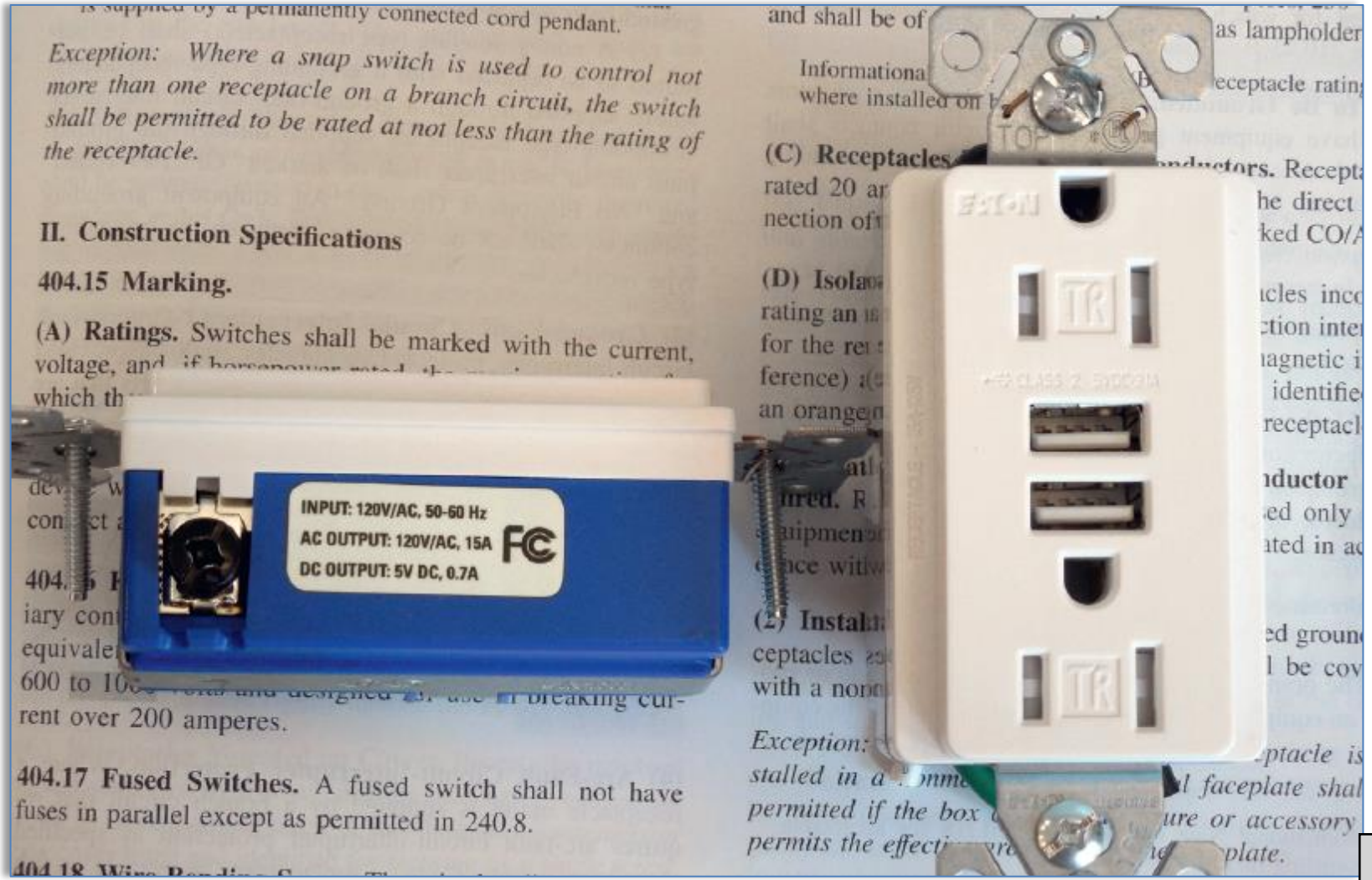
406.12

REVISION



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Courtesy of Eaton Corporation

408.4

REVISION

Descriptions Required

Change Summary

- The title of 408.4 has been changed from “Field Identification” to “Descriptions Required.”
- Every circuit and circuit modification is required to be legibly and permanently described with its clear, evident, and specific purpose or use.
- All switchboards, switchgear, and panelboards supplied by a feeder in other than one- and two-family dwellings must be marked to indicate the location of the power source.

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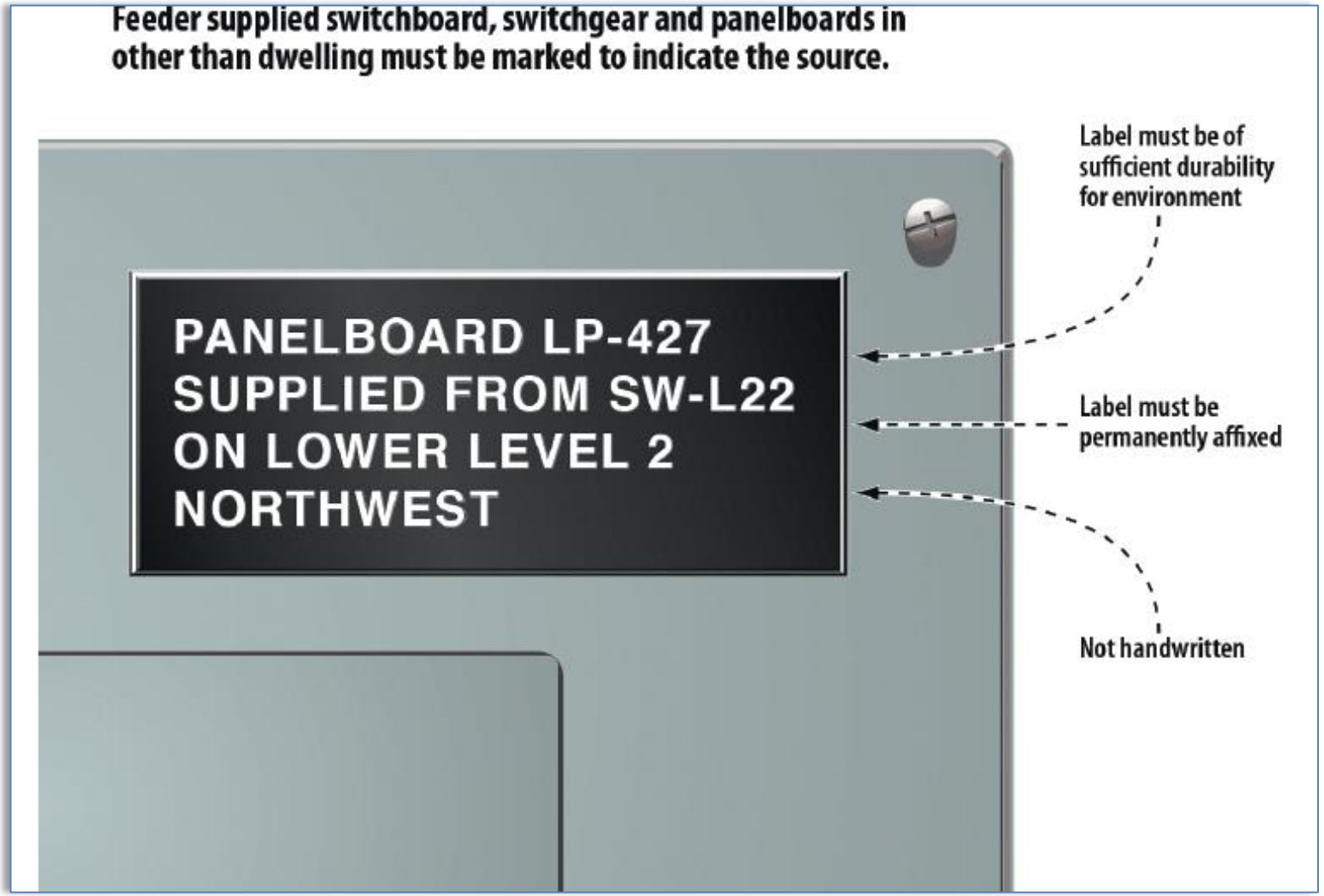
408.4

REVISION



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408.9

NEW

Replacement Panelboards

Change Summary

- A new 408.9 has been added to provide requirements for replacement panelboards.
- Panelboards listed for the specific enclosure are permitted to maintain their short-circuit current rating.
- Panelboards not listed for the specific enclosure with fault current over 10,000 amperes require field labeling. If fault current is less than 10,000 amperes, any previous listing marks must be removed.

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408.9

NEW

1025

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Courtesy of Michael J. Johnston

408.43

REVISION

Panelboard Orientation

Change Summary

- The 2020 *Code* prohibited panelboards from being installed in the face-up position because it created an unsafe working position and increased the likelihood that debris could accumulate in the panelboard.
- The requirement has also been modified for the 2023 *Code* to prohibit installation in the face-down position.
- Installation in a face-down position introduces working space concerns. Working on the panelboard would be awkward, increasing the likelihood of injury during an arc flash or arc blast incident.

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408.43

REVISION

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Courtesy of Michael J. Johnston

409.60

REVISION

Bonding

Change Summary

- Section 409.60 has been retitled “Bonding” and has been reorganized into list format for clarity.
- Section 409.60(A), “Grounding,” requires an EGC sized in accordance with 250.122 to be connected to an equipment grounding bus or equipment grounding termination point provided in a single-section industrial control panel.
- Section 409.60(B) requires multisection industrial control panels to be bonded together using a bonding jumper sized in accordance with 250.102(D).

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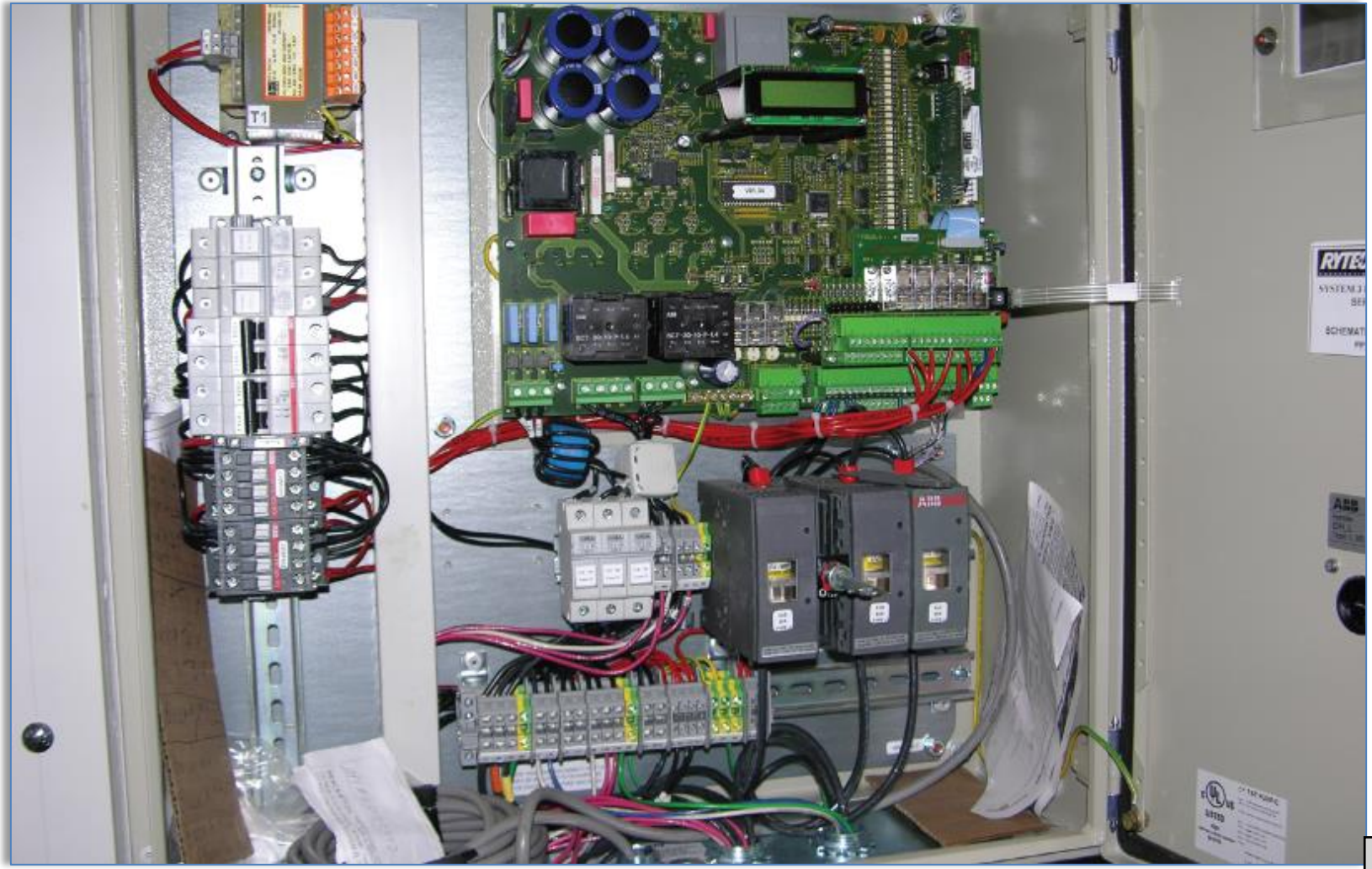
409.60

REVISION



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409.70

NEW

Surge Protection

Change Summary

- A new Section 409.70 has been added to require surge protection for safety circuits for personnel protection.
- A survey of facility managers in 2013 and 2014 by the Fire Protection Research Foundation found that 26% of safety circuits that were intended to protect personnel had surge damage.
- It was also found that 40% of the surges in industrial facilities were from causes within the plant rather than lightning-caused surges.

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409.70

NEW

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409.110

REVISION

Marking

Change Summary

- The marking requirements for industrial control panels have been clarified.
- The voltage, number of phases, and full-load current are required to be marked on the exterior of the enclosure for each supply circuit.
- If the industrial control panel is supplied by multiple sources of supply with multiple disconnecting means, the location of all sources exceeding 50 volts is required to be marked on the exterior.
- The other required markings must be inside or outside of the enclosure.

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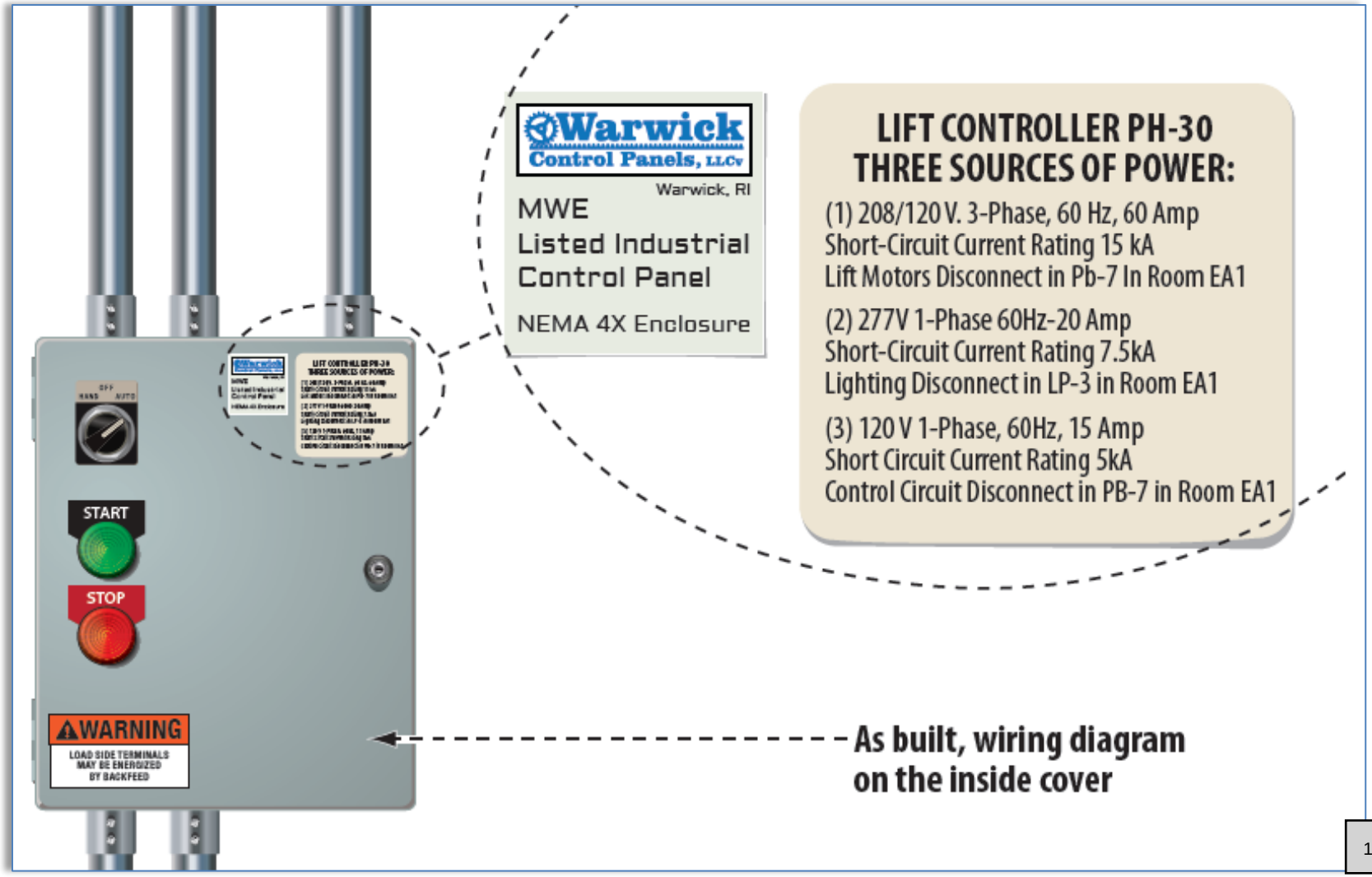
409.110

REVISION



1033

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410.42

REORGANIZE

Luminaires with Exposed Conductive Surfaces

Change Summary

- Section 410.42 was reorganized into a main rule that requires exposed conductive surfaces of a luminaire to be connected to an equipment grounding conductor.
- An exception covers parts that do not require an EGC connection, including:
  - Surfaces that are separated by a listed system of double insulation.
  - Small, isolated parts such as screws, clips, and bands that are separated by at least 1 ½ inches from terminals.
  - Portable luminaires with polarized attachment plugs.

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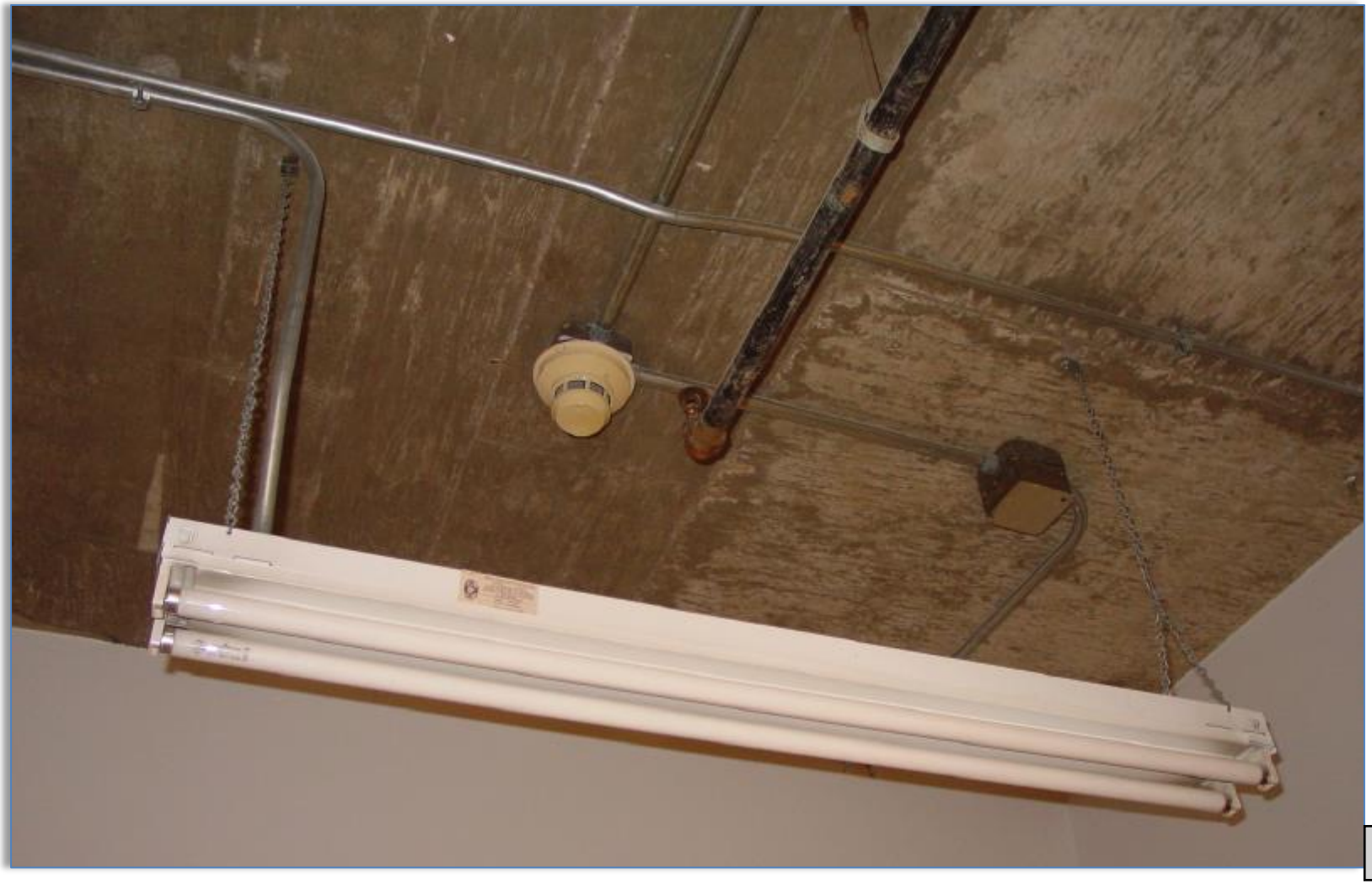
410.42

REORGANIZE



1035

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Courtesy of Michael J. Johnston

410.71

REVISION RELOCATE

Disconnecting Means-Fluorescent or LED Luminaires

Change Summary

- Section 410.130(G)(1) was moved into a new 410.71.
- The requirement has been expanded to include LED luminaire drivers that utilize double-ended lamps.
- LED luminaires are more energy-efficient but can still pose the same shock and electrocution hazards to workers.

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410.71

REVISION RELOCATE

1037

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Courtesy of Tom Garvey and Michael J. Johnston

410.190 through 197

NEW

Provisions for Germicidal Irradiation Luminaires

Change Summary

- A new Part XVII on germicidal radiation luminaires has been added to Article 410.
- Luminaires intended to emit germicidal radiation are required to be listed.
- Germicidal radiation luminaires must be installed in accordance with the manufacturer's instructions.
- Germicidal luminaires are not permitted in dwellings, unless listed and identified for dwellings.

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410.190 through 197

NEW

1039

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Article 422

DELETION REORGANIZE

Appliances

Change Summary

- Several sections in Article 422 were deleted because they were unnecessary for field applications.
- Section 422.6 requires that all appliances be listed. This eliminated the need for Sections 422.3 and 422.4.
- Sections 422.15 and 422.46 were deleted because they do not address unique field installation problems.
- Section 422.23 was deleted because it provides a redundant reference to the special permission requirement in 90.3.
- The flexible cord requirements in 422.43 were consolidated with other flexible cord requirements in 422.16(A).

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Article 422

DELETION **REORGANIZE**

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422.18

REVISION

Ceiling-Suspended (Paddle) Fans

Change Summary

- 422.18(A)(1) was revised to clarify that listed outlet boxes or outlet box systems must be identified for fan support.
- 422.18(A)(2) was revised to use the new terms for weight-supporting ceiling receptacle and weight-supporting attachment fitting.
- 422.18(B) was added to prohibit metal parts of paddle fans from being located within three feet horizontally and eight feet vertically from the top of a bathtub rim or shower threshold.

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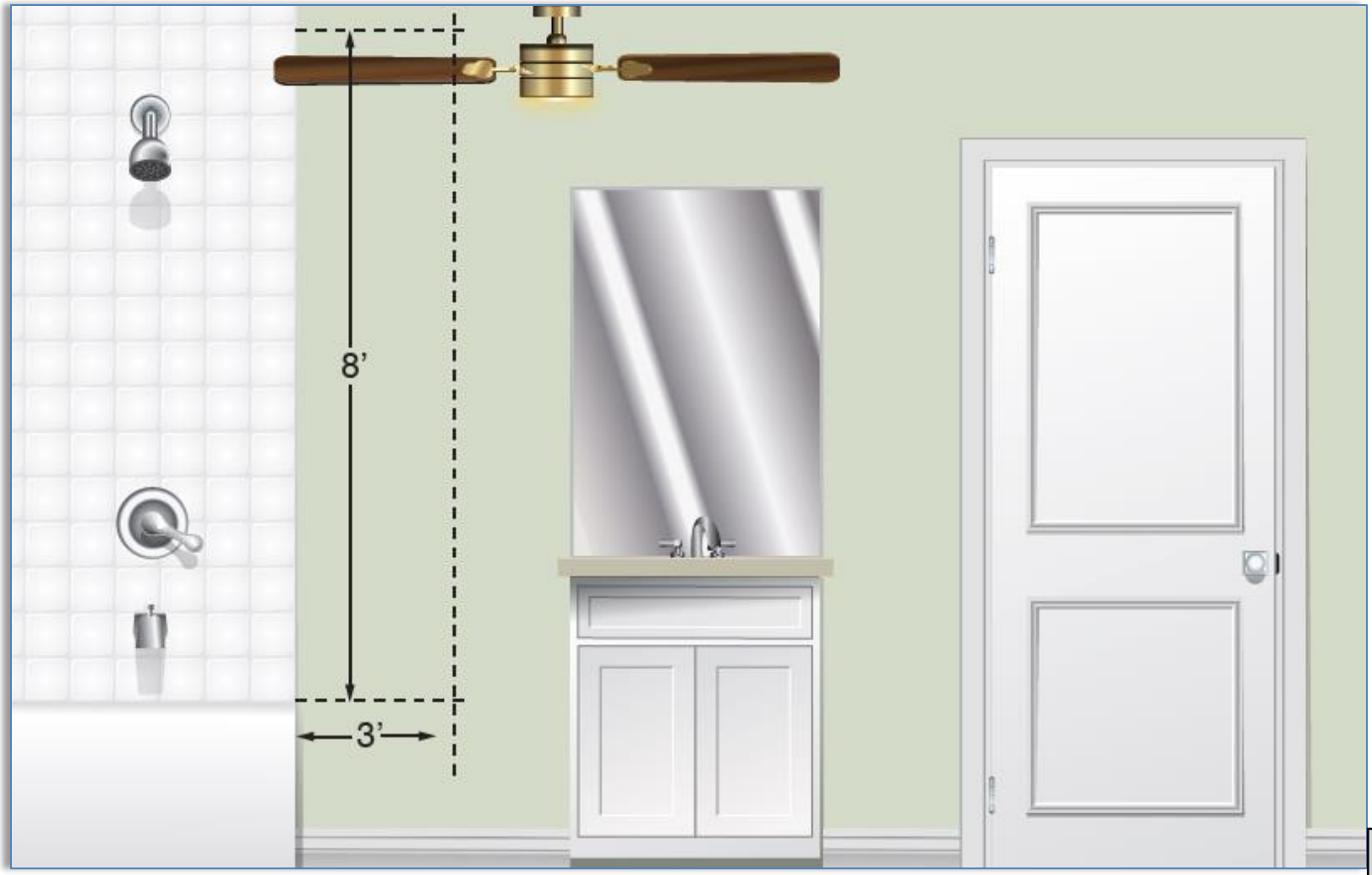
422.18

REVISION



1043

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424.48

NEW

Installation of Cables in Walls

Change Summary

- Section 424.48 recognizes a new heating system that consists of heating cable sets or heating panel sets that can be installed in, on, or behind walls.
- Heating cables and cable sets are required to be GFCI and AFCI protected.
- Heating cables and cable sets are not permitted more than four feet above the floor.

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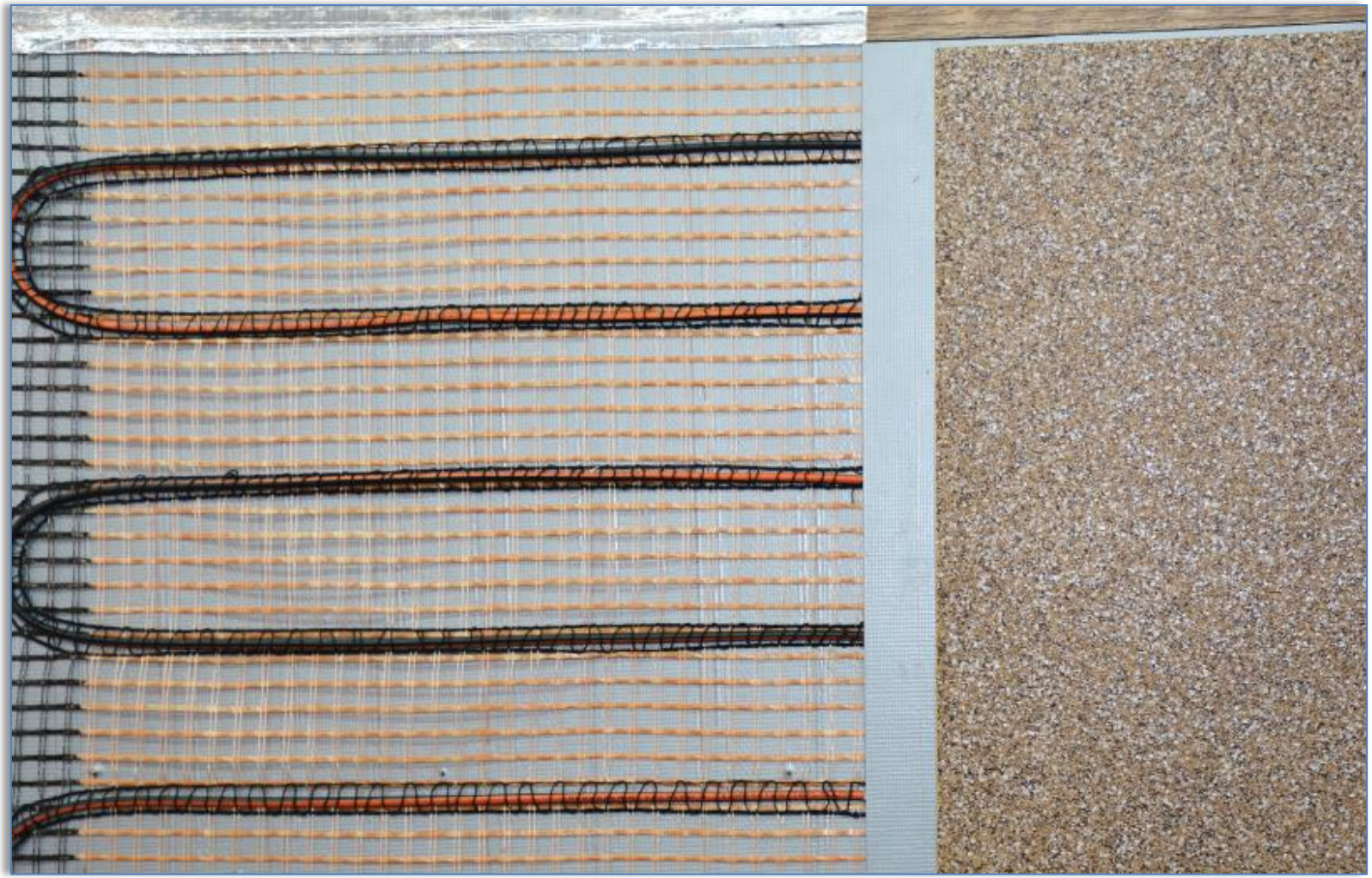
424.48

NEW



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430.1

REVISION

Scope

Change Summary

- Informational Note Figure 430.1 was revised to make it more useful. The table above the figure remains unchanged.
- For consistency, section numbers were removed from the figure.
- Blocks were added to the diagram indicating feeder overcurrent protection, motor controller disconnecting means, motor branch-circuit conductors, local motor branch-circuit disconnecting means (moved),and grounding.

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430.1

REVISION

1047

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Courtesy of Michael J. Johnston

430.6

REVISION

Conductor Ampacity and Motor Rating Determination

Change Summary

- For most general applications, the current values used for determining the ampacity of conductors, the ampere rating of switches, and the ampere rating of branch-circuit short-circuit and ground-fault protection are based on table values from Article 430, Part IV.
- New 430.6(A)(2)(3) was added to permit the use of nameplate current ratings for motors that exceed the motor sizes in Part XIV.
- Section 430.6 was changed into list format to make it easier to use.

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430.6

REVISION

1049

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Courtesy of Michael J. Johnston

430.52(C)

REVISION

Rating or Setting

Change Summary

- Section 430.52(C)(3) was revised to recognize the higher available inrush current that is available for Design B premium efficiency motors that are protected by an instantaneous-trip circuit breaker.
- Section 430.52(C)(6) was revised to recognize the higher inrush current for Design B premium efficiency motors supplied by a self-protected combination motor controller.
- Design B premium efficiency motors have been mandated in new federal energy efficiency regulations. Design B and Design B premium efficiency motors have high inrush currents because they are low-impedance equipment.

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430.52(C)

REVISION

1051

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Courtesy of Michael J. Johnston

430.83(F)

NEW

Ratings

Change Summary

- The new 430.83(F) prohibits installing a motor controller on a circuit where the motor controller's short-circuit current rating is exceeded.
- Section 430.8 generally requires motor controllers to be marked with their short-circuit current ratings.
- Section 110.20 requires the equipment short-circuit current ratings and other characteristics of the circuit to be selected and coordinated to permit the circuit protective devices to clear faults without extensive damage to the electrical equipment.

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430.83(F)

NEW

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440.8

REVISION

Single Machine and Location

Change Summary

- Air-conditioning and refrigeration equipment is prohibited from being installed within three feet horizontally and eight feet vertically above a bathtub rim or shower threshold, including the space directly above the shower or tub.
- This requirement primarily affects the installation of mini-split air-conditioning system evaporators.
- Bathrooms are typically very small rooms. A change in bathroom configuration may be necessary to accommodate the equipment of this type of system.

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440.8

REVISION

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440.22(A)

REVISION

Rating or Setting for Individual Motor-Compressor

Change Summary

- Section 440.22(A) was revised by splitting the last sentence and creating two new exceptions. The existing exception became Exception No. 3.
- The first exception addresses installations where the determined value of branch-circuit short-circuit and ground-fault protection does not correspond with the standard sizes of OCPDs.
- The second exception permits the value of an OCPD to be increased in size to as much as 225% if the motor will not start.

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440.22(A)

REVISION

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445.6

REVISION

Listing

Change Summary

- Previously, stationary generators rated 600 volts or less were required to be listed.
- This section now requires all generators to be listed. However, one-of-a-kind custom manufactured generators are permitted to be field labeled.
- UL 2200, Stationary Generator Assemblies, now also covers medium-voltage generators.

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445.6

REVISION

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445.11

REVISION

Marking

Change Summary

- The generator marking requirements were clarified.
- This criterion is needed to ascertain the performance characteristics of the generator and to establish the overcurrent protective device settings.
- A new requirement was added that prohibits mounting equipment on the generator assembly that conceals or obscures the generator nameplate.

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445.11

REVISION

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445.18 & 445.19

NEW REVISION

Disconnecting Means

Change Summary

- Section 445.18 was divided into two sections. Section 445.18 addresses disconnecting means, and new Section 445.19 addresses emergency shutdown of the prime mover.
- Section 445.18(B) was revised to clarify the need for the ability to isolate the generator output terminals from the paralleling system bus.
- A labeling requirement was added to identify the generator emergency shutdown.

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445.18 & 445.19

NEW REVISION

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450.43(C)

REVISION

Accessibility

Change Summary

- The title of 450.43(C) was changed from “Locks” to “Accessibility.”
- Transformer vault doors are required to open in the direction of egress. This has been modified to require that the door be capable of opening at least 90°.
- Similar changes for a 90° opening of egress doors have been implemented in 110.26(C), 110.33(A)(3), and 480.10(E).

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450.43(C)

REVISION

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460.24(A)

REVISION

Load Current

Change Summary

- Switches used to switch capacitive loads on circuits over 1,000 volts, nominal, shall be specifically rated for the switching of capacitive loads.
- Switches are often evaluated for switching inductive loads, but not capacitive loads.
- Capacitive loads can generate recovery voltages of two to three times the rated system voltage, which can cause external equipment flashovers, rupture of capacitors, and damage to surge protective devices.

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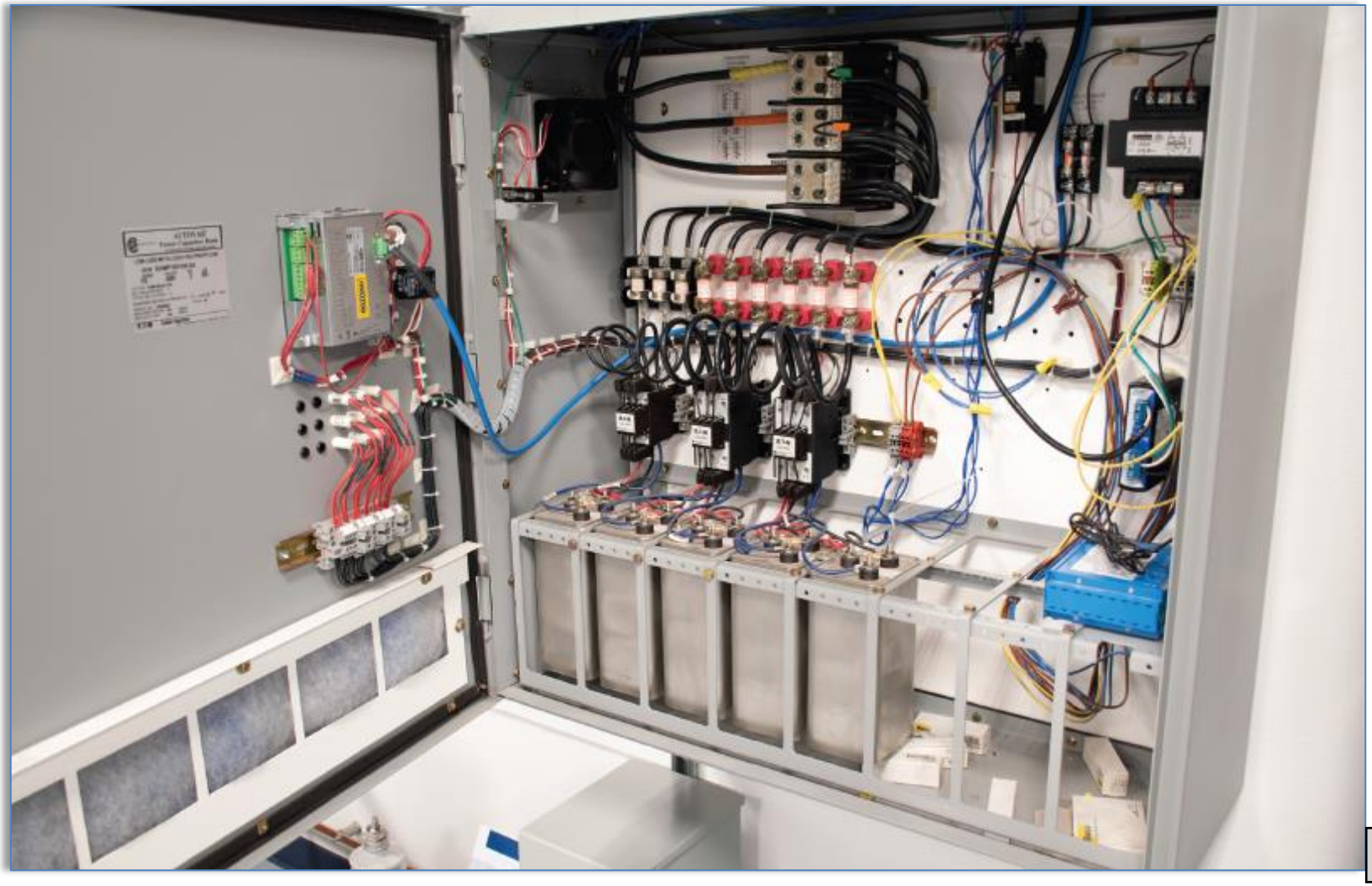
460.24(A)

REVISION



1067

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Courtesy of Eaton

Article 480

REVISION

Stationary Standby Batteries

Change Summary

- The title of Article 480 has been changed from “Storage Batteries” to “Stationary Standby Batteries.”
- The scope of Article 480 has been revised to limit it to stationary batteries exceeding one kilowatt-hour.
- A new Informational Note No. 1 points to Article 706 for batteries that do not meet the definition of stationary storage batteries.
- A reference was added in Informational Note No. 2 to point to *NFPA 855*, which is a fire protection standard for energy storage systems.
- *NFPA 111: Stored Energy Systems* also covers battery installations.

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Article 480

REVISION

© 2022 electrical training ALLIANCE

Article 495

REVISION RELOCATE

Equipment Over 1000 Volts ac, 1500 Volts dc, Nominal

Change Summary

- Article 490 has been relocated to become Article 495. The scope now covers equipment operating at more than 1,000 volts ac or 1,500 volts dc, nominal.
- Requirements for motors, capacitors, resistors, and reactors remain in Articles 430, 460, and 470, respectively.
- Requirements for transformers remain in Article 450. Moving those requirements may be warranted in the future.

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Article 495

REVISION | RELOCATE

1071

© 2022 electrical training ALLIANCE

Courtesy of Michael J. Johnston

90 Introduction

Chapter 1 General
100 Definitions
110 General Requirements for Electrical Installations

Chapter 2 Wiring and Protection
200 Use and Identification of Grounded Conductors
210 Branch Circuits Not Over 1000 Volts ac, 1500 Volts dc, Nominal
215 Feeders
220 Branch-Circuit, Feeder, and Service Load Calculations
225 Outside Branch Circuits and Feeders
230 Services
235 Branch Circuits, Feeders, and Services Over 1000 Volts ac, 1500 Volts dc, Nominal
240 Overcurrent Protection
242 Overvoltage Protection
245 Overcurrent Protection for Systems Rated Over 1000 Volts ac, 1500 Volts dc
250 Grounding and Bonding

Chapter 3 Wiring Methods and Materials
300 General Requirements for Wiring Methods and Materials
305 General Requirements for Wiring Methods and Materials for Systems Rated Over 1000 Volts ac, 1500 Volts dc, Nominal
310 Conductors for General Wiring
312 Cabinets, Cutout Boxes, and Meter Socket Enclosures
314 Outlet, Device, Pull, and Junction Boxes; Conduit Bodies; Fittings; and Handhole Enclosures
315 Medium Voltage Conductors, Cable, Cable Joints, and Cable Terminations
320 Armored Cable: Type AC
322 Flat Cable Assemblies: Type FC
324 Flat Conductor Cable: Type FCC
326 Integrated Gas Spacer Cable: Type IGS
330 Metal-Clad Cable: Type MC
332 Mineral-Insulated, Metal-Sheathed Cable: Type MI
334 Nonmetallic-Sheathed Cable: Types NM and NMC
335 Instrumentation Tray Cable: Type ITC
336 Power and Control Tray Cable: Type TC
337 Type P Cable
338 Service-Entrance Cable: Types SE and USE
340 Underground Feeder and Branch-Circuit Cable: Type UF
342 Intermediate Metal Conduit (IMC)
344 Rigid Metal Conduit (RMC)
348 Flexible Metal Conduit (FMC)
350 Liquidtight Flexible Metal Conduit (LFMC)
352 Rigid Polyvinyl Chloride Conduit (PVC)
353 High Density Polyethylene Conduit (HDPE Conduit)
354 Nonmetallic Underground Conduit with Conductors (NUCC)

355 Reinforced Thermosetting Resin Conduit (RTRC)
356 Liquidtight Flexible Nonmetallic Conduit (LFNC)
358 Electrical Metallic Tubing (EMT)
360 Flexible Metallic Tubing (FMT)
362 Electrical Nonmetallic Tubing (ENT)
366 Auxiliary Gutters
368 Busways
369 Insulated Bus Pipe (IBP)/Tubular Covered Conductors (TCC) Systems
370 Cablebus
371 Flexible Bus Systems
372 Cellular Concrete Floor Raceways
374 Cellular Metal Floor Raceways
376 Metal Wireways
378 Nonmetallic Wireways
380 Multioutlet Assembly
382 Nonmetallic Extensions
384 Strut-Type Channel Raceway
386 Surface Metal Raceways
388 Surface Nonmetallic Raceways
390 Underfloor Raceways
392 Cable Trays
393 Low-Voltage Suspended Ceiling Power Distribution Systems
394 Concealed Knob-and-Tube Wiring
395 Outdoor Overhead Conductors over 1000 Volts
396 Messenger-Supported Wiring
398 Open Wiring on Insulators

Chapter 4 Equipment for General Use
400 Flexible Cords and Flexible Cables
402 Fixture Wires
404 Switches
406 Receptacles, Cord Connectors, and Attachment Plugs (Caps)
408 Switchboards, Switchgear, and Panelboards
409 Industrial Control Panels
410 Luminaires, Lampholders, and Lamps
411 Low-Voltage Lighting
422 Appliances
424 Fixed Electric Space-Heating Equipment
425 Fixed Resistance and Electrode Industrial Process Heating Equipment
426 Fixed Outdoor Electric Deicing and Snow-Melting Equipment
427 Fixed Electric Heating Equipment for Pipelines and Vessels
430 Motors, Motor Circuits, and Controllers
440 Air-Conditioning and Refrigerating Equipment
445 Generators
450 Transformers and Transformer Vaults (Including Secondary Ties)

455 Phase Converters
460 Capacitors
470 Resistors and Reactors
480 Stationary Standby Batteries
495 Equipment Over 1000 Volts ac, 1500 Volts dc, Nominal

Chapter 5 Special Occupancies
500 Hazardous (Classified) Locations, Classes I, II, and III, Divisions 1 and 2
501 Class I Locations
502 Class II Locations
503 Class III Locations
504 Intrinsically Safe Systems
505 Zone 0, 1, and 2 Locations
506 Zone 20, 21, and 22 Locations for Combustible Dusts or Ignitible Fibers/Flyings
511 Commercial Garages, Repair and Storage
512 Cannabis Oil Equipment and Cannabis Oil Systems Using Flammable Materials
513 Aircraft Hangars
514 Motor Fuel Dispensing Facilities
515 Bulk Storage Plants
516 Spray Application, Dipping, Coating, and Printing Processes Using Flammable or Combustible Materials
517 Health Care Facilities
518 Assembly Occupancies
520 Theaters, Audience Areas of Motion Picture and Television Studios, Performance Areas, and Similar Locations
522 Control Systems for Permanent Amusement Attractions
525 Carnivals, Circuses, Fairs, and Similar Events
530 Motion Picture and Television Studios and Remote Locations
540 Motion Picture Projection Rooms
545 Manufactured Buildings and Relocatable Structures
547 Agricultural Buildings
550 Mobile Homes, Manufactured Homes, and Mobile Home Parks
551 Recreational Vehicles and Recreational Vehicle Parks
552 Park Trailers
555 Marinas, Boatyards, Floating Buildings, and Commercial and Noncommercial Docking Facilities
590 Temporary Installations

Chapter 6 Special Equipment
600 Electric Signs and Outline Lighting
604 Manufactured Wiring Systems
605 Office Furnishings
610 Cranes and Hoists
620 Elevators, Dumbwaiters, Escalators, Moving Walks, Platform Lifts, and Stairway Chairlifts
625 Electric Vehicle Power Transfer System
626 Electrified Truck Parking Spaces

630 Electric Welders
640 Audio Signal Processing, Amplification, and Reproduction Equipment
645 Information Technology Equipment
646 Modular Data Centers
647 Sensitive Electronic Equipment
650 Pipe Organs
660 X-Ray Equipment
665 Induction and Dielectric Heating Equipment
668 Electrolytic Cells
669 Electroplating
670 Industrial Machinery
675 Electrically Driven or Controlled Irrigation Machines
680 Swimming Pools, Fountains, and Similar Installations
682 Natural and Artificially Made Bodies of Water
685 Integrated Electrical Systems
690 Solar Photovoltaic (PV) Systems
691 Large-Scale Photovoltaic (PV) Electric Supply Stations
692 Fuel Cell Systems
694 Wind Electric Systems
695 Fire Pumps

Chapter 7 Special Conditions
700 Emergency Systems
701 Legally Required Standby Systems
702 Optional Standby Systems
705 Interconnected Electric Power Production Sources
706 Energy Storage Systems
708 Critical Operations Power Systems (COPS)
710 Stand-Alone Systems
722 Cables for Power-Limited Circuits and Fault-Managed Power Circuits
724 Class 1 Power-Limited Circuits and Class 1 Power-Limited Remote-Control and Signaling Circuits
725 Class 2 and Class 3 Power-Limited Circuits
726 Class 4 Fault-Managed Power Systems
728 Fire-Resistive Cable Systems
750 Energy Management Systems
760 Fire Alarm Systems
770 Optical Fiber Cables

Chapter 8 Communications Systems
800 General Requirements for Communications Systems
805 Communications Circuits
810 Antenna Systems.
820 Community Antenna Television and Radio Distribution Systems
830 Network-Powered Broadband Communications Systems
840 Premises-Powered Broadband Communications Systems

Objectives: Explaining what each code change is

Kristi Boggs, Co-Director

Mansfield Area Electrical JATC

67 S. Walnut St.

Mansfield, Ohio 44902

Office: (419) 526-4688

Cell: (419) 545-2767

File Attachments for Item:

ER-12 Solar PV and the 2023 NEC Part 1 (Matthews Electrical Services)

All certifications (4 hours)

Staff Notes:

ESIAC Recommendation:

Committee Recommendation:

Solar PV and the NEC Part 1

Course Outline

1. Structure
    a. Duration: 4 hour
    b. Format
        i. Webinar
            1. Register at www.matthewselectrical.net
            2. Webinar conducted at www.zoom.com
    c. Resources
        i. 2023 National Electrical Code
            1. Article 250 Grounding and Bonding
            2. Article 685 Integrated Electrical Systems
            3. Article 690 Solar Photovoltaic Systems
            4. Article 691 Large Scale Photovoltaic Electric Supply Stations
            5. Article 705 Interconnected Electric Power Production Sources
            6. Article 706 Energy Storage Systems
        ii. NFPA 70E Electrical Safety in the Workplace
        iii. PowerPoint Slides Developed by Matthews Electrical Services
        iv. Solar Energy International – website
        v. IAEI.org website
        vi. NFPA website
        vii. Various PV equipment manufacturers
        viii. Various PV publications: Home Power e.g.
2. Curriculum
    a. PV Basics
        i. History
        ii. Energy outlook
    b. Definitions
    c. Basic PV Math
        i. Ohms Law
        ii. Series and parallel connections
            1. Resistance, voltage and current calculations
            2. Solar arrays
            3. batteries
        iii. AC and DC differences
        iv. Power: kilowatts, KVA, kVAR, power factor
    d. Types of systems
        i. Stand-alone
        ii. Grid-direct
        iii. multimode
    e. Components

        i. Modules, arrays
        ii. Wires, cables, connectors
        iii. Inverters
        iv. Microinverters
        v. Dc converters
        vi. Batteries
        vii. Charge controllers
        viii. Utility meters
        ix. Panels
        x. Generators
f. Solar PV safety
g. How to read and interpret solar modules labels
h. How to read and interpret inverter labels
i. Article 690 requirements
        i. Overcurrent protection
        ii. Grounding and bonding
        iii. Ground fault protection
        iv. Arc fault protection
        v. Rapid shutdown

APPLICATION FOR CONTINUING EDUCATION APPROVAL
COURSE CONDITIONS AND GUIDELINES

The Ohio Board of Building Standards is committed to the ongoing education and professional development of board-certified personnel through the delivery of high-quality, accurate and engaging professional continuing education content. To this end, the Board reviews and approves Continuing Education Courses for building department personnel.

Board approval is granted for course instruction on current codes and standards, including the OBC, OMC, OPC, and RCO, and any other content areas directly related to the responsibilities of the certification for which credit is being requested.

Promotion: Any person or organization promoting an approved course is required to make full and accurate disclosure regarding course title, course approval number, number of credit hours, categories for which the BBS has approved the class, and fees in promotion materials and advertising. ***The Board does not grant retroactive approval. It is recommended that courses be submitted for approval well in advance of any scheduling of classes and advertising***. Advertising may not falsely state BBS approval before approval is granted. Course providers may state that BBS approval is pending.

Application Submission: All Applications and associated materials shall be submitted by email in .pdf format. Instructions for completing the application are attached.

Certificate of Completion: Course providers shall provide participants a certificate of completion containing the following information:

- Name of participant
- Title of approved courses
- BBS approval #
- BBS approved certifications
- Date of the continuing education program
- Number of approved credit hours awarded, and
- Signature of authorized sponsor or instructor.

Any person or organization administering an approved course shall return a completed BBS Course Attendance form by email.

Participants: Participants must attend the complete course as presented by the instructor to receive credit hours approved by the Board. The organization or instructor of online courses shall plan and execute methods to verify the individual's attendance and completion of the course. No partial credit will be given to any participant who failed to complete the entire course as approved.

Board approval: All courses are approved for the calendar year in which application is made. Courses may be renewed so long as the referenced code is in effect, and the CEUs, certification and content remain unchanged. When the referenced code is updated, courses must be updated, and new approvals obtained.

Facility/training area: BBS Course may be delivered in person or online, or both, at the sponsor's option.
Course facilities shall include the following:

In Person Classes:
Sufficient seating capacity
ADA accessible facilities
Appropriate Audio/Visual devices for delivery
Writing surfaces for participants

Online Classes:
Web-accessible
ADA accessible delivery
Tech support available
Live and recorded courses permitted

In-person facilities shall comfortably and safely seat at least the number of attendees present in the room and shall be climate controlled, non-smoking, and sound controlled so that outside noise will not interfere with the training.

Ohio Department of Commerce

Mike DeWine, Governor
Jon Husted, Lt. Governor

Sheryl Maxfield, Director

Board of Building Standards

Application for Continuing Education Course Approval

Provider Information:

Name: HENRY PETER MATTHEWS

Organization: MATTHEWS ELECTRICAL SERVICES

Address: 1203 MCKINLEY PLACE

E-mail: hpmatthews@att.net Telephone: 419-575-3488

Website: www.matthewselectrical.net

Conference Sponsor (if applicable) _____ Conference Email: _____

Check here if Course Renewal: _____ Prior course number _____ (*i.e. BBS2018-429*)

Renewals will only be granted for identical content and certifications, within the current code cycle.
Attach a copy of prior course approval letter for confirmation. No further information is required.

New Course Information:

Course title: Solar PV and the NEC Part 1

Course instructor: Henry Matthews

Course description: This course will be an introductory course to Solar PV installations and focusing on article 690 from the 2023 NEC.

Instructional hours per session: 4 Number of Sessions: multiple throughout 2024

Course Date(s) and Location: TBD (1st Quarter of 2024)

Special Content:

Code Administration: ☐
Existing Buildings: ☑
Electrical Instruction: ☑
Plumbing Instruction: ☐

Conference Course: _____
Conference Name: _____
Conference location: _____

Course to be offered online? ☑ **On Demand** ☐ **Webinar** ☑

Course Website: www.matthewselectrical.net

Detail online course participation confirmation method *(i.e. test, quizlets, participant activity confirmation)*:
Participation will be verified by Zoom attendance tracking, live roll call, polls and surveys.

Course applicable for the following certifications

Residential Certifications Only: ☑ Commercial Certifications: ☑
Administrative Course, All Certifications: ☐

Application materials included:

☑ Course Outline or Course Learning Objectives
☑ Presentation Materials/Slides (not required for roundtable courses)
☑ Assessment Materials (for online courses)
☑ Presenter Bio

Please submit application and materials in .pdf format to: michael.lane@com.ohio.gov or BBS@com.ohio.gov

Instructions for new Continuing Education Approval form

Provider Information

1. Please include all contact information.
2. If course is not part of a conference, leave conference sponsor and email blank.

Course Renewal

1. Indicate if the course is being submitted for renewal. Include prior approval letter and write in prior course number.
2. Certification approval for courses has now changed: all existing courses being renewed will be approved within the new classification system.
    a. Courses previously approved for only residential certifications will be approved for all residential certifications.
    b. Courses previously approved for at least on commercial certification will now be approved for all commercial certifications and all residential certifications.
    c. Courses on required instruction topics, Ohio Ethics, Code Administration and Existing Buildings, will be noted as Administrative Courses and be approved for all certifications.
3. Courses being renewed should skip the New Course information section and are not required to submit outline, agenda, slides or other instructional materials for review. Skip to Special Content, and mark any item that applies to the course.

New Course Information

1. Enter course title, name of instructor, and a brief description of the course content. Learning objectives may be substituted for course description, if desired.
2. Number of instructional hours per session is the length of instructional time.
3. Number of sessions: can be 1 or the number of sessions planned.
4. Course date(s) and location: not necessary at this time, enter if known.

Special Content

1. Indicate if the course will meet instructional time in Code Administration or Existing Buildings.
2. Indicate if the course is a plumbing or electrical course, for ESIAC review and trainee course tracking.
3. If the course is associated with a conference, indicate the conference name and location, as this will allow BBS to coordinate approvals with the conference provider.
4. If the course will be offered online, specify whether it will be on demand or offered as a virtual webinar, or both. Include website where the course will be provided.

Course applicable for the following certifications

This section represents a major change from previous BBS course approval forms.

1. If the course is only for residential certifications, check 'Residential Certifications Only'. The course, if approved, will be approved for all residential certifications.
2. If the course is appropriate for any commercial certifications, check Commercial Certifications. The course, if approved, will be approved for all commercial certification **AND** all residential certifications.
3. If the course is intended to meet required instruction in Code Administration (Chapter 1) or Existing Buildings (commercial or residential) check 'Administrative Course, All Certifications'.

Application Materials Included

This is a checklist for the course submitter's use, to be sure all materials necessary for review are included with the application. All materials should be submitted in .pdf format, along with the application, via email to Michael.Lane@com.ohio.gov or BBS@com.ohio.gov

BIOGRAPHY

Henry P. Matthews PE, CPE, CESCP, PVA, SMIEEE

Henry has over 31 years of experience in the electrical design, construction, engineering and safety fields. He has a passion for teaching and mentoring.

Henry obtained his Bachelor of Science degree in Electrical Engineering from Penn State University in 1989.

He also earned a Master of Business Administration from Bowling Green State University in 2003.

In addition, Henry earned several certificates including:

- Plumbing and Electrician from Penn Foster Career School
- Welding from Owens Community College in Findlay, Ohio
- Residential Solar PV Systems from Solar Engineering International

Henry currently holds the following licenses, and memberships:

- Licensed Electrical Contractor in Ohio
- Licensed Training Agency in Ohio
- Licensed Professional Engineer in Ohio, Michigan, Kentucky, Indiana, Illinois, Wisconsin
- Certified Plant Engineer (CPE)
- Certified Building Operator (CBO)
- Certified Electrical Compliance Safety Professional (CESCP) by NFPA
- Solar PV Associate by the North American Board of Certified Energy Practitioners
- Electric Vehicle Infrastructure Training Program (EVITP) certification
- Senior Member of the Institute of Electrical and Electronic Engineers (IEEE)
- Member of the International Association of Electrical Inspectors (IAEI)
- Member of the National Fire Protection Association (NFPA)
- Member of the Society of Maintenance and Reliability Professionals (SMRP)

Henry is currently employed as an Advanced Senior Engineer for Marathon Petroleum Company in Findlay, Ohio. During his 16 years at Marathon, Henry has worked as an Electrical Design Engineer, Project Engineer, Engineering Supervisor and currently as a Reliability Engineer.

Henry is also the owner of Matthews Electrical Services, a small, but full-service electrical contractor company.

Prior to this, he worked 13 years as an Electrical Engineer and a Plant Engineering Manager in at Cooper Standard Automotive, a major automotive parts supplier in Bowling Green, Ohio

Henry is the past co-chair of American Petroleum Institute Recommended Practice 545 Lightning Protection for Above Ground Storage Tanks.

He is current co-president of the Marathon Findlay Ohio Toastmasters club.

During his career, Henry has provided electrical, safety and engineering training to college students, industrial maintenance teams, engineering new hires and contractor groups.

Welcome to Solar PV and the 2023 NEC Part 1!

Solar PV Code Training

MATTHEWS ELECTRICAL SERVICES

OCILB Course number: 4871424

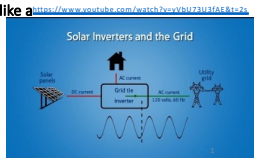
Please Join Webinar as a Panelist!

You won't have to present. It allows the host to verify your attendance and allows us to see and hear each other like a classroom

Please mute your microphones

Text me at cell no. ***419-575-3488*** *for any problems*

Enjoy the video as we wait for the webinar to start!



1

Solar PV Systems and the 2023 NEC, Part 1

Solar PV Code Training

MATTHEWS ELECTRICAL SERVICES

MATTHEWS ELECTRICAL SERVICES

2

2

Notice!

This course is based on the 2023 NEC.

3

3

4

Webinar Rules

- Attendee must be present the entire time (except breaks)
- Host my record this webinar
  - Proof of attendance and participant identity
  - Potential OCILB audits
- Turn on webcam:
  - After breaks
  - Before end of class
  - At instructor discretion to check attendance
- Mute microphone at all times
  - Prevents distraction during webinar
  - Instructor may activate participant microphone if verbal response is needed

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Webinar Rules (Continued)

- 5 minute breaks every hour
  - Return promptly after breaks
  - The instructor will check attendance after each break
- Emergencies
- Contingency Plans: Ohio Weather
- Unexpected interruption
  - Re-joining webinar
  - Problems:
    - send me a text message: 419-575-3488
    - Or email: hpmatthews66@att.net

6

6

WELCOME!

- Goals
  - Promote learning
  - Make session engaging
    - Discussion
    - Videos
    - Case Studies
    - Polls
  - Make 4 hours as productive as possible!

7

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Webinar Completion

- Certificate of completion will be sent via email to all attendees
- 4 hours of Ohio OCILB Code credits will be submitted to the state the same day
- 4 hours of CEU credits will be sent to the OBBS the same day
- Feedback is encouraged to improve future webinars!
- Send other inquires, feedback and questions to: hpmatthews@matthewselectrical.net
- 419-575-3488 (cell)

8

8

CERTIFICATE OF COMPLETION

THIS CERTIFIES THAT

SONNY DAY

OCILB License no: 12345 Electrical, Plumbing, HVAC, Refrigeration, Hydronics

HAS SUCCESSFULLY COMPLETED THE TRAINING REQUIREMENTS FOR

Solar PV and the NEC Part 1

OCILB COURSE NO: 4871424

4 CODE CREDIT HOURS

April 23, 2022

DATE

MATTHEWS ELECTRICAL SERVICES

Agency #48714

HENRY P. MATTHEWS PE, CESCP

INSTRUCTOR

9

9

Your Instructor: Henry Matthews

- Advanced Senior Engineer (Current): Oil and Gas Company (16 yrs)
- Plant Engineering Manager: Cooper Standard Automotive (13 yrs)
- Electrical Designer: Toledo Engineering Company (4 yrs)
- BS Electrical Engineering – Penn State University
- MBA – Bowling Green State University
- Registered Professional Engineer – OH, IN, KY, WI, MI, IL,WV
- Certified Professional Engineer – CPE
- Certified Electrical Safety Compliance Professional (CESCP) by NFPA
- Licensed Electrical Contractor – OH
- Registered Training Agency – OCILB OH #48714
- Registered Training Agency – Ohio Board of Building Standards (BBS)
- Senior Member of IEEE
- Member of NFPA – Builders and Architects division
- Member of International Association of Electrical Inspectors (IAEI)
- Member of Association of Facility Engineers (AFE)
- Co-chair API RP 545 – Lightning Protection for Above Ground Storage Tanks
- Over 29 years in the electrical design, construction and standards industry

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Solar Installations in 2023 Expected to Exceed 30 GW for the First Time in History

SEIA Solar Energy Industries Association®

Thursday, Sep 07 2023

Press Release

WASHINGTON D.C. — The U.S. solar industry expects to add a record 32 gigawatts (GW) of new capacity in 2023, a 52% increase from 2022, according to the U.S. Solar Market Insight Q3 2023 report released today by the Solar Energy Industries Association (SEIA) and Wood Mackenzie.

The solar market has been hampered in recent years by supply chain challenges brought on by the COVID-19 pandemic and exacerbated by restrictive trade policy. These challenges are beginning to abate, and as policies in the Inflation Reduction Act (IRA) take hold, Wood Mackenzie expects total operating solar capacity to grow from 153 GW today to 375 GW by 2028.

"The United States is now a dominant player in the global clean energy economy, and states like Florida, Texas, Ohio, and Georgia are at the forefront of this job growth and economic prosperity," **said SEIA president and CEO Abigail Ross Hopper.** "The solar and storage industry is delivering abundant clean energy that is generating tens of billions of dollars of private investment, and this is just the tip of the iceberg."

12

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Notable Solar Installations in Ohio

- **Hillcrest Solar** in Mt. Orab was developed by Innergex and came online in 2021. This **265 MW** project produces enough electricity to power **32,648 homes**.
- **Amazon, Meta, and Campbell Soup Co.** have all gone solar in Ohio. **Campbell Soup Co.'s 9.8 MW** project in Napoleon is one of the largest on-site corporate projects in the state.
- At **199.3 MW**, **Hardin Solar** in Alger is among the largest solar installations in Ohio. Completed by Invenergy in 2021, this solar project has enough electric capacity to power more than **24,554 homes**.

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Top 5 solar projects beginning construction in 2023

Project Name	Owner	Solar Project Capacity (MW)	Project Value (Million $)	State
Sawtooth Energy Center Project	Boulevard Associates, LLC	1,000	$1,720	Nevada
Smoky Valley Solar Project	CG Western Renewables III, LLC	1,000	$1,000	Nevada
Ditat Deus Solar Project	Ditat Deus Solar LLC	650	$1,000	Arizona
Beatty Energy Center Project	NextEra Energy Resources, LLC	500	$860	Nevada
Sleepy Orange Solar Project	Sleepy Orange Solar, LLC	500	$860	Nevada

**FirmoGraphs Estimates the value of the project based on 2021 Annual Technology Baseline (ATB) data from the National Renewable Energy Laboratory (NREL)*

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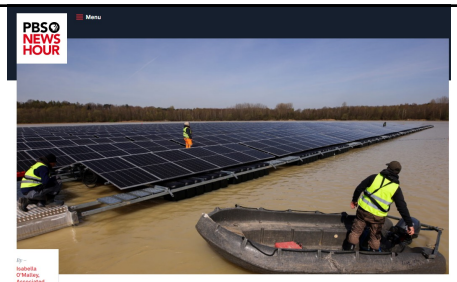

By – Isabella O'Malley, Associated Press

Leave your feedback

Long popular in Asia, floating solar catches on in the U.S.

Science May 12, 2023 7:04 PM EDT

15

This PairTree charging station from Paired Power features a canopy with solar panels to provide power for the station, shown here charging an electric tractor. Source: Paired Power

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Roll Call!

- Turn on your camera and microphone
- Wave, yell or do something creative to get my attention!
- After acknowledgment, mute your microphone
- Turn off your camera
- Thank you!

17

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Disclaimer #1

- I don't know everything!
- It will be IMPOSSIBLE to learn Solar PV in 4 hours!
- But we'll try to cover the main points

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Disclaimer #2

- The views and opinions presented in this class are those of Matthews Electrical Services and not necessarily those of the various entities the presenter represents or has previously or currently works for.
- The material used in this class is based on documented publicly-available information (NFPA, OSHA, IEEE etc.)
- The interpretation of this material is based on the presenters experience and training of the subject matter.

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Disclaimer #3

- This presentation uses video and props from various electrical equipment manufacturers. This is not intended to endorse any particular products, vendors or manufacturers.
- The content is shown for educational purposes only.

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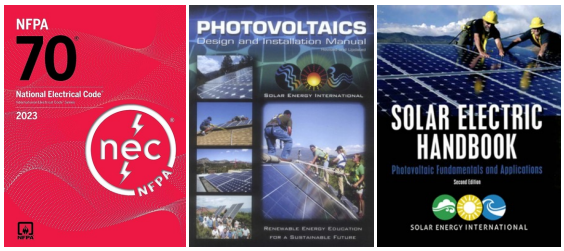

Resources

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Other Resources

- Solar Energy Industries Association www.seia.org
- Solar Energy International: www.solarenergy.org
- Power Engineering Magazine: www.power-eng.com
- North American Board of Certified Energy Professionals: www.nabcep.org
- PVWatts: www.pvwatts.nrel.gov
- Home Power Magazine: www.homepower.com
- NFPA: www.nfpa.org
- OSHA: www.osha.gov
- IAEI: www.iaei.org
- Mike Holt Enterpises: www.MikeHolt.com
- Electrical Construction and Maintenance (EC&M) website: www.ecmweb.com
- NEMA: www.nema.org
- UL: www.ul.com
- NECA: www.necanet.org
- Electrical Safety Foundation International (ESFi): https://www.esfi.org/

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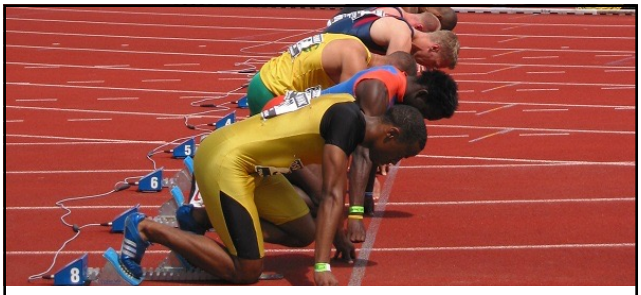

Let's Begin!

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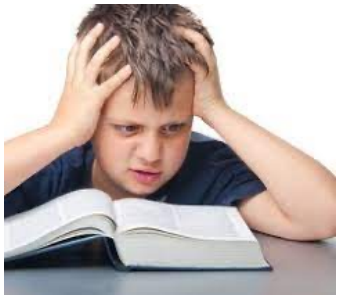
Article 690: Solar Photovoltaic Systems



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What's Happening in the USA and Ohio?

SEIA Solar Energy Industries Association®

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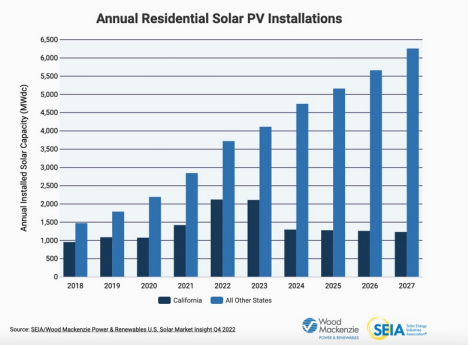

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Getting Started for the Contractor

- Getting qualified:
  - Electrical training: on the job, NEC, NFPA 70E etc.
- Getting Certified: NABCEP (www.nabcep.org)
- Know the rules and requirements:
  - NEC chapters 1-4
  - NEC article 690, 705
  - Local, state and federal building codes and ordinances
- Local Utility requirements: interconnections, special requirements
- Know the components, use listed products (solar modules, inverters)
- Roof installation: qualified? Partner with roofing contractor?
- Commissioning

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Getting Started for the Home-Owner or Client

- What type of system? Stand-alone, grid-tied, hybrid etc.
- How large?
- How complex? Batteries, monitoring? Diagnostics (MLPEs)?
- Utility constraints: interconnect agreements, net metering?
- Budget
- Financing: out of pocket, loan, grant etc.
- Available incentives: www.DSIREUSA.org
- Home-owner insurance: limitations, allowances
- Roof condition
- Home Owner Association: aesthetics, limitations

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Grid-Tied: Get in Line!

- Don't forget the utility interconnection agreement!
- Long processing times

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Finding Incentives

DSIRE®

NC CLEAN ENERGY TECHNOLOGY CENTER

https://www.dsireusa.org/

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Agenda

- Introduction to Solar PV
- Relevant NEC Articles
- PV Safety
- Definitions
- Basic PV Math
- PV Requirements

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Relevant NEC and NFPA Resources

2020 National Electrical Code

- Article 250 Grounding and Bonding
- Article 480 Storage Batteries
- Article 685 Integrated Electrical Systems
- Article 690 Solar Photovoltaic Systems
- Article 691 Large Scale Photovoltaic Electric Supply Stations
- Article 705 Interconnected Electric Power Production Sources
- Article 706 Energy Storage Systems

2021 NFPA 70E Electrical Safety in the Workplace

Applicable UL standards

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Article 690: Solar Photovoltaic (PV) Systems

- Part I: General (definitions)
- Part II: Circuit Requirements
  - Maximum voltage: no greater than 1000V (690.7)
    - One and two-family dwelling units limited to 600V.
    - Limited to 1500VDC when not located on or in buildings
- Good reference:
  - Photovoltaic Array Performance Model (SAND 2004-3535)
  - Sandia National Laboratories

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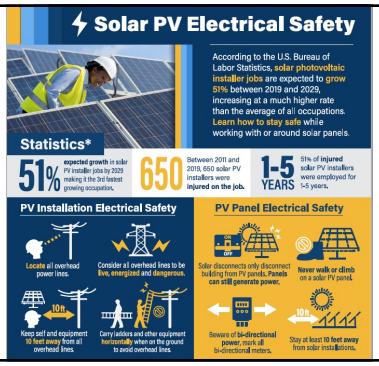

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Safety

- Can generate high levels of DC current
- Solar panels can generate power even with low levels of light.
- AFCIs required for DC circuits over 80V (690.11) – note exception
- Rapid shutdown requirements for systems on buildings (690.12)
  - Goal – protect firefighters, note exception
- External disconnect requirements
- DC current can be harder to interrupt than AC current
  - Bulkier disconnects and equipment
- PPE requirements
- Fall protection for roof-mounted systems

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Maximum Voltages: 690.7

Type of Building	Maximum Voltage
One and Two-Family Dwelling Units	600 volts
On or in buildings	1000 volts
Not located in or on buildings	Greater than volts*

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Fluke 393 FC CAT III 1500 V True-rms Solar Clamp Meter

Megger releases solar clamp meter that can measure 2,000 V and 1,500 A

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Some Familiar Safety Requirements

- Ground Fault Protection
- Arc Fault Protection
- Surge Protection
- Grounding and Bonding
- Labeling
- Listing

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Special Safety Requirements

- Rapid Shutdown
- Connector Intermatibility
- Array Boundaries and setbacks
- Exterior Disconnects (PV Disconnect)
- Special Labeling

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Lead with Safety!

https://www.youtube.com/watch?v=b_3TtswrUkw&t=82s

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Quiz

• What's the ideal orientation of a fixed roof-mounted solar PV array?

a) North
b) South
c) East
d) West

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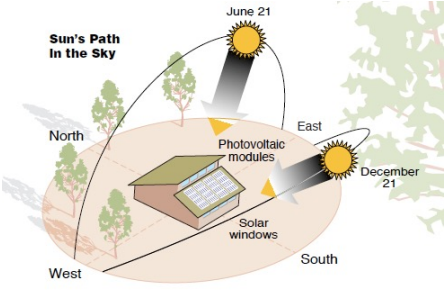

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Quiz

- Which location will produce the most efficient output from a solar module?

a) In the Arizona desert
b) On a Florida beach
c) An open field in Ohio
d) A treeless mountaintop in Vermont

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- Example: Panel rated for 350 watts at 25 deg C (77 deg F) STC (More on this later!)
- Arizona desert is 104 deg F = 40 deg C in July
- 40 deg C is 15 degrees above STC of 25 deg C
- Lose 0.34% power for every degree C above 25 deg C
- 350 watts x 0.34/100 = 3.5 watts loss each degree above 25 deg C
- 3.5 watts/deg C x 15 deg C = 52.5 watts
- 350 – 52.5 = 297.5 watts (may need more panels!)
- Current will rise (Isc) which will degrade module over time

Will get more power in cooler temps!

TEMPERATURE RATINGS	
NOCT (Nominal Operating Cell Temperature)	43°C (±2°C)
Temperature Coefficient of P_{MAX}	- 0.34%/°C
Temperature Coefficient of V_{OC}	- 0.25%/°C
Temperature Coefficient of I_{SC}	0.04%/°C

MAXIMUM RATINGS	
Operational Temperature	-40~+85°C
Maximum System Voltage	1500V DC (UL)
Max Series Fuse Rating	20A

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Types of PV Systems

- Rooftop
- Ground Mount
- Carport
- Floating

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PV Components

- Photovoltaic cell
- Module
- Panel
- Array
- Charge Controller
- Battery
- Inverter

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PV Components Continued

- Combiner Box
- DC Loads
- AC Loads
- Meters
- Panels

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Listing, Marking, Identification, Labeling: 690.4(B)

- Nationally Recognized Testing Laboratory (NRTL)
- ANSI Z535 standards
- NEC 690 requirements

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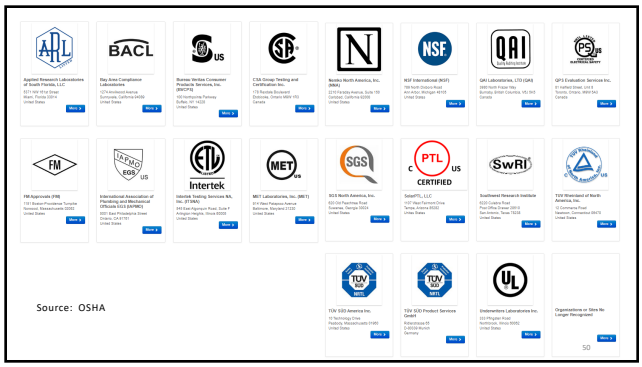

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Listing: 690.4(B)

- Equipment used for PV systems must be listed for "PV" use
- Fuses and circuit breakers must be listed for DC use
- BEWARE OF EQUIPMENT WITH INADEQUATE LISTINGS, RATINGS AND MARKINGS!! LOTS OF CHEAP IMITATIONS!!

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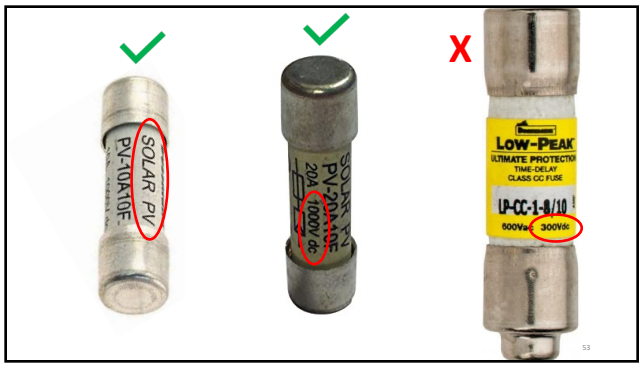
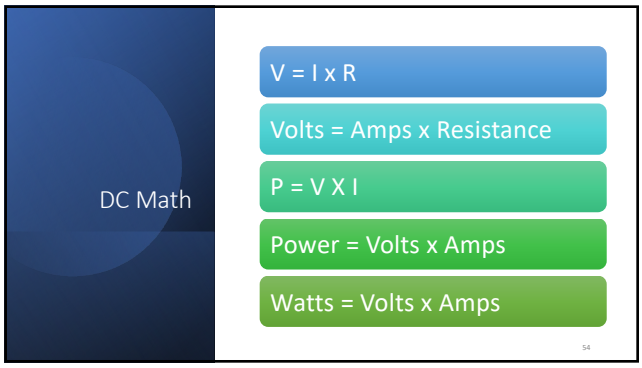
Which Fuse is Not Acceptable?

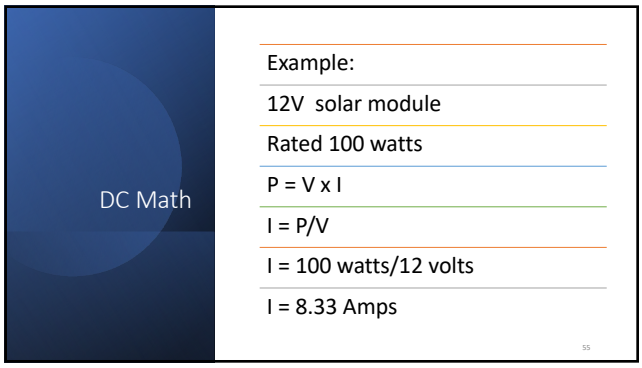
52


SOLAR PV
PV-10A10F
SOLAR PV
PV-20A10F
20A
1000V dc
X
LOW-PEAK
ULTIMATE PROTECTION
TIME-DELAY
CLASS CC FUSE
LP-CC-1-B/10
600Vac
300Vdc
53

53


DC Math
V = I x R
Volts = Amps x Resistance
P = V X I
Power = Volts x Amps
Watts = Volts x Amps
54

54


DC Math
Example:
12V solar module
Rated 100 watts
P = V x I
I = P/V
I = 100 watts/12 volts
I = 8.33 Amps
55

55

Types of Solar PV Systems

- PV Direct (no storage)
- Stand-Alone with Storage (Off-Grid, PV Direct)
- Grid-Tied (Grid Direct)
- Grid-Tied with Storage (Grid Interactive, Hybrid, Multimode etc.)

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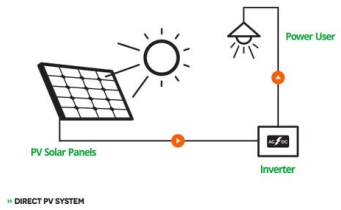
PV Direct



» DIRECT PV SYSTEM

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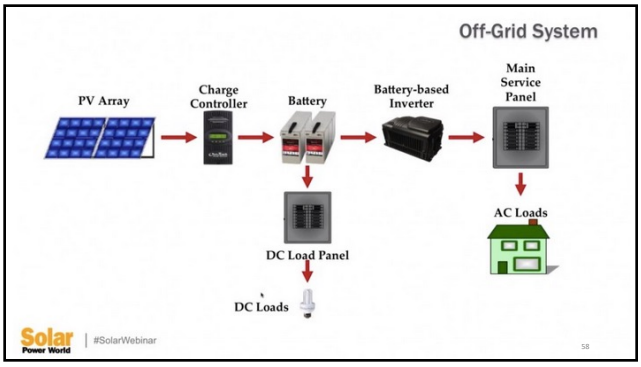

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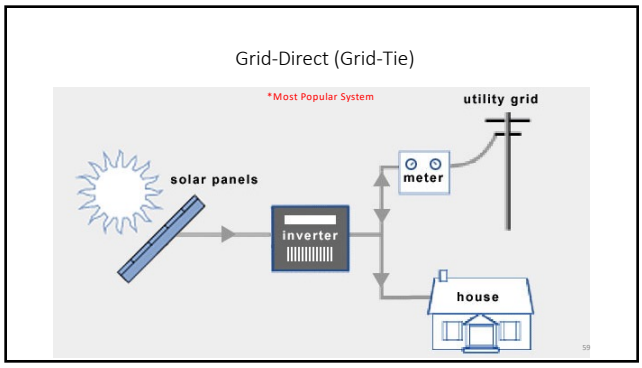
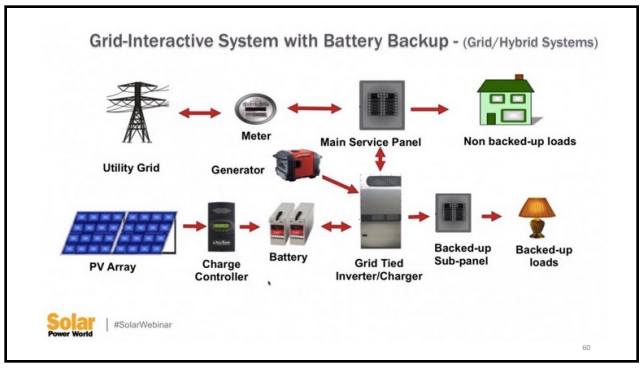

Grid-Direct (Grid-Tie)
*Most Popular System
utility grid
solar panels
meter
inverter
house

59


Grid-Interactive System with Battery Backup - (Grid/Hybrid Systems)
Utility Grid
Meter
Main Service Panel
Non backed-up loads
Generator
PV Array
Charge Controller
Battery
Grid Tied Inverter/Charger
Backed-up Sub-panel
Backed-up loads
Solar Power World
#SolarWebinar

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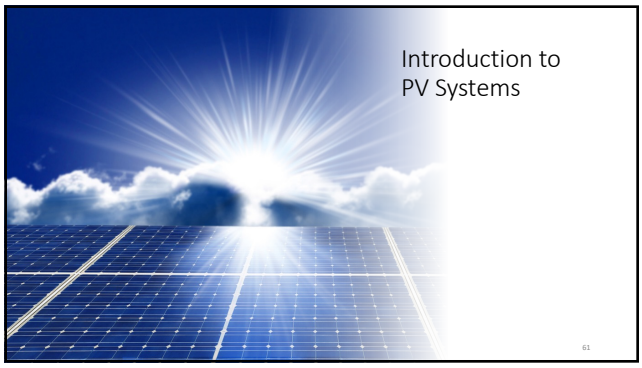
Introduction to PV Systems

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Definition: Electronic Power Converters

Examples:

- Inverters
- Micro-inverters
- DC-to-DC Converters
- Charge Controller

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String Inverter

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Ambient Temperature Range	−13 to 113 °F
Power Consumption: standby / nighttime	< 7 W / 0.1 W
Topology	Low frequency transformer, true sinewave
Cooling Concept	OptiCool™, forced active cooling
Mounting Location: indoor / outdoor (NEMA 3R)	●/●
LCD Display	●
Communication: RS485 / wireless	○/○
Warranty: 10-year	●
Compliance: IEEE-929, IEEE-1547, UL 1741, UL 1998, FCC Part 15 A & B	●

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Hybrid (Multi-Mode) Inverters

- Combines stand-alone and grid-direct capabilities
- Supports battery storage
- Most have MPPT inputs for optimized array utilization
- Some support generator backup to charge batteries
- Some support wind turbines to back up batteries

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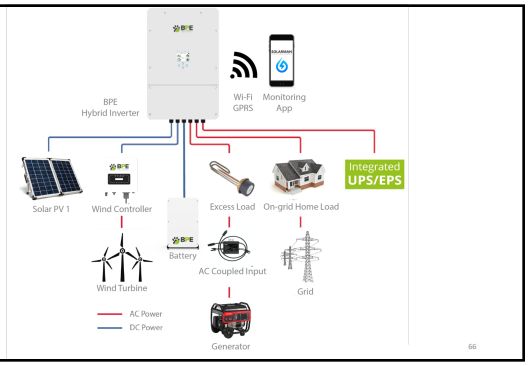

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Micro-inverters

https://enphase.com/installers/microinverters

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Micro-Inverter

- Installed at the module
- Considered a Module Level Power Electronics (MLPE)
- Converts DC volts to AC amps
- Allows maximum power output of each module
- Optimizes effects of shading and dirt on modules
- One module doesn't kill entire string
- Can monitor each module separately
- Allows for Rapid Shutdown
- Must be connected in parallel since output is in amps
- Adds cost to system, but optimes power output of array

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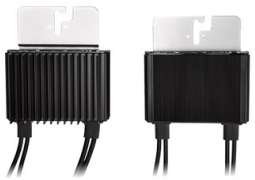
DC-to-DC Converter (Optimizer)



solaredge

69

69

DC-to-DC Converter (Optimizer)

- Considered a Module Level Power Electronics (MLPE)
- Attaches to module directly
- Converts DC volts to optimized DC volts, regulates voltage
- Connects in series
- Can be monitored separately
- Optimizes impacts of shading, dirt, panel tilt variances etc.
- One bad module doesn't shut down string
- Can add cost to system, but
- Increases power of array
- Supports Rapid Shutdown function

70

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Charge Controller (If Using Battery-Based System)

71

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Solar Modules

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Enemies of the Solar Module

- Shade
- Dirt
- Snow
- Bird Droppings
- Mismatch modules
- Poor connectors/connections
- Heat
- Poor module construction/materials
- Rodents (chewing on cables)
- Insects (spiders webs)
- Poor installation methods

73

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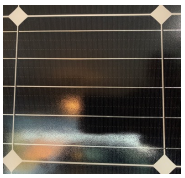
PV Cell



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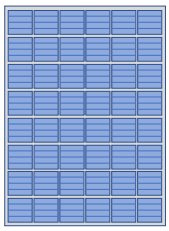
PV Module (Panel)



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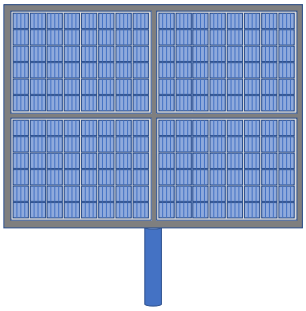
PV Panel



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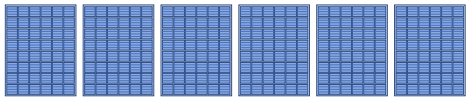
PV Array



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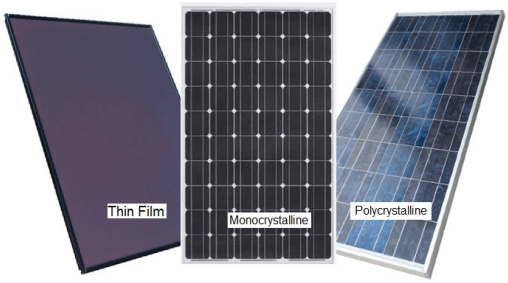
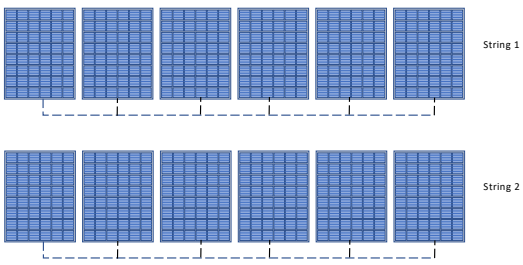
PV Module Types



78

78

Source circuits (strings): 690.1



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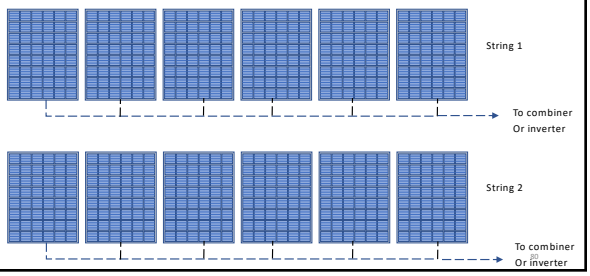
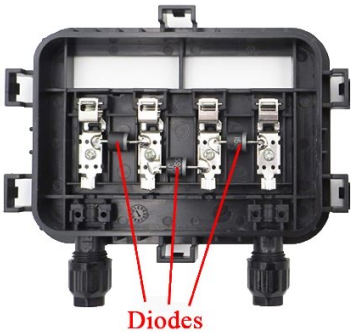
Source circuits (strings)



80



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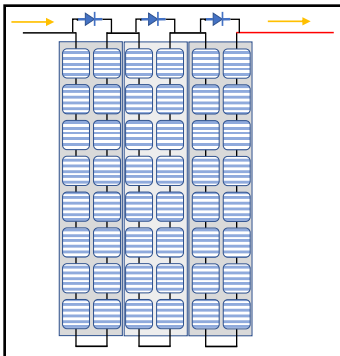
81



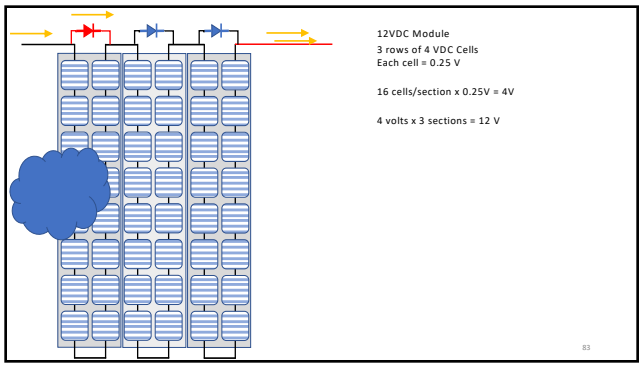
12VDC Module
3 rows of 4 VDC Cells
Each cell = 0.25 V

16 cells/section x 0.25V = 4V

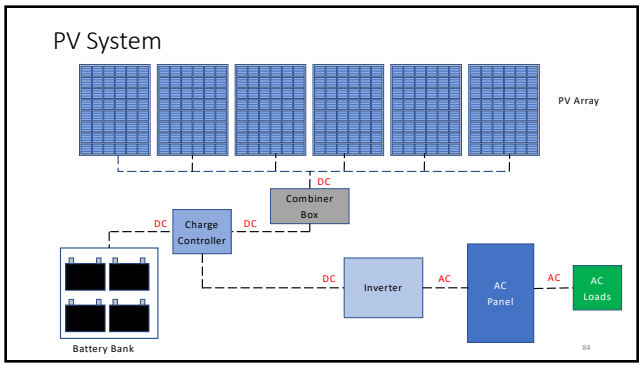
4 volts x 3 sections = 12 V

82

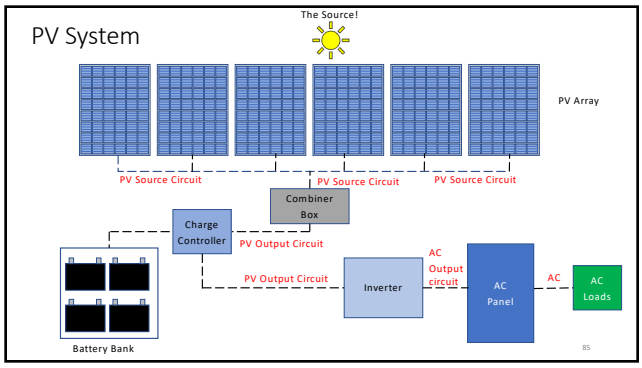
82


12VDC Module
3 rows of 4 VDC Cells
Each cell = 0.25 V
16 cells/section x 0.25V = 4V
4 volts x 3 sections = 12 V
83

83

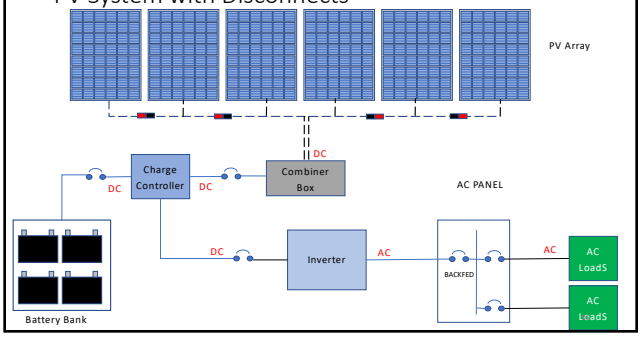

PV System
PV Array
DC
Combiner Box
DC
Charge Controller
DC
DC
Inverter
AC
AC Panel
AC
AC Loads
Battery Bank
84

84


The Source!
PV System
PV Array
PV Source Circuit
PV Source Circuit
PV Source Circuit
Combiner Box
Charge Controller
PV Output Circuit
PV Output Circuit
AC Output circuit
Inverter
AC Panel
AC
AC Loads
Battery Bank
85

85

PV System with Disconnects



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Disconnects: Two Types

- System [690.13]
- Equipment [690.15]

87

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Quiz

- Where are PV system equipment and disconnects not allowed? [690.4(E)]?

a) Basements
b) Garages
c) Bathrooms
d) Kitchens

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System Disconnects: 690.13

60 Amps DC

60 Amps AC

89

89

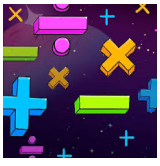
System Disconnects: 690.15

90

90

Series and Parallel Module Connections

- Modules in series
  - Voltages add
  - Current is the same
  - Power adds
- Modules in parallel
  - Voltages are the same
  - Current adds
  - Power adds
- Match inverter input specs



91

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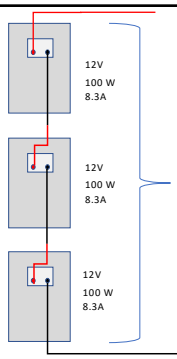
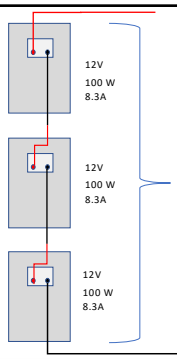
Series Connected

Hint: Positive to Negative



92

Series Connected



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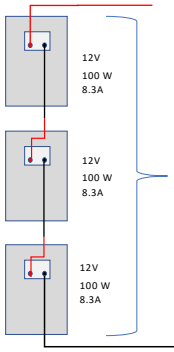
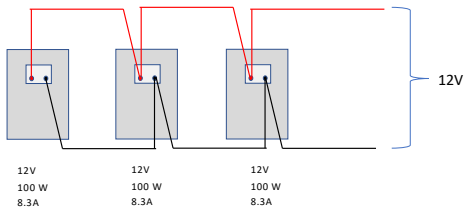
Series Connected



94

Parallel Connected

Hint: Positive to Positive
Negative to Negative



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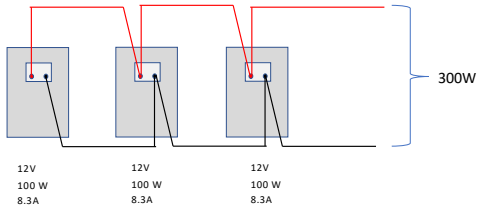
Parallel Connected



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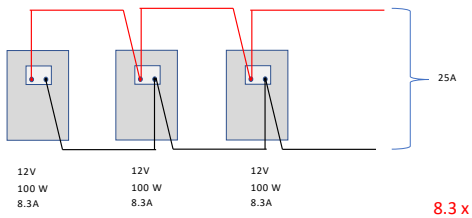
Parallel Connected

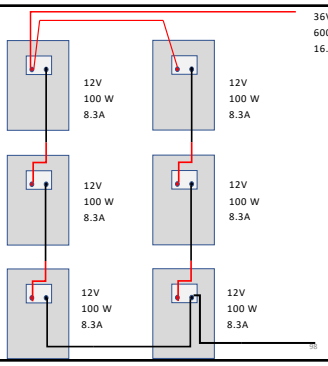


8.3 x 3 = 25

97

97

Series And Parallel Connected



98

Definitions

Coupling

- Refers to the way solar panels (modules) are coupled or linked to an energy storage or battery system

4-types

- DC coupled systems: Off – grid
- AC coupled systems: Off – grid
- AC coupled Battery Systems: Grid-tie
- DC coupled Hybrid Systems: Grid-tie

99

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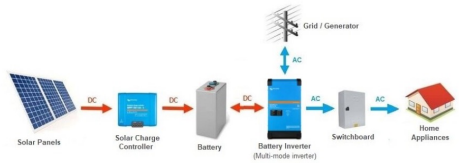
DC - Coupled



Basic layout diagram of a DC coupled (off-grid) solar battery system using an MPPT solar charge controller

100

100

AC - Coupled

Basic layout diagram of an AC coupled solar battery system - Grid-tie (hybrid) setup

101

101

AC – Coupled Batteries Grid-Tie

Basic layout diagram of a AC battery coupled with a AC solar system - Grid-tie (no backup shown)

102

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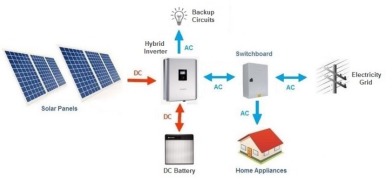
DC – Coupled Hybrid



Basic layout diagram of a hybrid solar inverter with DC battery system

103

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Solar Module Facts

Solar modules (panels) are less efficient as temperature increases

As temperature of the module increases:

- Current output increases
- Voltage output decreases

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Interesting Facts

- Solar modules are inherently current-limited
  - Short circuit current is dramatically less than other sources
  - Reason why fuses are not normally needed with one or two strings
    - Not enough current to trip CB or blow fuses
  - Backfeeding from a shorted panel is a major concern
    - Current from multiple shorted parallel strings can add up and be dangerous
- Batteries on the other hand can have thousands of short circuit amps

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Module Standard Test Conditions (STC)

Irradiance: 1000 W/m^2

Module cell temperature: 25°C (77°F)

Mass of Air: 1.5

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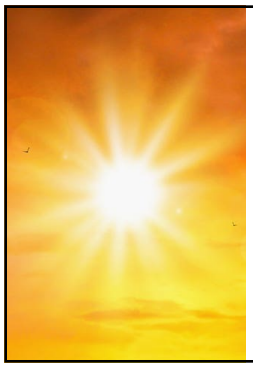

Irradiance

- Irradiance: 1000 W/m^2
  - Intensity of solar radiation striking the earth
  - Ranges from 0 to 1250 W/m^2
  - 1000 W/m^2 represents "Full Sun"

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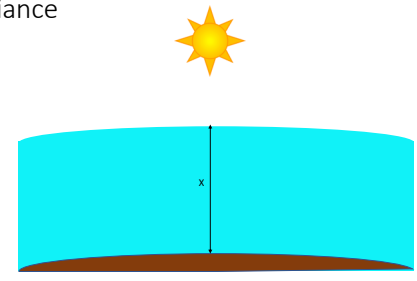
Irradiance



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Module Cell Temperature

- Module cell temperature: 25ºC (77ºF)
- Not a maximum
- Can reach 75ºC or more if sitting in full sun

110

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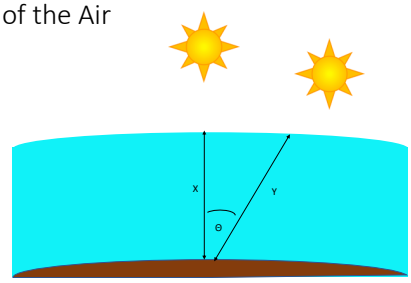
Mass of the Air



111

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Mass of Air

- Mass of Air: 1.5 or (AM 1.5)
  - Basically light directly above a module has shorter path and less atmosphere to get through
  - Light at an angle has to "work harder" to get to panel
  - 1.5 represents a situation that is less than ideal (1.0) and reflects majority of situations

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Labels: Manufacturer Marking and Listing

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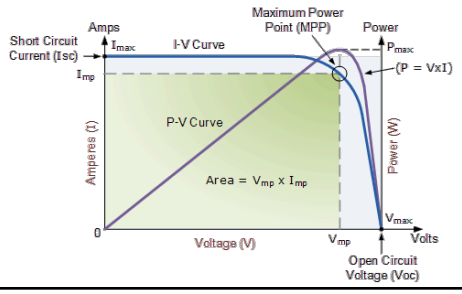
PV Module I-V Chart



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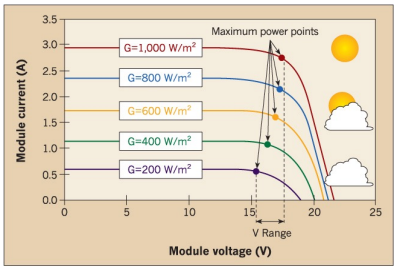
PV Module Irradiance Chart



Note: Voltage doesn't change as dramatically as current when irradiance changes

ecmweb

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Maximum Power Point Tracking (MPPT) aka Power Point Trackers

- A method used by inverters, micro-inverters and DC-to-DC optimizers to extract the maximum power from solar modules

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Combiner Boxes

- Use to Combine multiple array strings (circuits)
- Outputs from multiple inverters
- Must be NRTL listed
  - Cannot be custom built!
  - New for 2020 code cycle – previously could be custom

Following slides from Outback Power

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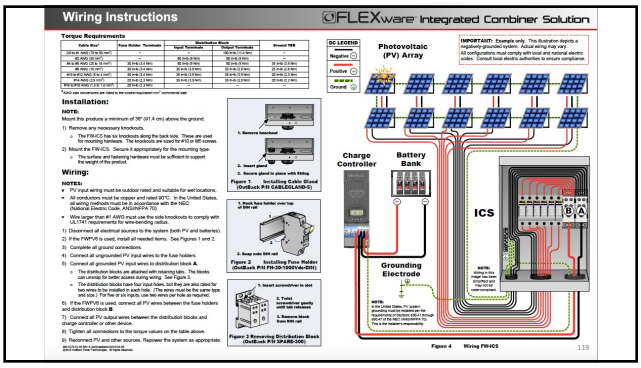

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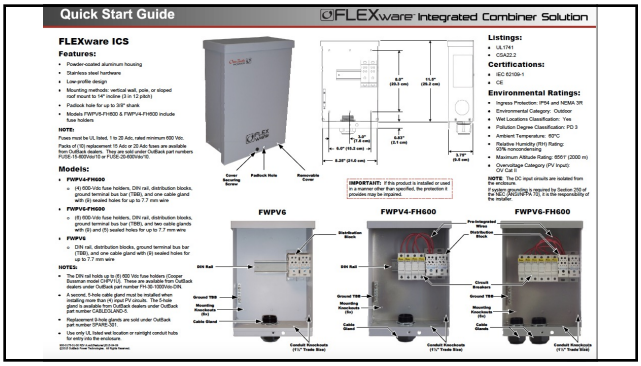

120

Maximum Voltage Limits (690.7)

- One and Two Family Dwelling units: <= 600 VDC
- Roof mounted systems (not 1 & 2 dwelling units): <= 1000 VDC
- Ground-mounted systems:
  - limited by available equipment requirements
  - Greater than 1000V
  - 1500V limit from 2020 NEC is deleted

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Installation requirements: 690.31(D)(1)

- PV system DC circuits in or on buildings if > 30V or 8 amps must be in
  - Metal raceway
  - Type MC (metal clad) cable
  - Metal enclosures

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PV WIRE

2kV PV Wire. Stranded Bare Copper Conductors. XLP Insulation. -40C to 90C Wet or Dry. Rated VW-1* Sunlight Resitance and Direct Burial.

Image not to scale. See Table 1 for Dimensions

CONSTRUCTION:

Conductors:
7, 37, & 61 Strands:
Class A, Compressed Concentric-Lay, Stranded Copper Conductors per ASTM B3, B8 (or B33 for Tinned Copper Construction)

19 Strand:
19 Wire Combination Unilay, Stranded Soft Drawn Bare Copper Conductors per ASTM B3, B787 (or B33 for Tinned Copper Construction)

Insulation: Cross-Linked Polyethylene (XLPE)

APPLICATIONS AND FEATURES:
Southwire Photovoltaic Wire is intended for use in solar power applications. Rated 90°C for Exposed or concealed wiring in wet or dry locations. Rate for Direct Burial.

SPECIFICATIONS:
- ASTM B3, B8, B33, B787
- UL 4703 - Type Photovoltaic Wire
- UL 44 - TYPE RHW-2

Southwire

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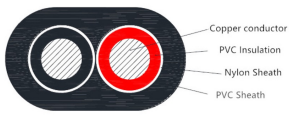
Distributed Generation (DG) Cable

UL 3003 STANGARD TYPE DG CABLE

Use and installation

This category covers multi-conductor, nonintegrally jacketed, distributed generation (DG) cable. This cable is intended for use with specific distributed generation equipment/devices such as photovoltaic modules, inverters, solar trackers, etc. DG cable is suitable for use between cable trays and utilization equipment.

Structure



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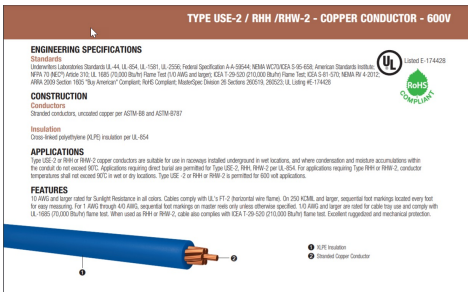
RHW-2 and USE-2



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Single Conductor Cables [690.31(C)(1)]

- Exposed cables shall be supported at intervals not to exceed 24 inches
- Methods:
  - Cable ties
  - Straps
  - Hangers
  - Or other **listed** and **identified for securement** and support in outdoor locations (sunlight resistant, wet location, chemical resistant, correct temperature rating etc.)

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Quiz

- Which would not be acceptable for an exterior PV installation?

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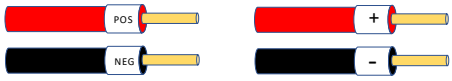
DC Circuit Conductor Markings – 690.31 (B)(2)

- Shall be identified at terminations, connections and splice points
- To indicate polarity
  - "POS" or "Positive" for positive conductors
  - "NEG" or "Negative" for negative conductors



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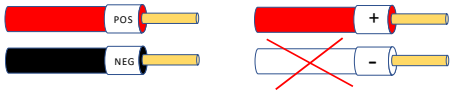
DC Circuit Conductor Markings

- Positive Conductor cannot be green, white or gray
- Negative conductor cannot be green, white*, gray or red
  - White allowed in previous code cycles



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Exercise!

Get PV Information for your area

https://pvwatts.nrel.gov/

Use PV Watts to estimate solar savings

Use Toledo, Ohio 43607 zip code

Assume 4000 watt (4 kw) array

Roof mounted

Use roof pitch of 4/12 (18.4 deg)

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I_{sc} x 1.25 x 1.25

- Sizing Conductors:
- Selection Overcurrent Protection Devices
- Article 690.8

Note: 1.25 x 1.25 = 1.56

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I_{sc} x 1.25 x 1.25

- First 1.25: for irradiance

- Second 1.25: for continuous current (> 3 hours)
  - (also to limit current to 80% (0.8) of OCPD)
  - FYI: 1/0.8 = 1.25

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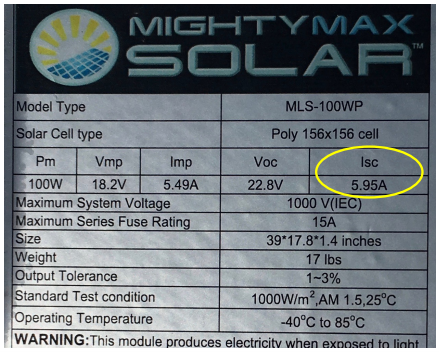

134

Current Calculations (Example)

- For single solar module
- Find Isc= 5.95 Amps
- Multiply Isc x 1.25 for continuous load = 5.95 x 1.25 = 7.43 amps
- Multiply this by another 1.25 (125%)
  - This is the potential of the array to generate overvoltage due to excessive sunlight
  - 7.43 x 1.25 = 9.30 Amps
- #12 wire rated at 25 amps at 70 deg C will work

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Adjustment Factors

- Ambient Temperature: see table 690.7(A) or Temp Coefficient of Voc
  - Must use for ambient temperature less than or equal to 25 deg C (77 deg F)!
  - PV output circuits will be higher in colder temperatures
- More than 3 conductors in a conduit or raceway
  - See table 310.15(C)(1)
- Conductors installed less than 7/8" from roof
  - See article 310.15 (B)
  - Otherwise a temperature adder of 33 deg C or 60 deg F is required
  - **THIS IS SIGNIFICANT! AVOID IF POSSIBLE!!!!!**

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From PV Module Specs

TEMPERATURE RATINGS	
NOCT (Nominal Operating Cell Temperature)	43°C (±2°C)
Temperature Coefficient of P_{MAX}	- 0.34%/°C
Temperature Coefficient of V_{OC}	- 0.25%/°C
Temperature Coefficient of I_{SC}	0.04%/°C

MAXIMUM RATINGS	
Operational Temperature	-40~+85°C
Maximum System Voltage	1500V DC (UL)
Max Series Fuse Rating	20A

- Beyond 25 deg C (77 deg F)
  - Voc Decreases with increasing temperature
  - Voc Increases with decreasing temperatures

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PV Source and Output Circuits Adjustment Factors

Table 690.7(A) Voltage Correction Factors for Crystalline and Multicrystalline Silicon Modules
(Multiply by the rated open-circuit voltage by the correction factor below)

Ambient Temperature (°C)	Factor	Ambient Temperature (°F)
24 to 20	1.02	76 to 68
19 to 15	1.04	67 to 59
14 to 10	1.06	58 to 50
9 to 5	1.08	49 to 41
4 to 0	1.10	40 to 32
-1 to -5	1.12	31 to 23
-6 to -10	1.14	22 to 14
-11 to -15	1.16	13 to 5
-16 to -20	1.18	4 to -4
-21 to -25	1.20	-5 to -13
-26 to -30	1.21	-14 to -22
-31 to -35	1.23	-23 to -31
-36 to -40	1.25	-32 to -40

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Don't Forget About Voltage Drop!

- Use maximum voltage drop of 2% as guide for one-way distance

Voltage

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Overcurrent Protection 690.9(A)(1)

- Same rules as NEC Article 240 Overcurrent Protection with notable exceptions (fuse or CB must protect wire)
- Overcurrent protection NOT required when:
  - Conductor ampacity > = maximum circuit current (Isc x 1.25)
  - *i.e. wire size can handle short circuit current with safety factor*
  - AND
  - Current from all sources <= maximum overcurrent (fuse or CB) size
    - Max overcurrent size is usually marked on the inverter nameplate
- In other words… NO CB OR FUSE REQUIRED!
- More in Part 2

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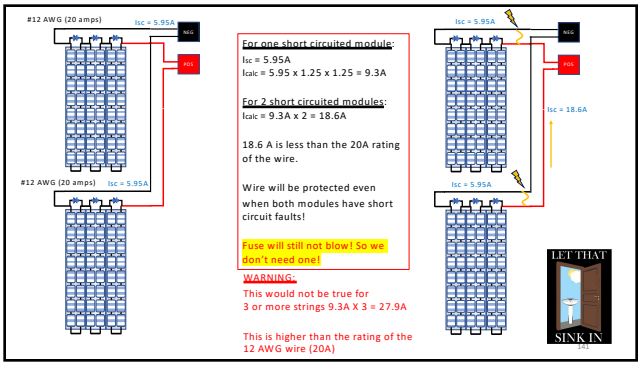

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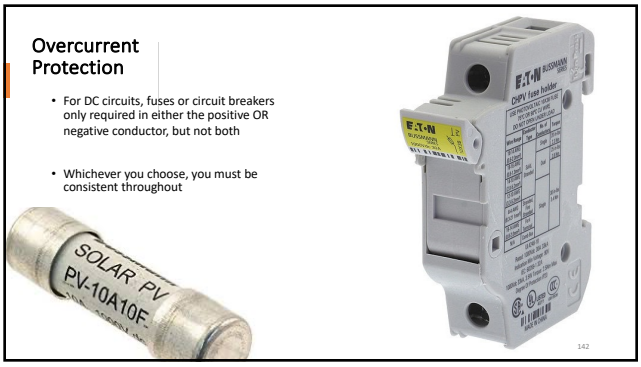

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Identification and Grouping of Conductors: 690.31(B)

- Allowed in the same enclosure or raceway: DC circuits with Class 1 remote control, signaling, and power-limited circuits of a PV system
- Not allowed in the same enclosure or raceway: PV system circuits with non-PV system circuits or inverter output circuits
- DC circuit conductors must be identified at terminations, connections and splice points

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Grounding and Bonding Part V

- All equipment required to be bonded together using equipment grounding conductor and sized per NEC 250.122
- Solidly grounding of PV systems for newer type systems is very rare
- Grounding to system accomplished via the EGC which is bonded to the facility grounding system
- Most newer inverters are "functionally grounded"

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Functional Grounding

- Provides ground fault protection via connection in inverter
- Only works when inverter is powered on!

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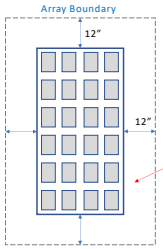
Rapid Shutdown Requirements – 690.12



Outside of Array Boundary:
Voltage limited to not more than 30 volts within 30 seconds of rapid shutdown start

Inside of Array Boundary:
Voltage limited to not more than 80 volts within 30 seconds of rapid shutdown start

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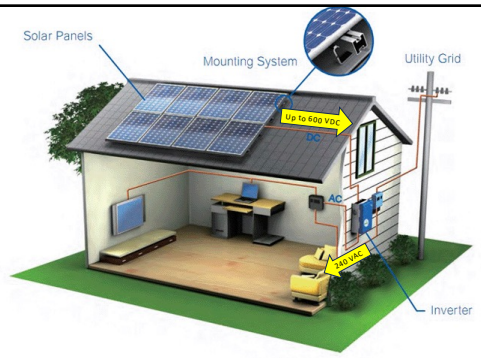

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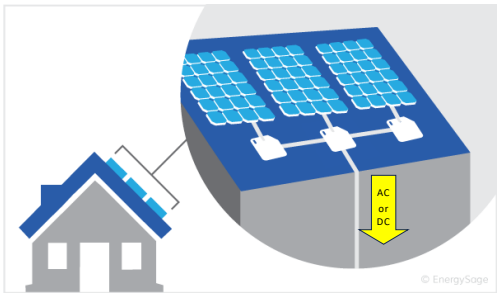
With Micro-inverters or DC to DC Optimizers



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Marking and Labeling Requirements- 690.31(B)(2)

- Components shall have the following markings:
  - PHOTOVOLTAIC POWER SOURCE or
  - SOLAR PV DC CIRCUIT
- Required for:
  - Exposed raceways, cable trays, and other wiring methods
  - Covers or enclosures of pull boxes and junction boxes
  - Conduit bodies in which any of the available conduit openings are unused
- Physical requirements:
  - White or red background
  - Spacing between labels shall not exceed 10 ft.

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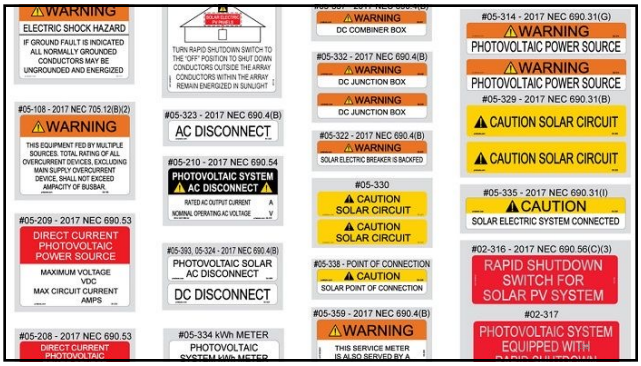

150

Mating Connector Requirements 690.33

- Shall be polarized
- Shall be constructed to guard against inadvertent contact with live parts
- Shall be the latching type
- Shall be of the same type and brand or listed for interconnectibility
- May require a tool to disconnect
- New word: Intermatability!

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Connector Guidance

- Single largest point of failure in PV systems
- Beware of wording like “MC4 Compatible”
- Use only MC4 or other approved connectors
- Use only approved crimpers
- Make sure wire fits properly in connector housing
- Some cut off connectors and install all new MC4 to ensure integrity
- https://www.youtube.com/watch?v=qjIdrBsim5s

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Part V. Grounding and Bonding

Starting at 690.41

- 6 types of grounding configurations
- Systems that exceed 30V or 8 amps shall have DC ground fault protection
  - GF devices shall provide indication of faults
- Exposed conductive surfaces of PV equipment shall be connected to an equipment grounding conductor.
- Equipment used for mounting PV modules and used to bond module frames shall be listed, labeled and identified for bonding PV modules.

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Grounding and Bonding

- Equipment Grounding Conductors sized per 250.122
  - Note: no need to increase EGC to account for voltage drop
- Grounding Electrode System
  - Required for a building or structure that supports a PV system
  - Follows rules in Article 250
  - For solidly grounded system, the grounded conductor sized per NEC 250.166
- See Part VIII, starting with section 250.160 for grounding of DC systems
- Note: Most PV systems are functionally grounded rather than solidly grounded

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Point of Interconnection

- Article 705: Interconnected Electronic Power Production Sources
- Applies to PV systems when "operating in parallel with a primary source(s) of electricity":
  - Examples: utility, generators, batteries, wind etc.
- Specific instructions for
  - Supply-side (Line-side) source connections
  - Load-side source connections
- Special labeling requirements:

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CONGRATULATIONS!

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Next Steps

- A Certificate of Completion will be emailed to those who successfully completed course
- 4 hours of Code Class Hours will be reported to the OCILB for Code Continuing Education Credits
- Contact instructor at hpmatthews@matthewselectrical.net for any questions or comments
- Make sure you completely sign out of webinar after the next slide!

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File Attachments for Item:

ER-13 Solar PV and the 2023 NEC Part 2 (Matthews Electrical Services)

All certifications (4 hours)

Staff Notes:

ESIAC Recommendation:

Committee Recommendation:

PV Solar Training and the NEC – Part 2

Webinar

1. Purpose

   Interest in solar photovoltaics, energy storage, microgrids, interconnected power sources and other emerging technologies is increasing due to the focus on climate impacts and green energy. However, there are NEC code requirements that many designers, installers and even inspectors may not be familiar with. Part of this due to the ever-changing developments in technology and products, and also to the evolving NEC requirements and other industry standards that try to keep up with the developments.

   This webinar is structured towards giving the participants an understanding of solar photovoltaics and related topics. This includes introducing the participants to terminology, the different types of PV systems, applicable codes and standards, types of equipment used, safety considerations for DC/AC systems and more.

   Specifically, this course will help clarify the various solar PV-related requirements in the NEC with a focus on articles 690, 691, 705, 250 and others. Attention will also be placed on batteries and energy-storage systems that can be an integral part of the PV installation.

   Part 2 of this series will expand upon the basic concepts from Part I and will go into more detail on solar PV installations.

2. Structure
   a. Duration: 4 hour
   b. Format
      i. Webinar
         1. Register at www.matthewselectrical.net
         2. Webinar conducted at www.zoom.com
   c. Resources
      i. 2023 National Electrical Code
         1. Article 250 Grounding and Bonding
         2. Article 685 Integrated Electrical Systems
         3. Article 690 Solar Photovoltaic Systems
         4. Article 691 Large Scale Photovoltaic Electric Supply Stations
         5. Article 705 Interconnected Electric Power Production Sources
         6. Article 706 Energy Storage Systems
      ii. NFPA 70E Electrical Safety in the Workplace

iii. PowerPoint Slides Developed by Matthews Electrical Services
iv. Solar Energy International – website
v. IAEI.org website
vi. NFPA website
vii. Various PV equipment manufacturers
viii. Various PV publications: Home Power e.g.

3. Curriculum
    a. Review of key points from Part 1
    b. Design of a residential, roof mount, grid-tie system
    c. Design examples
        i. Manual design using NEC article 690
        ii. NREL PVWatts system
        iii. Commercial software example
    d. Review of Rapid Shutdown requirements
    e. Labeling requirements
    f. Interconnection options per NEC Article 705

APPLICATION FOR CONTINUING EDUCATION APPROVAL
COURSE CONDITIONS AND GUIDELINES

The Ohio Board of Building Standards is committed to the ongoing education and professional development of board-certified personnel through the delivery of high-quality, accurate and engaging professional continuing education content. To this end, the Board reviews and approves Continuing Education Courses for building department personnel.

Board approval is granted for course instruction on current codes and standards, including the OBC, OMC, OPC, and RCO, and any other content areas directly related to the responsibilities of the certification for which credit is being requested.

Promotion: Any person or organization promoting an approved course is required to make full and accurate disclosure regarding course title, course approval number, number of credit hours, categories for which the BBS has approved the class, and fees in promotion materials and advertising. ***The Board does not grant retroactive approval. It is recommended that courses be submitted for approval well in advance of any scheduling of classes and advertising***. Advertising may not falsely state BBS approval before approval is granted. Course providers may state that BBS approval is pending.

Application Submission: All Applications and associated materials shall be submitted by email in .pdf format. Instructions for completing the application are attached.

Certificate of Completion: Course providers shall provide participants a certificate of completion containing the following information:

- Name of participant
- Title of approved courses
- BBS approval #
- BBS approved certifications
- Date of the continuing education program
- Number of approved credit hours awarded, and
- Signature of authorized sponsor or instructor.

Any person or organization administering an approved course shall return a completed BBS Course Attendance form by email.

Participants: Participants must attend the complete course as presented by the instructor to receive credit hours approved by the Board. The organization or instructor of online courses shall plan and execute methods to verify the individual's attendance and completion of the course. No partial credit will be given to any participant who failed to complete the entire course as approved.

Board approval: All courses are approved for the calendar year in which application is made. Courses may be renewed so long as the referenced code is in effect, and the CEUs, certification and content remain unchanged. When the referenced code is updated, courses must be updated, and new approvals obtained.

Facility/training area: BBS Course may be delivered in person or online, or both, at the sponsor's option.
Course facilities shall include the following:

In Person Classes:
Sufficient seating capacity
ADA accessible facilities
Appropriate Audio/Visual devices for delivery
Writing surfaces for participants

Online Classes:
Web-accessible
ADA accessible delivery
Tech support available
Live and recorded courses permitted

In-person facilities shall comfortably and safely seat at least the number of attendees present in the room and shall be climate controlled, non-smoking, and sound controlled so that outside noise will not interfere with the training.

Ohio | Department of Commerce

Mike DeWine, Governor
Jon Husted, Lt. Governor

Sheryl Maxfield, Director

Board of Building Standards

Application for Continuing Education Course Approval

Provider Information:

Name: HENRY PETER MATTHEWS

Organization: MATTHEWS ELECTRICAL SERVICES

Address: 1203 MCKINLEY PLACE

E-mail: hpmatthews@att.net Telephone: 419-575-3488

Website: www.matthewselectrical.net

Conference Sponsor (if applicable) _____ Conference Email: _____

Check here if Course Renewal: _____ Prior course number _____ (*i.e. BBS2018-429*)

Renewals will only be granted for identical content and certifications, within the current code cycle.
Attach a copy of prior course approval letter for confirmation. No further information is required.

New Course Information:

Course title: Solar PV and the NEC Part 2

Course instructor: Henry Matthews

Course description: This course will be follow up on Part 1 and will be based on an example of a residential, rooftop, grid-tied design using article 690 in the NEC.

Instructional hours per session: 4 Number of Sessions: multiple throughout 2024

Course Date(s) and Location: TBD (1st Quarter of 2024)

Special Content:

Code Administration: ☐
Existing Buildings: ☑
Electrical Instruction: ☑
Plumbing Instruction: ☐

Conference Course: _____
Conference Name: _____
Conference location: _____

Course to be offered online? ☑ **On Demand** ☐ **Webinar** ☑

Course Website: www.matthewselectrical.net

Detail online course participation confirmation method *(i.e. test, quizlets, participant activity confirmation)*:
Participation will be verified by Zoom attendance tracking, live roll call, polls and surveys.

Course applicable for the following certifications

Residential Certifications Only: ☑ Commercial Certifications: ☑
Administrative Course, All Certifications: ☐

Application materials included:

☑ Course Outline or Course Learning Objectives
☑ Presentation Materials/Slides (not required for roundtable courses)
☑ Assessment Materials (for online courses)
☑ Presenter Bio

Please submit application and materials in .pdf format to: michael.lane@com.ohio.gov or BBS@com.ohio.gov

Instructions for new Continuing Education Approval form

Provider Information

1. Please include all contact information.
2. If course is not part of a conference, leave conference sponsor and email blank.

Course Renewal

1. Indicate if the course is being submitted for renewal. Include prior approval letter and write in prior course number.
2. Certification approval for courses has now changed: all existing courses being renewed will be approved within the new classification system.
    a. Courses previously approved for only residential certifications will be approved for all residential certifications.
    b. Courses previously approved for at least on commercial certification will now be approved for all commercial certifications and all residential certifications.
    c. Courses on required instruction topics, Ohio Ethics, Code Administration and Existing Buildings, will be noted as Administrative Courses and be approved for all certifications.
3. Courses being renewed should skip the New Course information section and are not required to submit outline, agenda, slides or other instructional materials for review. Skip to Special Content, and mark any item that applies to the course.

New Course Information

1. Enter course title, name of instructor, and a brief description of the course content. Learning objectives may be substituted for course description, if desired.
2. Number of instructional hours per session is the length of instructional time.
3. Number of sessions: can be 1 or the number of sessions planned.
4. Course date(s) and location: not necessary at this time, enter if known.

Special Content

1. Indicate if the course will meet instructional time in Code Administration or Existing Buildings.
2. Indicate if the course is a plumbing or electrical course, for ESIAC review and trainee course tracking.
3. If the course is associated with a conference, indicate the conference name and location, as this will allow BBS to coordinate approvals with the conference provider.
4. If the course will be offered online, specify whether it will be on demand or offered as a virtual webinar, or both. Include website where the course will be provided.

Course applicable for the following certifications

This section represents a major change from previous BBS course approval forms.

1. If the course is only for residential certifications, check 'Residential Certifications Only'. The course, if approved, will be approved for all residential certifications.
2. If the course is appropriate for any commercial certifications, check Commercial Certifications. The course, if approved, will be approved for all commercial certification **AND** all residential certifications.
3. If the course is intended to meet required instruction in Code Administration (Chapter 1) or Existing Buildings (commercial or residential) check 'Administrative Course, All Certifications'.

Application Materials Included

This is a checklist for the course submitter's use, to be sure all materials necessary for review are included with the application. All materials should be submitted in .pdf format, along with the application, via email to Michael.Lane@com.ohio.gov or BBS@com.ohio.gov

BIOGRAPHY

Henry P. Matthews PE, CPE, CESCP, PVA, SMIEEE

Henry has over 31 years of experience in the electrical design, construction, engineering and safety fields. He has a passion for teaching and mentoring.

Henry obtained his Bachelor of Science degree in Electrical Engineering from Penn State University in 1989.

He also earned a Master of Business Administration from Bowling Green State University in 2003.

In addition, Henry earned several certificates including:

- Plumbing and Electrician from Penn Foster Career School
- Welding from Owens Community College in Findlay, Ohio
- Residential Solar PV Systems from Solar Engineering International

Henry currently holds the following licenses, and memberships:

- Licensed Electrical Contractor in Ohio
- Licensed Training Agency in Ohio
- Licensed Professional Engineer in Ohio, Michigan, Kentucky, Indiana, Illinois, Wisconsin
- Certified Plant Engineer (CPE)
- Certified Building Operator (CBO)
- Certified Electrical Compliance Safety Professional (CESCP) by NFPA
- Solar PV Associate by the North American Board of Certified Energy Practitioners
- Electric Vehicle Infrastructure Training Program (EVITP) certification
- Senior Member of the Institute of Electrical and Electronic Engineers (IEEE)
- Member of the International Association of Electrical Inspectors (IAEI)
- Member of the National Fire Protection Association (NFPA)
- Member of the Society of Maintenance and Reliability Professionals (SMRP)

Henry is currently employed as an Advanced Senior Engineer for Marathon Petroleum Company in Findlay, Ohio. During his 16 years at Marathon, Henry has worked as an Electrical Design Engineer, Project Engineer, Engineering Supervisor and currently as a Reliability Engineer.

Henry is also the owner of Matthews Electrical Services, a small, but full-service electrical contractor company.

Prior to this, he worked 13 years as an Electrical Engineer and a Plant Engineering Manager in at Cooper Standard Automotive, a major automotive parts supplier in Bowling Green, Ohio

Henry is the past co-chair of American Petroleum Institute Recommended Practice 545 Lightning Protection for Above Ground Storage Tanks.

He is current co-president of the Marathon Findlay Ohio Toastmasters club.

During his career, Henry has provided electrical, safety and engineering training to college students, industrial maintenance teams, engineering new hires and contractor groups.

Welcome and Good Morning!

Solar PV and the NEC Part 2

OCILB Course number: 4871429
OBBS Course number:

When logging on, please join as a Panelist!

Please mute your microphone
Enjoy the movie while we wait for class to start!

*Text me at cell no. **419-575-3488** for any problems*

Thank You!

1

Solar PV Systems and the NEC Part 2

2

Notice!

This course is based on the 2023 NEC.

3

Thank You for Choosing **Matthews Electrical Services** for your OHIO OCILB Electrical Code Training Needs!

4

But First!

We have to cover some administrative stuff

5

Webinar Rules

- Attendee must be present the entire time (except breaks)
- Turn on webcam:
  - After breaks
  - Before end of class
  - At instructor discretion to check attendance
- Mute microphone at all times
  - Prevents distraction during webinar
  - Instructor may activate participant microphone if verbal response is needed

6

Webinar Rules (Continued)

- 5 minute break every hour.
  - Return promptly after breaks
  - The instructor will check attendance after each break
- Emergencies
- Contingency Plans: Ohio Weather
- Unexpected interruption
  - Re-joining webinar
  - Problems:
    - send me a text message: 419-575-3488
    - Or email: hpmatthews66@att.net

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WELCOME!

- Goals
  - Promote learning
  - Make session engaging
    - Discussion
    - Videos
    - Case Studies
    - Polls
  - Make 4 hours as productive as possible!

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Webinar Completion

- Certificate of completion will be sent via email to all attendees
- 4 hours of Ohio OCILB Code credits will be submitted to the state board within 48 hours of class
- Feedback is encouraged to improve future webinars!
- Send other inquires, feedback and questions to: hpmatthews@matthewselectrical.net
- 419-575-3488 (cell)

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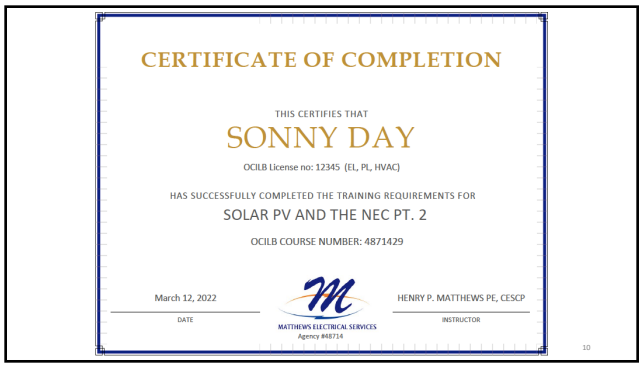
CERTIFICATE OF COMPLETION
THIS CERTIFIES THAT
SONNY DAY
OCILB License no: 12345 (EL, PL, HVAC)
HAS SUCCESSFULLY COMPLETED THE TRAINING REQUIREMENTS FOR
SOLAR PV AND THE NEC PT. 2
OCILB COURSE NUMBER: 4871429
March 12, 2022
DATE
MATTHEWS ELECTRICAL SERVICES
Agency #48714
HENRY P. MATTHEWS PE, CESCP
INSTRUCTOR
10

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Roll Call!
• Turn on your camera and microphone
• Wave, yell or do something creative to get my attention!
• After acknowledgment, mute your microphone
• Turn off your camera
• Thank you!
11

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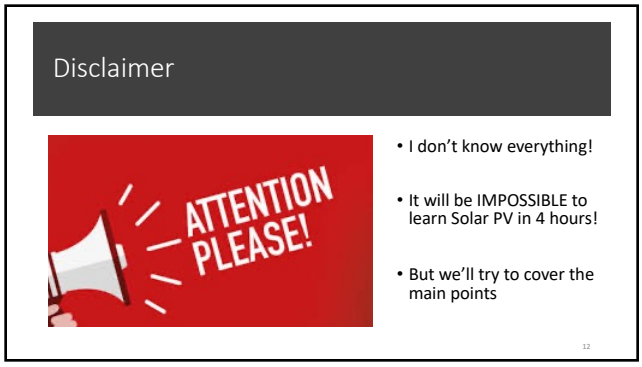
Disclaimer
ATTENTION PLEASE!
• I don't know everything!
• It will be IMPOSSIBLE to learn Solar PV in 4 hours!
• But we'll try to cover the main points
12

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Disclaimer

There are multiple methods to calculate the necessary components for a roof-top solar PV installation.

This course will only present a few and is not intended to be a comprehensive guide for a proper installation.

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Ohio Dives Into Floating Solar

By Rick Laezman | Nov 3, 2023

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After establishing a foothold as a land-based form of energy generation, **solar power** is also taking to water.

Last month, a local water utility in the state of Ohio announced a unique partnership with **D3Energy,** a Florida-based **floating solar power** developer.

The project involves the installation of a 3.2-megawatt array of solar panels that will float over the surface of one of the utility's water treatment ponds.

Siting solar panels over water has many benefits, not the least of which is land. Over the years, the utility has increased the capacity of its water treatment facilities to meet the demands of rapid population growth. That growth will continue, necessitating more expansion of water treatment facilities in the future, and those expansions will require land.

By doubling down on the use of pond surface area for solar panels, the utility does not have to make the difficult choice about the best use of its land. Instead, it can invest in the expansion of its power generation and supply and still have the acreage it will need to accommodate future growth and expansion of its water treatment and delivery systems.

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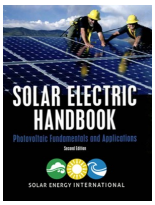
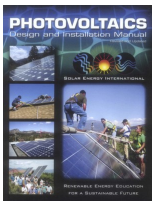
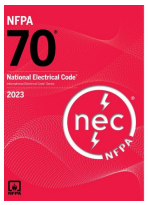
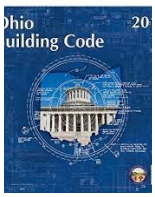
Resources









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Other Resources

- Solar Energy International: www.solarenergy.org
- North American Board of Certified Energy Professionals: www.nabcep.org
- PVWatts: www.pvwatts.nrel.gov
- Home Power Magazine: www.homepower.com
- NFPA: www.nfpa.org
- OSHA: www.osha.gov
- Northern Arizona Wind and Sun: www.solar-electric.com
- altE Store: www.altestore.com
- IAEI: www.iaei.org
- Mike Holt Enterpises: www.MikeHolt.com
- Electrical Construction and Maintenance (EC&M) website: www.ecmweb.com
- NEMA: www.nema.org
- UL: www.ul.com
- NECA: www.necanet.org
- Electrical Safety Foundation International (ESFi): https://www.esfi.org/

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Agenda

- Review of basic Solar PV Concepts
- Design of "Simple" rooftop PV system

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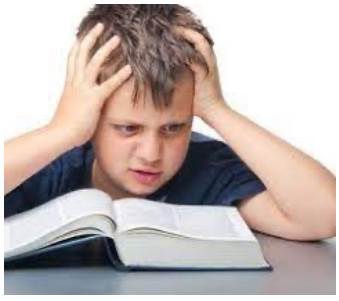
Article 690: Solar Photovoltaic Systems



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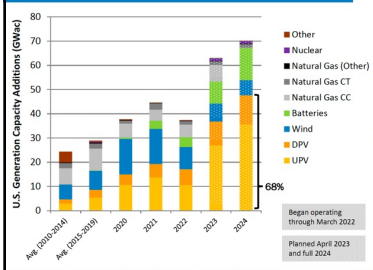
U.S. Generation Capacity Additions by Source: 2010–2022 and *Planned* 2023–2024



- EIA projects the percentage of U.S. electric capacity additions from solar will grow from 46% in 2022 (17 GWac) to 58% in 2023 (37 GW_{ac}), and 68% (47 GWac) in 2024.
  - Wind accounts for 12% and batteries 14%, and nuclear 2% of estimated capacity in 2023; in 2024 those percentages are 9%, 19%, and 2%, respectively.
  - Natural gas accounts for the remaining 13% in 2023.
- Over the next two years, EIA projects there will be nearly 100 GWac of capacity additions from wind and solar alone.
- Wood Mackenzie/SEIA projects 26-30 GW_{dc} of solar installations in 2023 and 30-36 GW_{dc} in 2024, depending both on favorable supply chain conditions (both domestic and international) as well as the ability to optimize the Inflation Reduction Act bonus credits.
  - Over the next five years, Wood Mackenzie/SEIA projects about 20 GWdc upside or downside relative to their base case as a result of these factors.

Sources: EIA Form 860M/Preliminary Monthly Electric Generator Inventory ("Planned" and "Operating") and EIA Short-term Energy Outlook Table 7e, downloaded April 25, 2023; Wood Mackenzie and SEIA US Solar Market Insight Full Report 2022 Year in Review, Mar 2023.

NREL | 30

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Relevant NEC and NFPA Resources

2023 National Electrical Code

- Article 250 Grounding and Bonding
- Article 480 Storage Batteries
- Article 685 Integrated Electrical Systems
- Article 690 Solar Photovoltaic Systems (only 10 pages!)
- Article 691 Large Scale Photovoltaic Electric Supply Stations
- Article 705 Interconnected Electric Power Production Sources
- Article 706 Energy Storage Systems

NFPA 70E Electrical Safety in the Workplace

Applicable UL standards

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Listing, Marking, Identification, Labeling

- Nationally Recognized Testing Laboratory (NRTL)
- ANSI Z535 standards
- NEC 690 requirements

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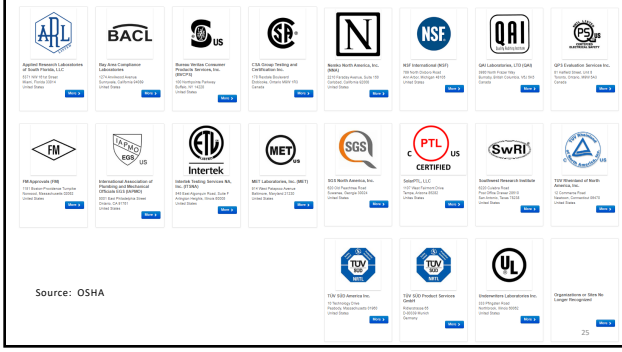

Source: OSHA

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Marking and Listing

- Equipment used for PV systems must be listed for "PV" use
- Fuses and circuit breakers must be listed for DC use
- BEWARE OF EQUIPMENT WITH INADEQUATE LISTINGS, RATINGS AND MARKINGS!! LOTS OF CHEAP IMITATIONS!!

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Some UL PV Inverter Listings

- UL 1741:
  - Standard for Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources
- UL 62109:
  - Power Converters for use in Photovoltaic Power Systems - Part 1: General Requirements
- UL 1699B:
  - Photovoltaic (PV) DC Arc-Fault Circuit Protection

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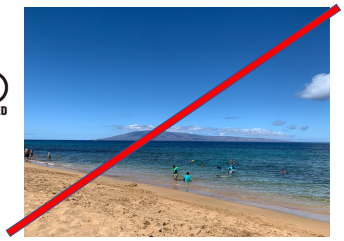
UL 1741

Inverter interconnection requirements for Grid-Tied Inverters



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Some UL PV Module Listings

- UL 1703:
  - Standard for Standard for Flat-Plate Photovoltaic Modules and Panels
- UL 61730-1:
  - Standard for Photovoltaic (PV) Module Safety Qualification
- UL 61730-2:
  - Photovoltaic (PV) Module Safety Qualification - Part 2: Requirements for Testing

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#13. Copper Mountain Solar Facility, Boulder City, NV - 802 MW

31

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#2. Bhadla Solar Park, India - 2,245 MW
(2.245 Gigawatt)

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1. Golmud Solar Park – China

The Golmud Solar Park in China is the world's largest solar farm with an installed solar capacity of **2.8 GW**, putting it just above the second entry in our list.

It's a hugely impressive site with nearly **seven million** solar panels all working to deliver clean energy. China has big ambitions for the Golmud Solar Park as well – they're hoping to reach **16 GW** within the next five to six years.

To put that into context, a single gigawatt could power **one million** UK homes for an hour, or around **100 million** LED light bulbs.

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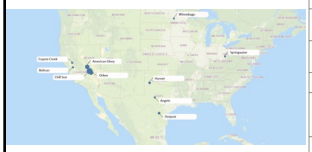
10 projects to watch in the solar-plus-storage pipeline

by David Cox, PE - President FirmoGraphs 4.19.2022



Name Project	Owner	Solar Generation Capacity (MW)	BESS Capacity (MWh)	State
Chill Sun Solar Project	Naturgy Candela Devco, LLC	2,250 MW	\	Nevada
American Glory Solar Project	American Glory, LLC	1,500 MW	6,000	Nevada
Orken Solar Project	Orken Solar LLC	1,500 MW	6,000	Nevada
Outpost Solar Project	Hecate Energy Outpost Solar LLC	513.7 MW	\	Texas
Hornet Solar	Hornet Solar, LLC	500 MW	\	Texas
Coyote Creek Agrivoltaic Ranch Project	Sacramento Valley Energy Center, LLC	200 MW	400	California
Angelo Solar	Angelo Solar, LLC	195 MW	\	Texas
Springwater Solar Project	Springwater Solar, LLC	155 MW	300*	Ohio
Winnebago Solar Project	Winnebago Solar and Storage LLC	150 MW	200*	Minnesota
Beltran Solar Energy Center	Beltran Solar, LLC	140 MW	600*	California

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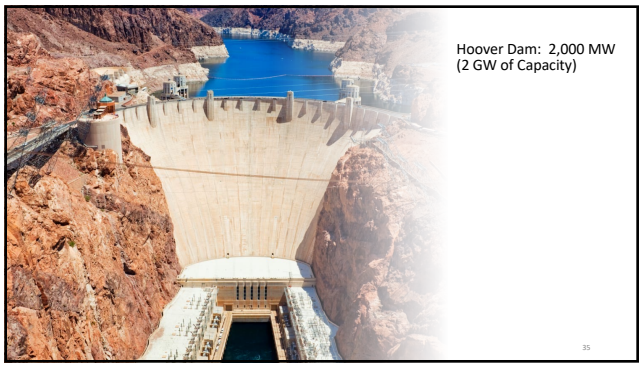

Hoover Dam: 2,000 MW
(2 GW of Capacity)

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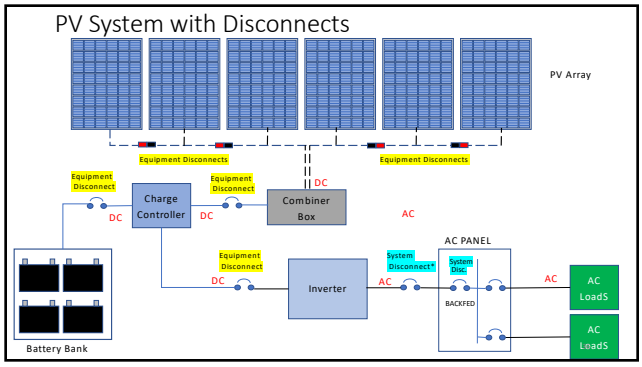

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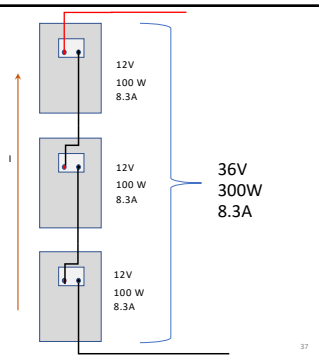
Series Connected



Sanity check:
Watts = Volts x Amps
Power = V x I
P = 36 x 8.3 = 298.8 watts

37

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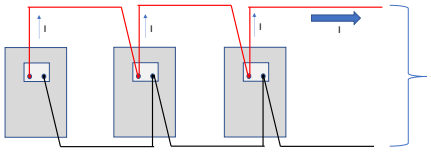
Parallel Connected



12V
100 W
8.3A

12V
100 W
8.3A

12V
100 W
8.3A

Sanity check:
Watts = Volts x Amps
Power = V x I
P = 12 x 24.9 = 298.8 watts

38

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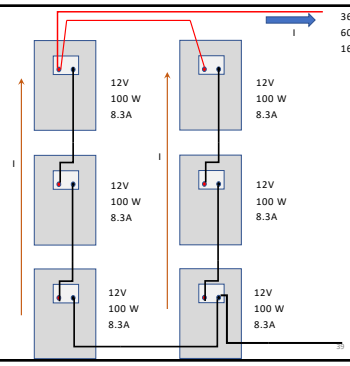
Series And Parallel Connected



Sanity check:
Watts = Volts x Amps
Power = V x I
P = 36 x 16.6 = 597.6 watts

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Solar Module Facts

Solar modules (panels) are less efficient as temperature increases

As temperature of the module increases:

- Current output increases
- Voltage output decreases

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Module Standard Test Conditions (STC)

Irradiance: 1000 W/m^2

Module cell temperature: 25°C (77°F)

Mass of Air: 1.5

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Maximum Voltage Limits (690.7)

- One and Two Family Dwelling units: <= 600 VDC
- Roof mounted systems (not 1 & 2 dwelling units): <= 1000 VDC
- Ground-mounted systems:
  - limited by available equipment requirements
  - Special rules for systems >1000 VDC (690.31(G))

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Installation requirements

- PV system DC circuits in or on buildings if > 30V or 8 amps must be in
  - Metal raceway
  - Type MC (metal clad) cable
  - Metal enclosures

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PV WIRE

2kV PV Wire. Stranded Bare Copper Conductors. XLP Insulation. -40C to 90C Wet or Dry. Rated VW-1.* Sunlight Resitance and Direct Burial.

Image not to scale. See Table 1 for Dimensions

CONSTRUCTION:

Conductors:
7, 37, & 61 Strands:
Class A, Compressed Concentric-Lay, Stranded Copper Conductors per ASTM B3, B8 (or B33 for Tinned Copper Construction)

19 Strand:
19 Wire Combination Unilay, Stranded Soft Drawn Bare Copper Conductors per ASTM B3, B787 (or B33 for Tinned Copper Construction)

Insulation: Cross-Linked Polyethylene (XLPE)

APPLICATIONS AND FEATURES:
Southwire Photovoltaic Wire is intended for use in solar power applications. Rated 90°C for Exposed or concealed wiring in wet or dry locations. Rate for Direct Burial.

SPECIFICATIONS:
- ASTM B3, B8, B33, B787
- UL 4703 - Type Photovoltaic Wire
- UL 44 - TYPE RHW-2

Southwire

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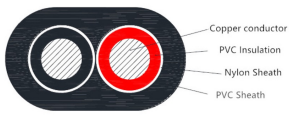
Distributed Generation (DG) Cable

UL 3003 STANGARD TYPE DG CABLE

Use and installation

This category covers multi-conductor, nonintegrally jacketed, distributed generation (DG) cable. This cable is intended for use with specific distributed generation equipment/devices such as photovoltaic modules, inverters, solar trackers, etc. DG cable is suitable for use between cable trays and utilization equipment.

Structure



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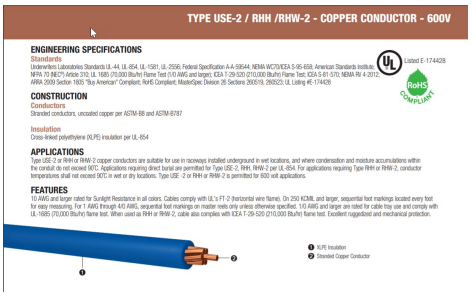
RHW-2 and USE-2


TYPE USE-2 / RHH /RHW-2 - COPPER CONDUCTOR - 600V

ENGINEERING SPECIFICATIONS

Standards

Underwriters Laboratories Standards UL-44, UL-854, UL-1581, UL-2556; Federal Specification A-A-59544; NEMA WC70/ICEA S-95-658; American Standards Institute; NFPA 70 (NEC®) Article 310; UL 1685 (70,000 Btu/hr) Flame Test (1/0 AWG and larger); ICEA T-29-520 (210,000 Btu/hr) Flame Test; ICEA S-81-570; NEMA RN 4-2012; ARRA 2009 Section 1605 "Buy American" Compliant; RoHS Compliant; MasterSpec Division 26 Sections 260519, 260523; UL Listing #E-174428

Listed E-174428

CONSTRUCTION

Conductors

Stranded conductors, uncoated copper per ASTM-B8 and ASTM-B787

Insulation

Cross-linked polyethylene (XLPE) insulation per UL-854

APPLICATIONS

Type USE-2 or RHH or RHW-2 copper conductors are suitable for use in raceways installed underground in wet locations, and where condensation and moisture accumulations within the conduit do not exceed 90°C. Applications requiring direct burial are permitted for Type USE-2, RHH, RHW-2 per UL-854. For applications requiring Type RHH or RHW-2, conductor temperatures shall not exceed 90°C in wet or dry locations. Type USE -2 or RHH or RHW-2 is permitted for 600 volt applications.

FEATURES

12-AWG and larger rated for Sunlight Resistance in all colors. Cables comply with UL's FT-2 (horizontal wire flame). On 250 KCMIL and larger, sequential foot markings located every foot for easy measuring. For 1 AWG through 4/0 AWG, sequential foot markings on master reels only unless otherwise specified. 1/0 AWG and larger are rated for cable tray use and comply with UL-1685 (70,000 Btu/hr) flame test. When used as RHH or RHW-2, cable also complies with ICEA T-29-520 (210,000 Btu/hr) flame test. Excellent ruggedized and mechanical protection.

1. XLPE Insulation
2. Stranded Copper Conductor

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Maximum Current [690.8(A)(1) & (2)]

(1) For PV module
- Must account for the ability to have more irradiance than STD (1000 w/m^2)
- Multiply module short circuit current (Isc) x 1.25

(2) For inverters, microinverters and DC-to-DC converters
- These devices will limit the maximum current
- No need to multiply by 1.25
- Use manufacturer's maximum current number

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Key Inverter Specifications

- Output Data:
  - Max output power: 208V/240V, 9995 VA/9995VA Output configuration: 1-NPE 208/240V
  - Frequency range (adjustable): 45-55 Hz/50-66 Hz
  - Nominal operating frequency: 60 Hz
  - Total harmonic distortion: < 2.5%
  - Power factor range: 0 -1 inductive/capacitive
  - Maximum continuous output current: @ 208V, 48.1 Amps; @240V, 41.6 A
  - OCPD/AC Breaker size: @208V, 70A; @240V, 60A
  - Maximum efficiency: 96.7%
  - CEC efficiency: 96.0% @ 240V

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I_{SC} x 1.25 x 1.25

- Sizing Conductors
- Selecting Overcurrent Protection Devices
- Article 690.8

Note: 1.25 x 1.25 = 1.56

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I_{SC} x 1.25 x 1.25

- First 1.25: for irradiance

- Second 1.25: for continuous current (> 3 hours)
  - (also to limit current to 80% (0.8) of OCPD)
  - FYI: 1/0.8 = 1.25

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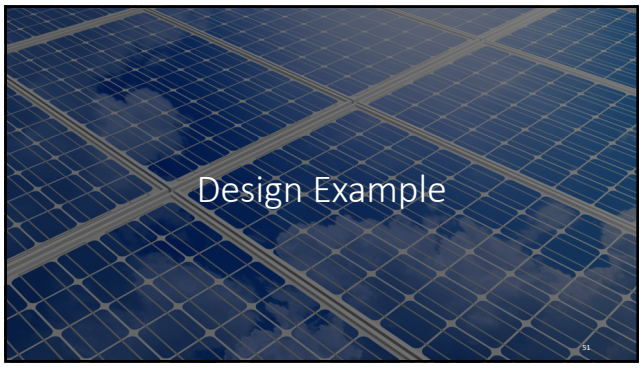

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What Type of System Do You Want?

- Stand-alone (Off-Grid) with battery storage
- Grid-tied (no-storage)
- Grid-tied (with battery storage) aka: Hybrid or Multimode

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PV Cost Factors

- How much energy do you want to offset? Some or all?
- What is your budget?
- What incentives are available to offset costs?

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PV Size Factors

- How much power do you want to generate?
  - Look at utility bills
  - Calculate loads from equipment nameplate data
  - Estimate loads from published data
  - Monitor and measure energy usage (most accurate)
- How much roof space do you have?
- How much sunlight is available in your area?
- Size and Wattage of solar modules

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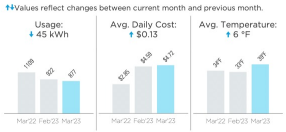
Billing Information

Usage History (kWh):

Usage Details:

↑↓Values reflect changes between current month and previous month.



Total usage for the past 12 months: 14,609 kWh

Average (Avg.) monthly usage: 1,217 kWh

Meter Read Details:

Meter #884392645					
Previous	Type	Current	Type	Metered	Usage
29507	Actual	30384	Actual	877	877 kWh
Service Period 02/13 - 03/14					Multiplier 1
Next scheduled read date should be between Apr 12 and Apr 17 .					

Does not provide max demand information.
May be available upon request

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Power Monitoring

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Resources

- Hand Calculations based on the NEC: Article 690 and others
- Free Software: NREL (PV Watts e.g.), Sketchup
- Paid Software: HelioScope, Aurora Solar etc.

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Project Information

- Location: Toledo, Ohio 43607
- Type: Residence
- Type of installation: Roof-top
- Roof orientation: North-South
- Service: 240/120V

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Solar Irradiation Information

- Find peak sun hours/day (many sources)
  - https://footprinthero.com/peak-sun-hours-calculator

Your annual average:

4.43 peak sun hours per day

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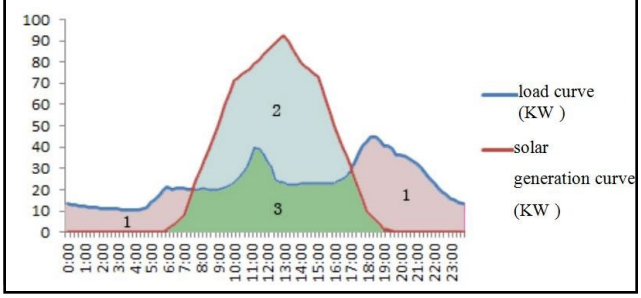
typical daily solar generation curve and load curve



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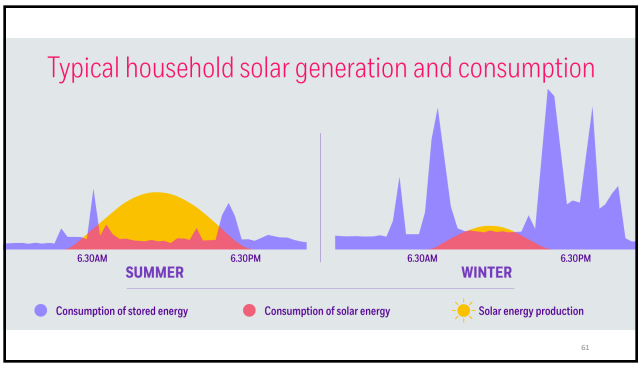

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Solar Irradiance Information

- 4.43 peak sun hours per day
- 1217 avg kwh/month (from AEP bill)
- 1217/30 = 40.6 kwh/day avg.
- 40.6 kwh = 40.6 x 1000 = 40,600 watt-hours/day
- Watts/day = 40,600 watt-hours/4.43 peak sun hours = 9164.8 watts/day
- Round up to **10,000 watts** (with safety buffer)

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Choose Inverter Size

Select 10,000 watt inverter based on calculations

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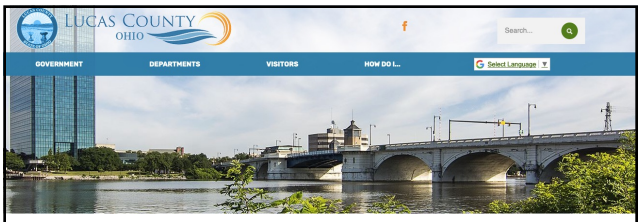

Lucas County Ohio Building Codes

- Residential: Residential Code of Ohio, 2019 edition
- Energy: International Energy Conservation Code, 2018 edition
- Electrical: 2017 NEC
- https://www.co.lucas.oh.us/334/Codes

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LUCAS COUNTY BUILDING REGULATIONS

Climatic and Geographic Design Criteria

One-, Two-, and Three-Family Dwellings, Section R301, the following local design criteria is established for Lucas County, and shall be used in Table R301.2 (1). These criteria may also be used where permitted in Ohio Building Code chapter 16, Structural Design.

GROUND SNOW LOAD: 20 pounds per square foot.

WIND SPEED: 90 miles per hour 3-second gust.

SEISMIC DESIGN CATEGORY: A or B.

SUBJECT TO DAMAGE FROM WEATHERING: Severe.

FROST LINE DEPTH: Thirty-six inches (36") minimum depth of footing below finish grade.

SUBJECT TO DAMAGE FROM TERMITES: Moderate to heavy.

WINTER DESIGN TEMPERATURE: 6,494 heating degree days per year; 1° F.

ICE SHIELD UNDERLAYMENT REQUIRED: Yes.

FLOOD HAZARDS: Effective 03/16/83; community 39095C FIRM maps effective 08/16/11 and 03/16/16

AIR FREEZING INDEX: 1,500 degree days below 32°F.

MEAN ANNUAL TEMPERATURE: 50°F.

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Desired PV Size and Parameters

- Location: Toledo, Ohio 43607
- Toledo design temperature: ASHRAE 2% Annual Design Dry Bulb Temperature: 90 deg F
  - https://www.copper.org/applications/electrical/building/rooftop.html
- 10,000 watts (assume small house with small loads)
- Roof-mounted
  - Wiring and conduit installed at least 1" above roof*
  - Roof with 20 degree pitch
- Existing electrical service: 120/240V, 200A main and busbar rating*
- Limit for residential systems is 600V
- Estimate potential savings: www.pvwatts.nrel.gov

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		2% Design Temp.	Temperature inside conduit in direct sunlight				Max Temp.
			Distance above roof. Up to:				
			1/2"	3½"	12"	36"	
OH	Ohio						
OH	AKRON/CANTON	88	148	128	118	113	100
OH	CINCINNATI MUNICIPAL AP L	92	152	132	122	117	105
OH	CLEVELAND	89	149	129	119	114	102
OH	COLUMBUS	90	150	130	120	115	102
OH	COLUMBUS RICKENBACKE	91	151	131	121	116	114
OH	DAYTON	89	149	129	119	114	103
OH	DAYTON WRIGHT PATTERSON A	91	151	131	121	116	103
OH	FINDLAY AIRPORT	89	149	129	119	114	102
OH	MANSFIELD	87	147	127	117	112	99
OH	OHIO STATE UNIVERSITY	90	150	130	120	115	98
OH	SOUTH BASS ISLAND	84	144	124	114	109	97
OH	TOLEDO	90	150	130	120	115	104

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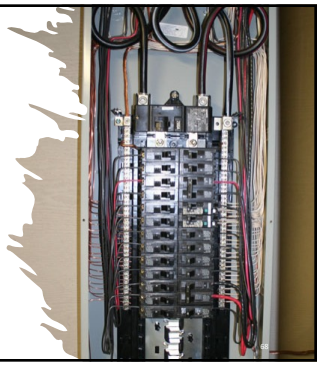
Electrical Service

- Main Panel
  - 120/240V
  - 200 A Main*
  - 200A rated busbar*
  - 42 spaces
  - 10 unoccupied spaces



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Design Rules of Thumb and Considerations

- Avoid placing modules in shady areas
- Use modules from the same manufacturer and model
- Use quality modules, inverters and connectors
- Create symmetric arrays as much as possible
- Consider how you will run wire

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Design Rules of Thumb and Considerations

- Determine orientation of panels: portrait or landscape
- Remember setbacks for fire personnel
- Check on roof warranty!
- Should qualified roofers install mounting hardware? Are they qualified to install solar equipment?
- Try to limit strings to maximum of 2 if possible
  - The number of MPPT inputs for many string inverters
  - May be able to avoid additional overcurrent protection

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Roof and Solar Panel Considerations

- Wind loading
- Snow loading
- Seismic movement
- Typic of roof: shingles, shakes, metal, other
- Flashing and sealing

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Quiz: Which location would have the most efficient use of their solar PV system?

Hint: Uninhibited exposure

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Roof Safety

- Watch for overhead power lines
- Use tie off points and fall protection
- Use insulated ladders if possible

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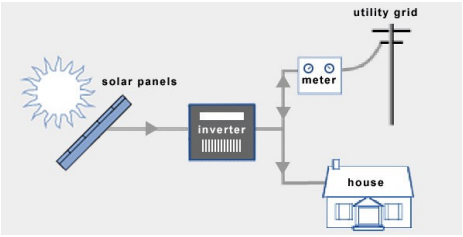
Decision: Grid-Tied (no storage)



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What If We Did Add Batteries

- How many would we need?
- How many hours per day would we need battery power?
- How many days of back up do you need?
- What type of battery would you use? Lead Acid, Lithium Ion, others
- What is depth of discharge of battery?

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Battery Example

CB6-400 **(6V400Ah)**

CB (Electric Vehicle) series is specially designed for frequent deep cycle discharge. By using the specially designed active material and strong grids, the CB series battery offers reliable performance in high load situations and can deliver more than 300 cycles at 100% DOD. Suitable for mobility scooters, electric wheel chairs, golf buggies etc.

Specification

Cells Per Unit	3
Voltage Per Unit	6
Capacity	400Ah@10hr-rate to 1.80V per cell @25°C 416Ah@20hr-rate to 1.75V per cell @25°C
Weight	Approx. 57.5 Kg/126.76 Lbs (Tolerance±1.5%)
Max. Discharge Current	4000A (5 sec)
Internal Resistance	Approx. 1.1 mΩ
Operating Temperature Range	Discharge: -20℃~60 ℃ Charge: 0℃~50℃ Storage: -20℃~60℃
Normal Operating Temperature Range	25℃±5℃
Float charging Voltage	6.8 to 6.9 VDC/unit Average at 25℃
Recommended Maximum Charging Current Limit	120 A
Equalization and Cycle Service	7.3 to 7.4 VDC/unit Average at 25℃
Self Discharge	CB Valve Regulated Lead Acid (VRLA) batteries can be stored for more than 6 months at 25℃. Self-discharge ratio less than 3% per month at 25℃. Please charge batteries before using.
Terminal	Terminal F14/F22
Container Material	A.B.S. UL94-HB, UL94-V0 Optional.

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Batteries Example

- 400 amp-hour battery, 6 Volt = 2,400 watt-hour battery
- Lead acid, Valve Regulated Lead Acid
- 50% Depth of Discharge (longer battery life)
- Provide 2 days of backup power
- 10,000 watts determined to meet emergency and non-daylight loads
- 10,000 watts/240 volts = 41.67 amps, round up to 42 amps

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Batteries Example

- 42 amps x 2 days x 24 hours/day = 2016 amp-hours
- 2016/0.5 for 50% depth of discharge = 4032 amp-hours
- 4032 amp-hours/400 amp-hours per battery = 10.08 batteries
- Round down to 10 batteries
- Approx. cost/battery: $550
- Approx. cost of batteries: $550 x 10 = $5500
- Also need charge controller

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Select Inverter

- Many, many options!
- Chose depending on type of system you want
- Chose quality inverters
- Make sure they have the right listings (NRTL)!

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Inverter Selection Analogy

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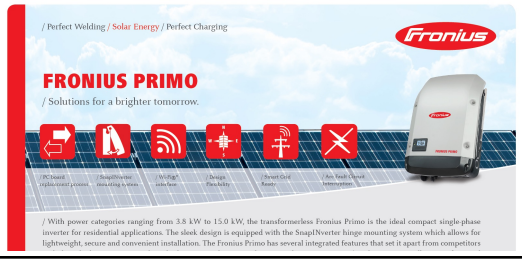
Inverter Selection

Will choose grid-direct inverter for this example



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Key Inverter Specifications

- Model: Fronius Primo 10.0-1
- Protection class: NEMA 4X
- Inverter Topology: Transformerless
- Ambient operating temperature range: -40 to 140 deg F
- Revenue grade metering: Optional (ANSI C12.1 accuracy)
- Certifications and compliance: UL 1741-2010, UL1998, IEEE 1547.1-2003, ANSI IEEE C652.41, UL1699B, CSA TIL M-07

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Key Inverter Specifications

- Protective Devices:
  - DC reverse polarity protection
  - Anti-Islanding: UL 1741-2016, IEEE 1547-2003 and NEC 2017
  - AFCI: Yes (Article 690.11)
  - Rapid Shutdown compliant: per section 690.12
  - Ground fault protection: Yes (Article 690.41(B))
  - DC Disconnect: Yes (Article 690.13)

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Key Inverter Specifications

- Input Data:
  - Recommended PV power (kWp): 8.0 – 12. 0 KW
  - Max. usable input current (MPPT 1/MPPT 2): 33.0/18.0A
  - Max. usable input current (MPPT 1 + MPPT 2): 51 A
    - We will ignore MPPTs for this exercise!
  - Max. array short circuit current (1.5 x Imax): 49.5A/ 27.0
  - Nominal input voltage: 415V
  - Operating voltage range: 80V- 600V
  - DC startup voltage: 80V
  - MPP Voltage range: 220- 480V
  - Max. input voltage: 600V
  - Admissible conductor size DC: 14 AWG – 6 AWG copper direct… see spec sheet
  - Number of MPPT: 2
  - Integrated DC string fuse holders: 4- and 4+ for MPPT 1, no fusing required on MPPT 2

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Key Inverter Specifications

- Output Data:
  - Max output power: 208V/240V, 9995 VA/9995VA (Hint: Think of Watts)
    - Nearly 10,000 watts (10 kW)
  - Output configuration: 1-NPE 208/240V
  - Frequency range (adjustable): 45-55 Hz/50-66 Hz
  - Nominal operating frequency: 60 Hz
  - Total harmonic distortion: < 2.5%
  - Power factor range: 0 -1 inductive/capacitive
  - Maximum continuous output current: @ 208V, 48.1 Amps; @240V, 41.6 A
  - OCPD/AC Breaker size: @208V, 70A; @240V, 60A
  - Maximum efficiency: 96.7%
  - CEC efficiency: 96.0% @ 240V

85

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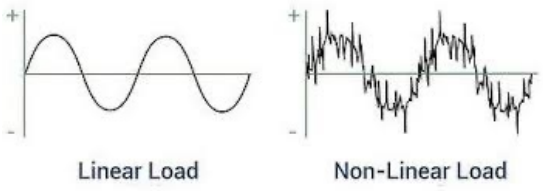
Harmonic Distortion



Linear Load Non-Linear Load

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PV Module Specifications

- Maximum Power (Pmp): 350 W
- Voltage at Pmp (Vmp): 36.1 V
- Open-Circuit Voltage (Voc): 42.7 V
- Current at Pmp (Imp): 9.7 A
- Short Circuit Current (Isc): 10.77A
- Maximum System voltage: 1000 V
- Temperature Coefficients:
  - TkVoc: -0.24 %/deg C
  - TkPmp: -0.30 %/deg C
- Maximum series fuse size: 20 A

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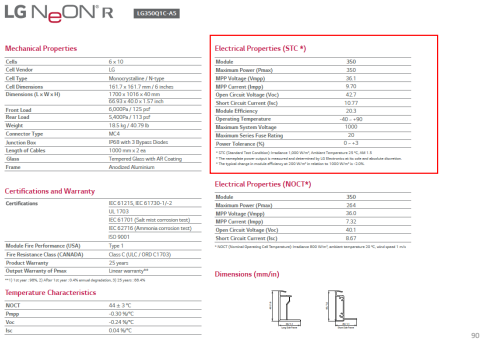

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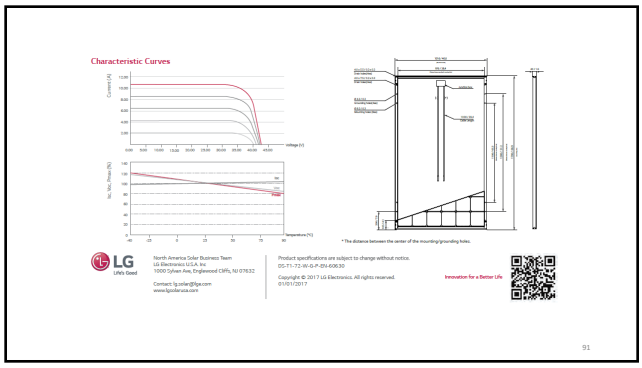

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How to Determine Maximum Number of Modules

Maximum Inverter input wattage: 12,000 watts

Desired array wattage: 10,000 watts

Solar module (panel) wattage: 350 watts

Maximum number of modules: 10,000/350 = 28.57

Round down to 28

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Temperature Adjustments

- TkPmp: -0.30 %/deg C

		2% Design Temp.	Temperature inside conduit in direct sunlight — Distance above roof. Up to: 1/2"	3½"	12"	36"	Max Temp.
OH	Ohio						
OH	AKRON/CANTON	88	148	128	118	113	100
OH	CINCINNATI MUNICIPAL AP L	92	152	132	122	117	105
OH	CLEVELAND	89	149	129	119	114	102
OH	COLUMBUS	90	150	130	120	115	102
OH	COLUMBUS RICKENBACKE	91	151	131	121	116	114
OH	DAYTON	89	149	129	119	114	103
OH	DAYTON WRIGHT PATTERSON A	91	151	131	121	116	103
OH	FINDLAY AIRPORT	89	149	129	119	114	102
OH	MANSFIELD	87	147	127	117	112	99
OH	OHIO STATE UNIVERSITY	90	150	130	120	115	98
OH	SOUTH BASS ISLAND	84	144	124	114	109	97
OH	TOLEDO	90	150	130	120	115	104

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Temperature Corrections

- 90 deg F = 32.22 deg C for Toledo
- 32.22 deg C – 25 deg C (STD) = 7.22 deg C
- TkPmp: -0.30 %/deg C
- TkPmp: -0.003 x 350 watts = -1.05 watts
- TkPmp: -1.05 x 7.22 = -7.581 watts
- Power adjustment: 350 watts – 7.581 watts = 342.42 watts
- 10,000 watt array/342.42 watts per module = 29.2 modules
- Will use 2 strings of 14 modules for symmetry
- May need more modules due to higher ambient temps
- May also explain why certain installations may not achieve desired power

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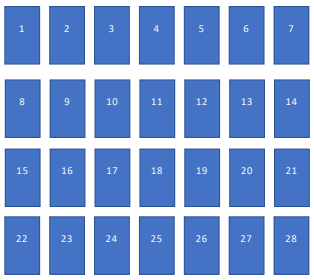

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How to determine maximum number of series modules per string on roof

1. Maximum system voltage for 1 & 2 family dwelling units: 600 VDC
   - Voc of modules: 42.7 V
   - 600V/42.7V = 14.04, round down to 14
2. Maximum inverter input voltage: 600 VDC
   - Voc of modules: 42.7 volts
   - 600V/42.7V = 14.04, round down to 14

Therefore, the maximum series modules per string = 14

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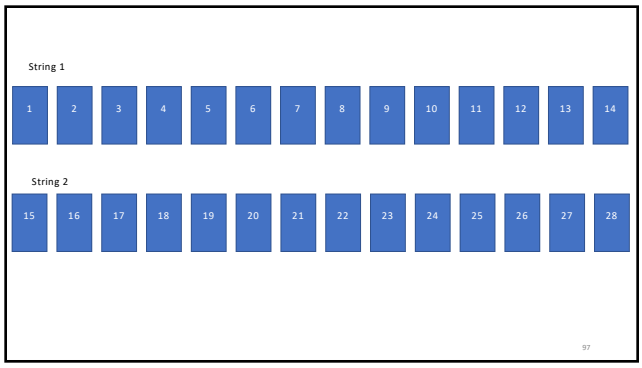

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How to Determine Wattage Per String

- 14 modules x 342.42 watts per module = 4793.88 watts per string
- Remember 342.42 is the derated watts for Toledo area
- Original module wattage is 350 watts

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How to Determine Wattage Per Inverter

- 2 strings of 14 modules = 28 modules
- 28 modules x 342.42 watts per module = 9587.76 watts
- Round up to 9588 watts

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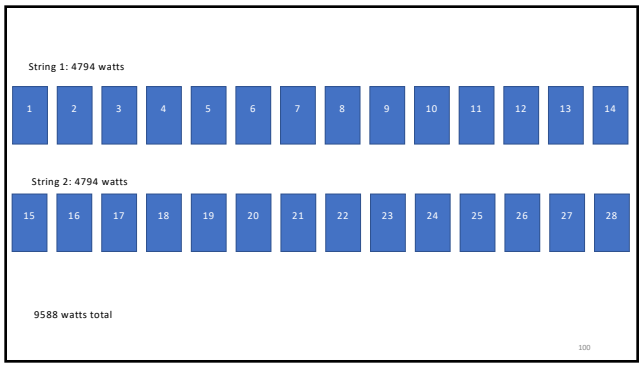

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How To Determine Array Size on Roof

1. Manually measure roof space and module size (good but tedious)
2. Construction drawings (hard to find, unless new)
3. Use software:
   a) PVWatts by NREL (free): not as accurate as (1)
   b) Use Google Maps or Google Earth
      a) https://earth.google.com/web/search/43607/@41.64610424,-83.60142898,193.16483429a,47.63752548d,35y,0h,0t,0r/data=CigiJgokCSLSAoZO0_0RAERHO4XQh00RAGVoyPmOJ5ITAIQY4Y1FH5ITA
   c) Helioscope, Aurora, PVSyst etc. (subscription based): Best but $$
   d) Some inverter manufacturers have free design software with purchase: SolarEdge for example

https://www.solaredge.com/us/products/installer-tools/designer#/

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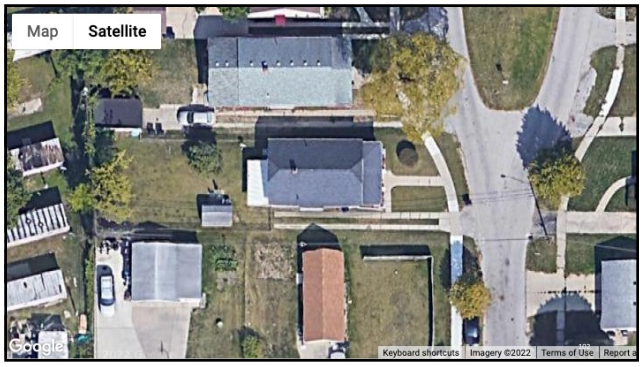

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Roof Considerations

Warranty
Insurance
Type of roof
Slope
Obstructions: vents, chimneys, skylights etc.
Setbacks per IBC and Ohio Building Code
Shading from trees, other homes etc.
Access

103

103

Planning

- Setbacks
- Ridgeline setback
- Module dimensions:
  - 40" x 68"
  - ½" gap in between modules
- Direction of roof rafters for rail mounting
- Type of mounting
- Determine orientation to module: portrait or landscape
- Iron Ridge website: https://www.ironridge.com/design-tools/

104

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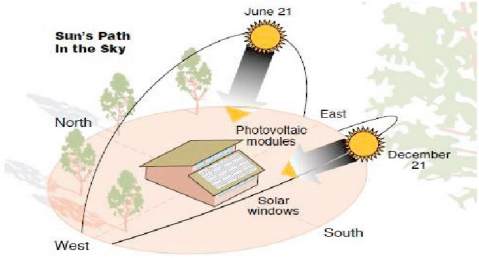
PV Array considerations

- Orientation: portrait or landscape
- Direction: NSEW – usually don't have much choice
- **South facing modules and arrays are optimal**
- Try to create symmetry among arrays
- Try to limit number of array strings
- Tilt angle: default if same plane as roof
- Orient to minimize shading
- Roof access
- Firemen access (setbacks)

105

105



106

106

Where would you NOT place modules?

107

107

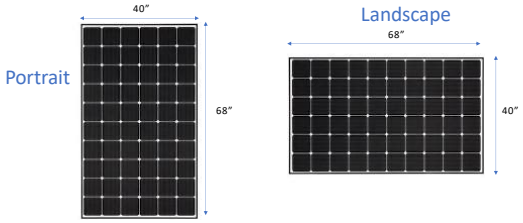
108

108

109

Manual Calculation – Measure Roof

- Main Roof: 50 feet length x 40 feet width (East-West)
- Small Roof: 10 feet length x 40 feet width (North-South)
- Modules:



110

110

Intermodule Spacing

111

111

Manual Calculation (continued)

- Max number of panels East-West on main roof:
- 50 feet x 12 inches/ft = 600 inches
- 1/2 inch module spacing
- 600 inches/(40 inches module width + 0.5 inches) = 14.8 = 14 modules

- Max number of panels North-South on main roof:
- 40 feet x 12 inches/ft = 480 inches
- ½ inch module spacing
- 480 inches/68 inches module width + 0.5 inches) = 7 modules

112

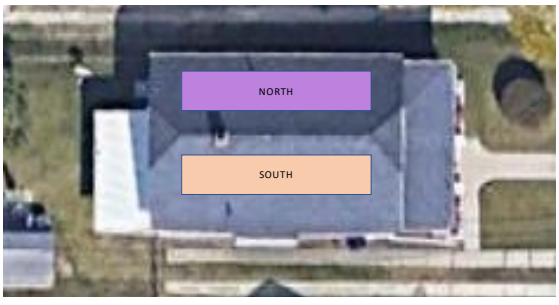
112

Manual Calculation (continued)

- Arrange panels on roof and secondary roof as needed
- Keep strings to limit of 14
- Minimize number of strings to 2 to match inverter MPPT inputs

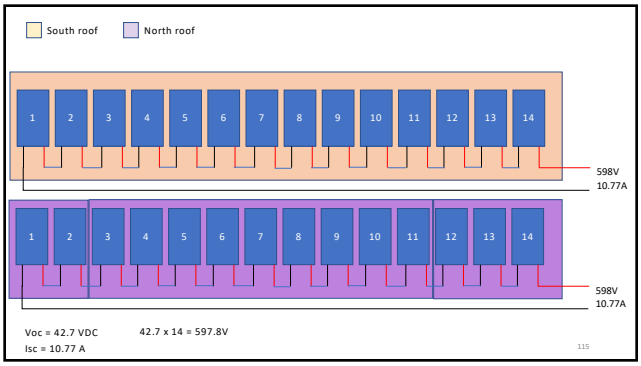
113

113



114

114



115

Calculating Wire Size

Remember This?

- Isc = 10.77A
- Isc x 1.25 x 1.25 = 16.82 A
- #12 AWG PV wire sufficient
- Potential adders:
  - Derate for more than 3 conductors in conduit
  - Derate for less than 7/8" above roof
  - Derate for high temperature areas
  - Derate for voltage drop on long runs. Max of 2% recommended

116

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Calculating Overcurrent Protection Per String

Remember This?

- Isc = 10.77A
- Isc x 1.25 x 1.25 = 16.82 A
- Wire size from previous calculation: #12 AWG (good for 20A)
- Wire can easily handle 16.82 amps
- Even if there was a short circuit, fuse or CB would not blow/trip
- Therefore, a fuse or CB is not required in this case [690.9(A)(1)]

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690.9 Overcurrent Protection.

(A) Circuits and Equipment.

PV system dc circuit and inverter output conductors and equipment shall be protected against overcurrent. Circuits sized in accordance with **690.8(A)(2)** are required to be protected against overcurrent with overcurrent protective devices. Each circuit shall be protected from overcurrent in accordance with **690.9(A)(1)**, (A)(2), or (A)(3).

(1) Circuits Where Overcurrent Protection Not Required.

Overcurrent protective devices shall not be required where both of the following conditions are met:

Isc x 1.25

(1) The conductors have sufficient ampacity for the maximum circuit current.

(2) The currents from all sources do not exceed the maximum overcurrent protective device rating specified for the PV module or electronic power converter.

118

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Review

- Maximum current: Isc x 1.25 = 10.77 x 1.25 = 13.46 A
- #12 PV wire good for 20A: ref [690.9(A)(1)(1) ✓
- PV Module Max Fuse Rating: 20A ref [690.9(A)(1)(2)] ✓
- Inverter maximum array short circuit current: ref [690.9(A)(1)(2)
  - MPPT 1: 49.5A ✓
  - MPPT 2: 27A ✓

119

119

However!

- If String 1 and String 2 **both** had short circuits:
  - Imax of string 1 = 13.46 A
  - Imax of string 2 = 13.46 A
- Then the maximum current would be: 2 x 13.46 = 26.92 amps
- This maximum now exceed requirements in 690.9(A)(1)
  - #12 PV wire good for 20A: X
  - PV Module Max Fuse Rating: 20A X
  - Inverter maximum array short circuit current:
    - MPPT 1: 49.5A ✓
    - MPPT 2: 27A ✓

120

120

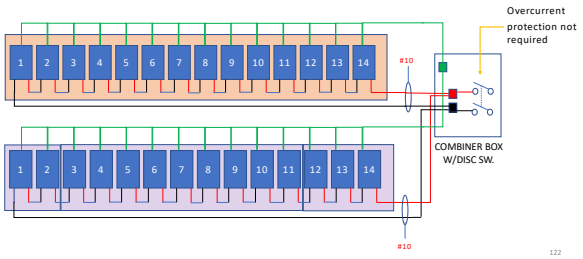
Recommendation

- Increase wire size from #12 to #10
- #10 Good for 30A
- Both circuits short circuited:
  - Maximum current: 2 x 13.46 = 26.92 amps
  - #10 PV wire good for 30A: ✓
  - PV Module Max Fuse Rating: 20A X
  - Inverter maximum array short circuit current:
    - MPPT 1: 49.5A ✓
    - MPPT 2: 27A ✓

121

121

Increase wire size to avoid overcurrent protection



122

122

(E) Type of Disconnect.

The PV system disconnecting means shall simultaneously disconnect the PV system conductors that are not solidly grounded from all conductors of other wiring systems. The PV system disconnecting means or its remote operating device or the enclosure providing access to the disconnecting means shall be capable of being locked in accordance with **110.25**. The PV system disconnecting means shall be one of the following:

(1) A manually operable switch or circuit breaker

(2) A connector meeting the requirements of **690.33(D)(1)** or (D)(3)

(3) A pull-out switch with the required interrupting rating

(4) A remote-controlled switch or circuit breaker that is operable locally and opens automatically when control power is interrupted

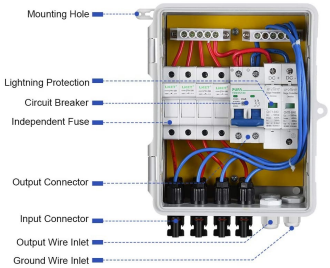
(5) A device listed or approved for the intended application

Informational Note: Circuit breakers marked "line" and "load" may not be suitable for backfeed or reverse current.

123

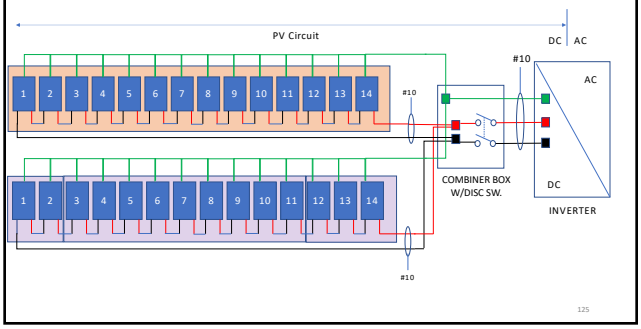
123

Combiner Boxes



124

Inverter



125

Key Inverter Specifications

- Output Data:
  - Max output power: 208V/240V, 9995 VA/9995VA (
  - Output configuration: 1-NPE 208/240V
  - Frequency range (adjustable): 45-55 Hz/50-66 Hz
  - Nominal operating frequency: 60 Hz
  - Total harmonic distortion: < 2.5%
  - Power factor range: 0 -1 inductive/capacitive
  - Maximum continuous output current: @ 208V, 48.1 Amps; @240V, 41.6 A
  - OCPD/AC Breaker size: @208V, 70A; **@240V, 60A**
  - Maximum efficiency: 96.7%
  - CEC efficiency: 96.0% @ 240V

126

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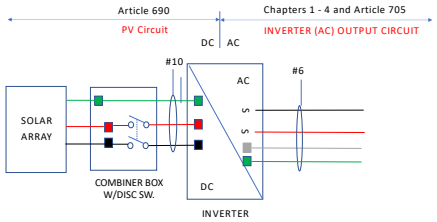
INVERTER OUTPUT CONDUCTOR SIZE

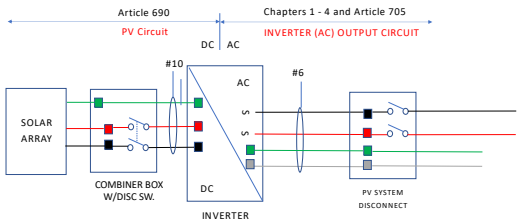


Inverter Specs: Maximum continuous output current: 240V, 41.6 A
Imax = 41.6 x 1.25 = 52 amps ➡ #6 wire (good for 65A)

127

127

PV DISCONNECT

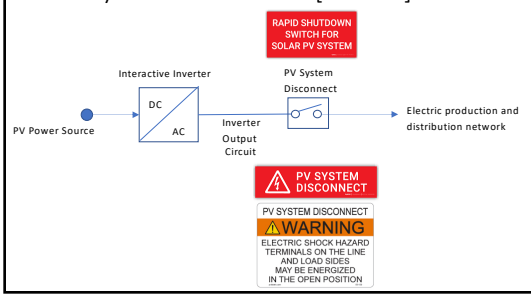


Inverter Specs: Maximum continuous output current: 240V, 41.6 A
Imax = 41.6 x 1.25 = 52 amps ➡ #6 wire (good for 65A)

128

128

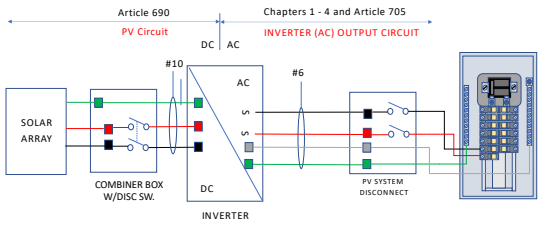
PV System Disconnect [690.13]



129

129

AC POINT OF INTERCONNECTION



Inverter Specs: Maximum continuous output current: 240V, 41.6 A
Imax = 41.6 x 1.25 = 52 amps ➡ #6 wire (good for 65A)

130

130

Inverter Output OCPD

- **Minimum Output OCPD** = Inverter maximum current (Imax) x 1.25
- From spec sheet, Inverter maximum AC output current = 41.6A @ 240V
- 41.6 x 1.25 = 52A
- Round up to next standard size: 60A

- **Maximum Output OCPD** from spec sheet
  - 60 A @ 240V

- OCPD options: only 60A in this case*
  - *Sometimes min and max are different*

131

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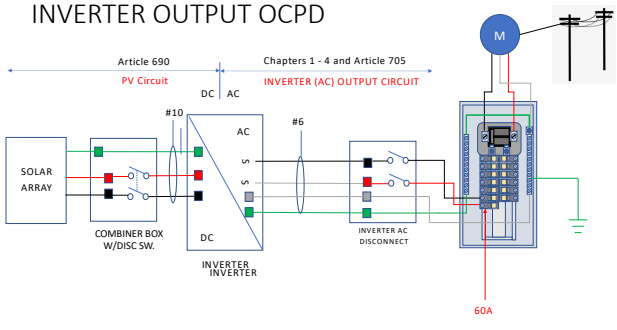
INVERTER OUTPUT OCPD



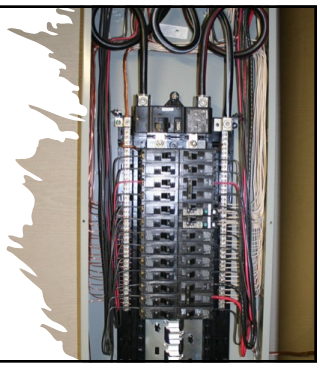
132

132

Point of Interconnection

- Line side [NEC 705.11]
- Load side [NEC 705.12]

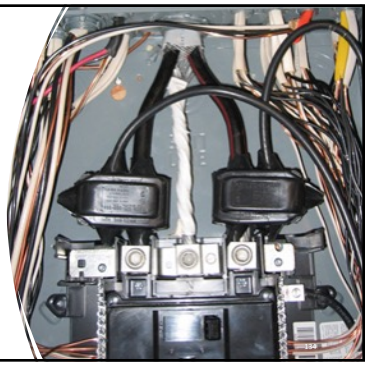
Play 8:30 – 13:15



133

Line Side Interconnection

- See section 705.11
- Multiple rules in section 230 apply
- Tap rules apply



134

705.12 Load side point of interconnection option

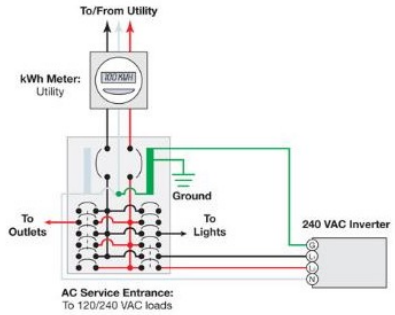
- To use this option…
- 1.25 x the maximum continuous output of the inverter, plus the main supply overcurrent device of the service panel, must not exceed 120%* of the panel's busbar rating

*AKA the 120% rule

135

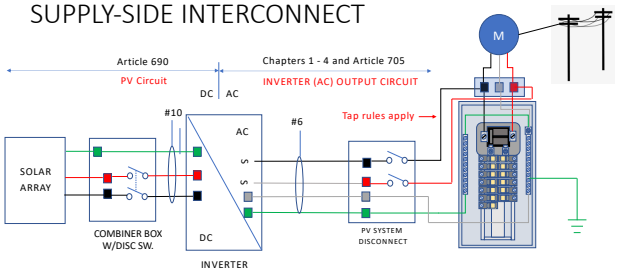
135

Load side point of interconnection option



136

SUPPLY-SIDE INTERCONNECT



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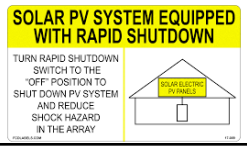
Rapid Shutdown Requirements 690.12

- To reduce the shock hazards for firefighters
- Initiation devices[690.12(C)]
  - Service Disconnection Means
  - PV system disconnecting means
  - Readily accessible switch that plainly indicated whether it is on the "off" or "on" position

RAPID SHUTDOWN SWITCH FOR SOLAR PV SYSTEM



138

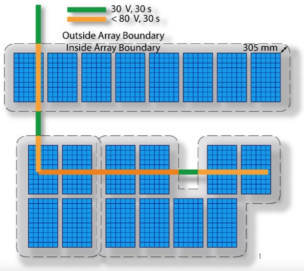
US Rapid Shutdown Compliance

NEC 2017/2020 Rooftop Systems Must Comply with Both:

690.12(B)(1) Control Conductors Outside Array Boundary
Mandatory - No flexibility
≤ 30 V within 30 Seconds

and

690.12(B)(2) Control Conductors Inside Array Boundary
3 options:
(1) UL 3741 PV Hazard Control Array
(2) MLPE
(3) No metal or exposed cables (BIPV)



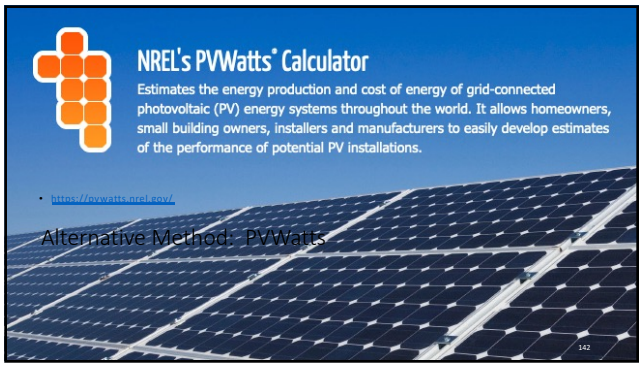
139

Inverter Has Provision for Rapid Shutdown

- Protective Devices:
  - DC reverse polarity protection
  - Anti-Islanding: UL 1741-2016, IEEE 1547-2003 and NEC 2017
  - AFCI: Yes (Article 690.11)
  - Rapid Shutdown compliant: per section 690.12
  - Ground fault protection: Yes (Article 690.41(B))
  - DC Disconnect: Yes (Article 690.13)

140

141



142

PV Watts Input

- Address: Toledo, Ohio 43607
- Kilowatts: 10 (10,000 watts)
- Module type: Standard
- Array Type: Fixed (roof mount)
- System losses: 14.08 (default)
- Tilt: 20 (default)
- Azimuth: 180 degrees (due south)
- Rate type: Residential
- Rate: $0.14

143

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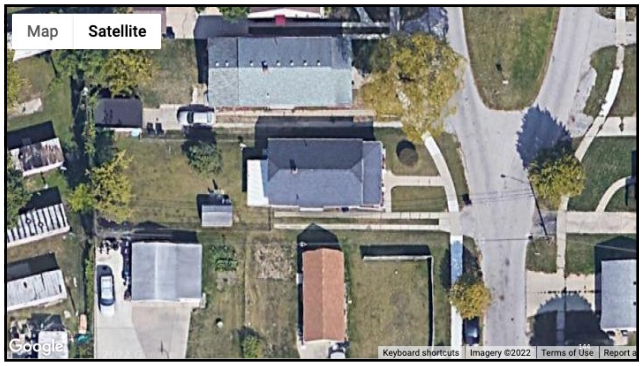

144

RESULTS

12,945 kWh/Year*

System output may range from 12,401 to 13,387 kWh per year near this location.

Month	Solar Radiation (kWh / m² / day)	AC Energy (kWh)	Value ($)
January	2.63	723	101
February	3.45	818	115
March	4.53	1,147	161
April	5.34	1,265	177
May	5.99	1,419	199
June	6.52	1,443	202
July	6.54	1,475	207
August	6.08	1,357	190
September	5.29	1,199	168
October	3.63	866	121
November	2.75	679	95
December	2.12	554	78
Annual	4.57	12,945	$ 1,814

145

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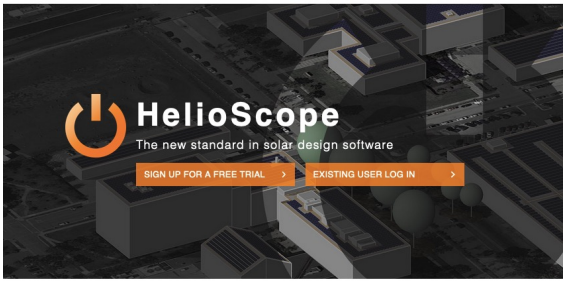
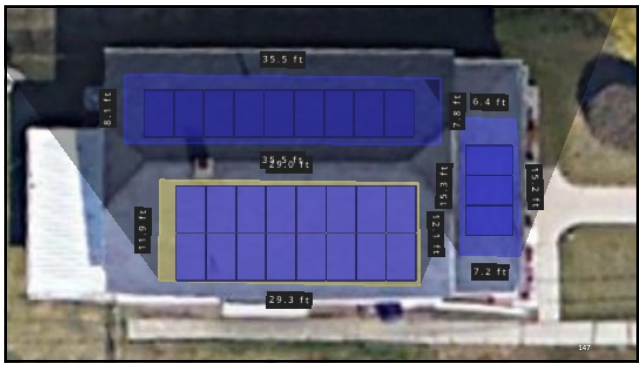
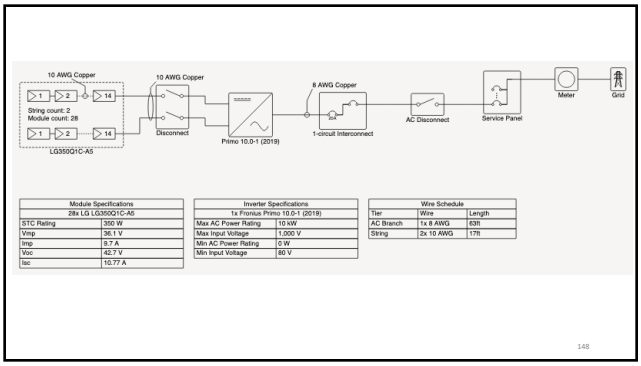
Folsom Labs



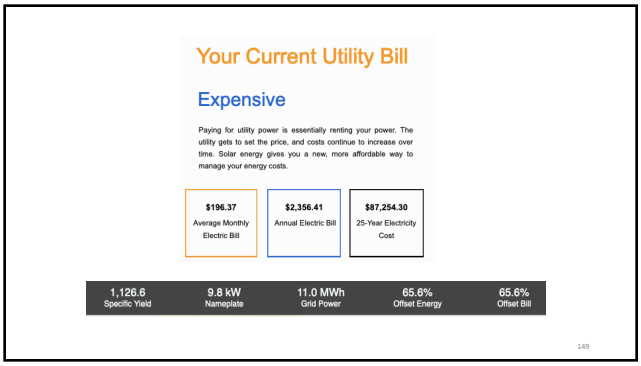
146



147


10 AWG Copper
10 AWG Copper
8 AWG Copper
String count: 2
Module count: 28
1
2
14
Disconnect
Primo 10.0-1 (2019)
1-circuit Interconnect
AC Disconnect
Service Panel
Meter
Grid
LG350Q1C-A5
Module Specifications
28x LG LG350Q1C-A5
STC Rating 350 W
Vmp 36.1 V
Imp 9.7 A
Voc 42.7 V
Isc 10.77 A
Inverter Specifications
1x Fronius Primo 10.0-1 (2019)
Max AC Power Rating 10 kW
Max Input Voltage 1,000 V
Min AC Power Rating 0 W
Min Input Voltage 80 V
Wire Schedule
Tier Wire Length
AC Branch 1x 8 AWG 63ft
String 2x 10 AWG 17ft
148

148


Your Current Utility Bill
Expensive
Paying for utility power is essentially renting your power. The utility gets to set the price, and costs continue to increase over time. Solar energy gives you a new, more affordable way to manage your energy costs.
$196.37
Average Monthly Electric Bill
$2,356.41
Annual Electric Bill
$87,254.30
25-Year Electricity Cost
1,126.6
Specific Yield
9.8 kW
Nameplate
11.0 MWh
Grid Power
65.6%
Offset Energy
65.6%
Offset Bill
149

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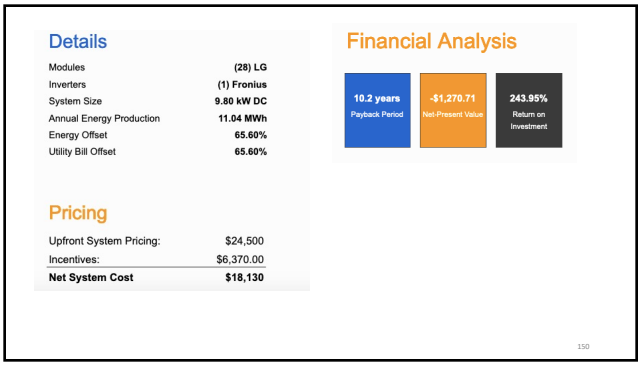
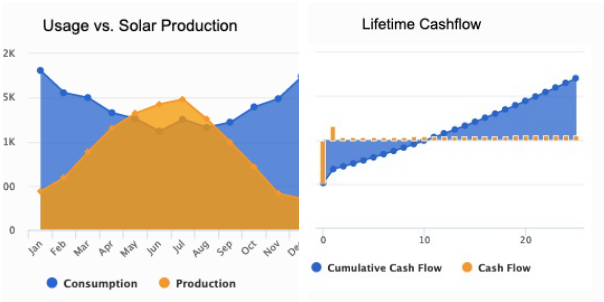

Details
Modules (28) LG
Inverters (1) Fronius
System Size 9.80 kW DC
Annual Energy Production 11.04 MWh
Energy Offset 65.60%
Utility Bill Offset 65.60%
Pricing
Upfront System Pricing: $24,500
Incentives: $6,370.00
Net System Cost $18,130
Financial Analysis
10.2 years
Payback Period
-$1,270.71
Net-Present Value
243.95%
Return on Investment
150

150



151

151

Sizing Conductors

- Two methods per article 690.8(B)
- Ampacity must be the larger of <u>both</u> methods:
  - (1) Without adjustment and correction factors (we did this in ex)
    - Maximum current x 1.25

    OR

  - (2) With adjustment and correction factors (conditions of use)
    - Number of conductors in conduit
    - Ambient temperature adjustments
    - Less than 7/8" above roof (if applicable)

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(2) Adjustment and Correction Factors

- Installation conditions:
  - Toledo 2% ASHRAE Annual Design Dry Bulb Temp*: 90 deg. F (32.2 deg C)
  - Wiring and conduit installed greater than 1 inch above roof
  - Not more than 3 wires installed in conduit

one of several methods that may be used

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Adjust for Ambient Temperature

- Adjustment required for all temperatures above or below 30 deg C (86 deg F)
- ASHRAE 2% Annual Dry Bulb Temp: 32.2 deg C *(one of several approved methods)*
- See Table 310.15(B)(1)

Ambient Temp deg C	60 deg C	75 deg C	90 deg C	Ambient Temp deg F
31-35	0.91	0.94	0.96	87-95
36-40	0.82	0.88	0.91	96-104
41-45	0.71	0.82	0.87	105-113
46-50	0.58	0.75	0.82	114-122
51-55	0.41	0.67	0.76	123-131
56-60	----	0.58	0.71	132-140
61-65	----	0.47	0.65	141-158

154

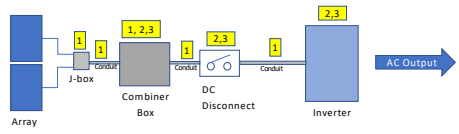
154

LABELING, LABELING, LABELING!

155

155

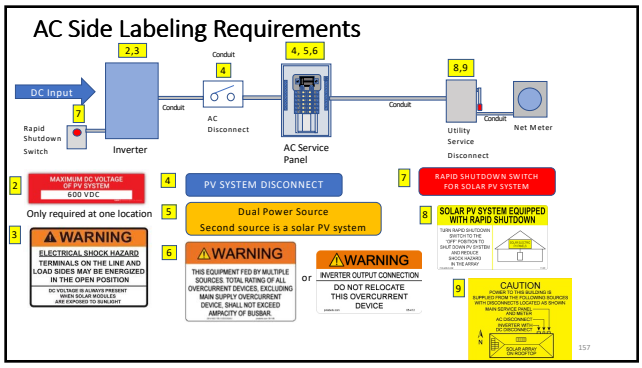
DC Side Labeling Requirements



Only required at one location

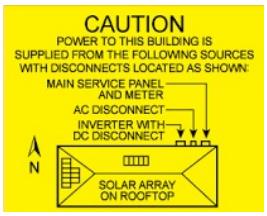
156

156



157

Directory



158

158

CONGRATULATIONS!

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Next Steps

- A Certificate of Completion will be emailed to those who successfully completed course
- 4 hours of Code Class Hours will be reported to the OCILB for Code Continuing Education Credits
- Contact instructor at bpmatthews@matthewselectrical.net for any questions or comments
- Make sure you completely sign out of webinar after the next slide!

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161

161

File Attachments for Item:

ER-14 2023 NEC Changes (Ohio Certificate Renewal)

All certifications (4 hours)

Staff Notes:

ESIAC Recommendation:

Committee Recommendation:

Application for Continuing Education Course Approval

Application for Continuing Education Course Approval

Provider Information

Name *: Harold Plant

Organization: Ohio Certificate Renewal

Email *: mayda@ohiocertificate.com

Phone Number *: (614) 451-9003

Address *: P.O. Box 211102

City *: Columbus

State *: Ohio

Zip Code *: 43211

Website: ohiocertificate.com

Conference Sponsor (if applicable):

Conference Email:

☐ Check here if Course Renewal

Prior course number(s)' (i.e. BBS2018-429):

Renewals will only be granted for identical content and hours, within the current code cycle. Attach a copy of prior course approval letter for confirmation. No further information is required

New Course Information

Course title: 2023 NEC Changes

Course instructor: J.D. White

Course description:

Designed for Electrical contractors and inspectors, this course provides a review of changes in the 2023 NEC. This 4-hour class covers highlights of changes including working space and barriers in electrical equipment, GFCI Protection, Outdoor outlets, disconnects, EVSE requirments and energy management systems.

Instructional hours per session:

Number of Sessions:

Course Date: 2024-01-19

Course Location: webinar

Special Content

- ☐ Code Administration
- ☐ Existing Buildings
- ☐ Electrical Instruction
- ☐ Plumbing Instruction

Conference Course:

Conference Name:

Conference location:

Course to be offered online?

- ☑ Yes
- ☐ No

☑ On Demand ☑ Webinar

Course Website: ohiocertificate.com

1201

Detail online course participation confirmation method (i.e. test, quizlets, participant activity confirmation):

Quizlets and periodic activity confirmation will be used to confirm attendance.

Course applicable for the following certifications *

- [ ] Residential Certifications Only
- [ ] Administrative Course, All Certifications
- [x] Commercial and Residential Certifications

Application materials included *

- [x] Course Outline or Course Learning Objectives
- [x] Presentation Materials/Slides (not required for roundtable courses)
- [ ] Assessment Materials (for online courses)
- [x] Presenter Bio
- [ ] Prior Course Approval Letter

Upload less than 100mb (Please attach PDF files only) *

File Name	Size
2023NEC-Changes-4hr-BBS20231130.pdf	688.11 kB

Applicant Full Name *

Harold L. Plant

Date of Submission

12/01/2023

Instructions for new Continuing Education Approval form

Provider Information

1. Please include all contact information.
2. If course is not part of a conference, leave conference sponsor and email blank.

Course Renewal

1. Indicate if the course is being submitted for renewal. Include prior approval letter and write in prior course number.
2. Certification approval for courses has now changed: all existing courses being renewed will be approved within the new classification system.
    a. Courses previously approved for only residential certifications will be approved for all residential certifications.
    b. Courses previously approved for at least one commercial certification will now be approved for all commercial certifications and all residential certifications.
    c. Courses on required instruction topics, Ohio Ethics, Code Administration and Existing Buildings, will be noted as Administrative Courses and be approved for all certifications.
3. Courses being renewed should skip the New Course information section and are not required to submit outline, agenda, slides or other instructional materials for review.

Skip to Special Content, and mark any item that applies to the course.

New Course Information

1. Enter course title, name of instructor, and a brief description of the course content.
Learning objectives may be substituted for course description, if desired.
2. Number of instructional hours per session is the length of instructional time.
3. Number of sessions: can be 1 or the number of sessions planned.
4. Course date(s) and location: not necessary at this time, enter if known.

Special Content

1. Indicate if the course will meet instructional time in Code Administration or Existing Buildings.
2. Indicate if the course is a plumbing or electrical course, for ESIAC review and trainee course tracking.
3. If the course is associated with a conference, indicate the conference name and location, as this will allow BBS to coordinate approvals with the conference provider.
4. If the course will be offered online, specify whether it will be on demand or offered as a virtual webinar, or both. Include website where the course will be provided.

Ohio Certificate Renewal
(614) 451-9003
OhioCertificate.com
P.O. Box 211102 Columbus, Ohio 43221-1102

Ohio Certificate Renewal
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2023 NEC Changes

Outline:

110.26(A)(4) - Working Space Around Electrical Equipment

215.15 Barriers in Electrical Equipment

210.8 - GFCI Protection

- 210.8(A)(6) - GFCI Protection in Dwelling Units
- 210.8(B) GFCI Protection in Other Than Dwelling Units
- 210.8(D) - Specific Appliances
- 210.8(F) Outdoor Dwelling Unit Outlets

210.17 Guest Rooms and Suites

215.18(A)-(E), 225.42(A)-(E) and 230.67(A)-(E) Surge Protection Requirements Expanded

220.70 Energy Management Systems (EMSs)

225.41 Emergency Disconnects

406.12 Tamper-Resistant Receptacles

410.184 Horticultural Lighting

440.11 Disconnects in Residential Spaces

511.17 Wiring and Equipment Installed Above Hazardous (Classified) Locations

555.15 Replacement of Equipment in Marine Locations

- 555.4 Location of Service Equipment Near Docks

555.36(C) Shore Power Receptacle Disconnecting Means

625.40 Electric Vehicle Branch Circuit

- 625.49 Island Mode (Electric Vehicle Power Transfer System)

680.5 GFCI and SPGFCI Protection

680.22 Receptacles, Luminaires, and Switches

700.3(A) Tests and Maintenance

700.11 Class-2-Powered Emergency Lighting Systems

706.7 Commissioning and Maintenance of Energy Storage Systems

Q&A

Objectives:

- Understanding of the changes to the 2023 NEC
- Learn an understanding of the GFCI and SPGFCI Protection requirements.
- Gain a deeper understanding of the rationale behind the changes in the 2023 NEC.
- Understanding of the Expanded Surge Protection Requirements
- Understanding of NEC requirements for Luminaires, Switches and Receptacles
- Gain a deeper understanding of requirements for energy storage systems.

JD White

200 Phoenix Ct.
Lexington, SC 29072

614-546-7884
jd.white2000@gmail.com

Objective:

To provide timely and informative teaching relative to Electrical Theory, Electrical Practices, and NEC Updates. All teaching is primarily geared for licensed contractors, architects, engineers, electrical inspectors, and electrician apprentices. Electrical Design and Drafting of small to moderate sized projects, using AutoCAD.

Work and Teaching Experience:

06/2007 - Present
Columbus State Community College
Title: Skilled Trades Apprenticeship Supervisor
Supervisor: Doug House, 614-287-2576

01/2006 – Present
Voltaire Electric Company, Inc. – Columbus, OH
Electrical System Design and Drafting
Title: Consultant 614-546-7884

06/2007 - Present
Columbus State Community College
Title: Adjunct Faculty Teaching:
Electrical Courses, National Electric Code, Employability, Construction Overview, Construction Estimating, Manual Drafting, and AutoCAD
Supervisor: Doug House, 614-287-2576

09/1999 – Present
Electrician Apprenticeship Instructor
Title: Year 1 – Year 4 Lead Instructor
OCILB Instructor, as needed
IEC Central Ohio 614-473-1050

10/2001 – Present
OCILB Instructor, 1-2 seminars per year
Ohio Contractor Training 614-203-1531

12/2008 – Present
OCILB Instructor, 4 seminars per year
Rebecca Warren Training 614-402-6551

JD White

200 Phoenix Ct.
Lexington, SC 29072

614-546-7884
jd.white2000@gmail.com

11/2017 – Present
OCILB Instructor, 2-6 seminars per year
HalfMoon Education Services 715-835-5900

10/2005 - 08/2006
MG Abbott Electric Company – Columbus, OH
Title: Commercial Electrician, Estimator, and ITS Coordinator
Supervisor: Joe Abbott-President, 614-837-3614

07/1995 - 08/2005
Just Dandy Electric Systems, Inc. – Columbus, OH
Title: Owner, Electrician, Estimator, Project Designer...

08/1989 - 07/1995
Safeway Electric Company, Inc. – Columbus, OH
Title: Commercial Electrician, Commercial Division Manager
Supervisor: Andy Untch, 614-443-7672

10/1987 - 08/1989
Mansfield Wesleyan Church – Mansfield, OH
Title: Senior Pastor
Supervisor: Rev. Clyde Hanks-District Supervisor

09/1982 - 07/1987
Delphos Wesleyan Church – Delphos, OH
Title: Senior Pastor
Supervisor: Walter Jefferies-District Supervisor

07/1976 - 09/1982
MG Abbott Electric Company – Columbus, OH
Title: Electrician, Field Supervisor
Supervisor: Gene Abbott-Owner

07/1972 - 06/1974
US Navy – Quonset Point-RI
Title: ADJ (Aviation Machinist Mate Jet)
Supervisor: Various

JD White

200 Phoenix Ct.
Lexington, SC 29072

614-546-7884
jd.white2000@gmail.com

Licensure:

Electrical
11/1990
Cities of: Columbus, Elyria, Springfield, Youngstown, Toledo, Dayton, and others
07/1992

Electrical State of Ohio
02/1996
State of Ohio #EL 14058

Fire Alarm Installer
02/2003
State of Ohio #54.25.3708

Education:

06/2005 – 05/2015
Columbus State Community College – Columbus, OH
ATS Electrical System Architecture Designer

09/1982 - 05/1987
Indiana Wesleyan University – Marion, IN
Christian Ministries & Biblical Literature

06/1981 - 05/1982
Columbus Technical Institute – Columbus, OH
General Education Studies

06/1973
GED Central High School, Columbus, OH

07/1972 - 08/1973
Naval Aviation Technical Training Center
Aviation A School Jet Engines – Memphis, TN
Naval Aviation Technical Training Center
Aviation B School Helicopters – Quonset Pt, RI
Rating: Aviation Machinist Mate Jet

References:

Joe Abbott - Previous Employer: 614-837-3614
Barb Tipton – Present Employer: 614-473-1050
Dr. Andy Rezin – Previous Supervisor: 614-551-8378
Doug House – Present Supervisor: 614-287-2576
Other References Available Upon Request

Sample Ad:

EL-ESI Electrical Code

Friday, June 23, 2023

Instructor: J.D. White

7:30 AM - 3:45 PM (EST)
Morning Session: 7:30 AM to 11:20 AM Eastern Time.
Afternoon Session: 12 PM noon to 3:45 PM Eastern Time.

This course consists of two 4-hour sessions. Attend both for a full 8 hours.

Approved Code class for OCILB, ICC and Ohio BBS.

This webinar will satisfy OCILB requirements for EL ESI PL HY HV RE

View Details and Register
Registration Closes the day before at 8 pm.

Just want to do a half day?

Choose a **4-hour webinar** with option to attend in the morning or afternoon

1209

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2023 NEC Changes

Presented by J.D. White

1

110.26(A)(4) - Working Space Around Electrical Equipment

- The requirement from Sec. 110.26(C)(2) that open equipment doors do not impede access to and egress from the working space was relocated to Sec. 110.26(A)(4) in the 2023 NEC.
- This rule now specifies that when open equipment doors result in an egress path that is less than 24 in. wide or 6 ft, 6 in. high, the opening must be increased to prevent the equipment doors from impeding the egress path.
- Revisions also clarify that the space in front of equipment must be unobstructed by fixed cabinets, walls, or partitions.

2

215.15 Barriers in Electrical Equipment

During maintenance and servicing, it is very likely an electrical worker can be exposed to inadvertent contact with energized parts on the line side of a feeder tap or secondary conductor disconnect, even if the disconnect is in the open position.

3

215.15 Barriers in Electrical Equipment

- The new Sec. 215.15 requires the line-side busbar or terminals of equipment supplied by feeder taps or transformer secondary conductors to be protected from inadvertent contact by placing barriers over the exposed energized parts. This mirrors the line-side barrier protection requirements for services found in Sec. 230.62(C) and **applies to panelboards, switchboards, switchgear, or motor control centers** supplied by feeder taps or transformer secondary conductors.

4

210.8 - GFCI Protection

- In Sec. 210.8, the term "ground-fault circuit-interrupter" has been changed to "listed Class A GFCI," aligning with the NEC's allowance for acronyms.
- The text detailing measurement procedures has been revised to specify that the measurement applies to all power-supply cords plugged into a receptacle — not just appliance cords. The GFCI protection required by Sec. 210.8(A) and (B) can be provided using either a breaker with GFCI protection or a receptacle with GFCI protection. However, the use of a GFCI receptacle is somewhat limited by the requirement that the GFCI must be readily accessible.

5

210.8(A)(6) - GFCI Protection in Dwelling Units

- This revision involves removing the phrase "receptacles serving the countertop" from Sec. 210.8(A)(6), thereby expanding the GFCI protection requirement to include any cord- and plug-connected appliance in kitchens — not just on countertops. A new Exception No. 4 was added to say that the internal receptacle in a bathroom exhaust fan does not require GFCI protection unless required by the installation or listing instructions.

6

FOR REVIEW ONLY

210.8(B) GFCI Protection in Other Than Dwelling Units

- The word "kitchens" was added as list item (2) and removed from list item (3) in Sec. 210.8(B). This change clarifies that all areas with permanent provisions for food serving, beverage service, or cooking must be protected. This means GFCI protection is now required for receptacles in the break area of a commercial occupancy.

7

210.8(D) - Specific Appliances

- Changes in Sec. 210.8(D) now require GFCI protection to be provided for the branch circuit or the outlet supplying listed appliances rated 150V to ground and 60A or less.
- This rule previously referenced other Sections to determine if protection was required. Now you can just read the list. Note: The appliances in list items Sec. 210.8(D)(8) through (12) are commonly installed as hardwired outlets, and the GFCI protection requirements of Sec. 210.8(A) and (B) only apply to receptacles.
- The shock hazards exist whether appliances are hardwired, or cord- and plug-connected; therefore, GFCI protection must be provided for the appliance branch circuit or outlet.

8

210.8(F) Outdoor Dwelling Unit Outlets

- The rule in Sec. 210.8(F) for outdoor outlets was new in the 2020 Code, and its introduction caused a big problem with air-conditioning units in areas outside of dwelling units.
- The battle over its introduction continued during the 2023 Code cycle and ultimately resulted in a new exception for listed HVAC equipment. In addition, the dwelling unit receptacles rated 50A or less in garages, accessory buildings, outdoors, and boathouses that already had GFCI protection requirements now require the outlet to be protected, and GFCI protection must be added for unprotected existing equipment that is replaced.

9

210.17 Guest Rooms and Suites

- 210.17 Branch Circuit Requirements in Guest Rooms and Guest Suites
- Per Sec. 210.17, assisted living facilities with permanent provisions for cooking were added to the list of guest rooms and guest suites that must now have branch circuits installed to meet the dwelling unit requirements. This rule was reorganized into a list, and the new list item (3), "Assisted living facilities," lets us know that if guest rooms or guest suites in hotels, motels, and assisted living facilities include permanent provisions for cooking, then the dwelling unit branch-circuit rules must be met.

10

215.18(A)-(E), 225.42(A)-(E) and 230.67(A)-(E) Surge Protection Requirements Expanded

- Surge protection requirements have been expanded to dormitories, guest rooms/suites of hotel/motels and sleeping rooms of nursing homes and limited care facilities.
- The text in Articles 215.18(A)-(E), 225.42(A)-(E) and 230.67(A)-(E) is almost the same in each article. The text just resides in different Articles of the NEC and while few words differ in (A), the intent is the same.

11

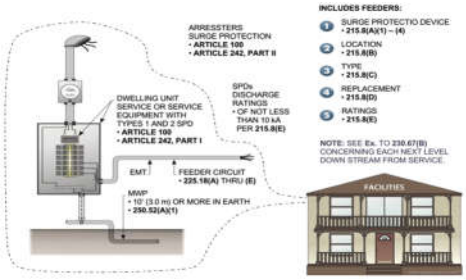
Surge Protection Requirements Expanded

- A new section has been added to clarify the proper protection of areas served by feeders and outside branch circuits that are extended distances away from services which can can result in limited surge protection. The new section addresses the surge-protective device, location, type, replacement, and ratings.
- The current exception in 230.67 achieves the goals of this exception by not requiring the surge-protective device at the service when surge protection is provided at each next level distribution equipment downstream towards the load.
- It's also worth noting that the required SPD's nominal discharge rating must be at least 10 kA. This is a new and significant change from the previous 2020 NEC language.

12

FOR REVIEW ONLY

Surge Protection Requirements Expanded



13

220.70 Energy Management Systems (EMSs)

- Digital control has become a big part of electrical systems these days. A new Sec. 220.70 was added for energy management systems that can control the maximum load of a service.

14

225.41 Emergency Disconnects

- A new Sec. 225.41 requires outside emergency disconnects for feeders supplied to one- and two-family dwelling units. This mirrors the requirements in Sec. 230.85 for service-supplied dwelling units so first responders are always able to shut off the power on the exterior of a dwelling regardless of how it is supplied. Section 225.41(B) requires the identification of the location of other isolation disconnects for other power sources where those disconnects are not located adjacent to the emergency disconnect.

15

406.12 Tamper-Resistant Receptacles

- Additional locations (such as boathouses, mobile homes, motel rooms, dorms, and childcare facilities to name a few) will now require tamper-resistant receptacles per Sec. 406.12.
- Exception No. 3 was clarified to say that a single receptacle for a single appliance or a duplex receptacle for two appliances, not readily accessible and located within the space designated for the appliance(s) are exempt from this rule.

16

410.184 Horticultural Lighting

To address certain potential hazards in the horticultural lighting industry, Sec. 410.184 clarifies that GFCI protection is required where the horticultural lighting is connected with flexible cords using separable connectors or attachment plugs. A new Exception allows lighting equipment supplied by circuits over 150V to be protected with a listed special-purpose ground-fault circuit interrupter that trips at 20mA instead of 6mA.

17

440.11 Disconnects in Residential Spaces

- To prevent a hazard from energized parts, Sec. 440.11 was revised to require disconnecting means with doors that can open to expose live parts to be lockable or require tools to open them when installed in areas readily accessible to unqualified persons.

18

FOR REVIEW ONLY

511.17 Wiring and Equipment Installed Above Hazardous (Classified) Locations

- Section 511.17 went through quite a transformation as it was reorganized into a list format with additional requirements for listed fittings and equipment grounding conductors (EGCs) added to the mix. The term “Class I” was replaced by “Hazardous (Classified)” in five locations, including the title of this Section, as the zone classification system no longer uses the “Class I” designation. This Section was also reorganized from a long paragraph into nine list items for usability, and requirements were added to most of the wiring methods.

19

555.15 Replacement of Equipment in Marine Locations

- Section 555.15 was added to deal with equipment that is replaced at docking facilities. This new Section requires that where electrical equipment is modified or replaced at a docking facility, those repairs, modifications, or replacements must comply with the provisions of the NEC. The circuit that supplies the equipment must then be inspected. If existing equipment is damaged, it must be identified, documented, and repaired by a qualified person to the minimum requirements of the edition of this Code to which it was originally installed.

20

555.36(C) Shore Power Receptacle Disconnecting Means

- The new subdivision (C) in Sec. 555.36 requires an externally operable emergency disconnect, clearly marked “Emergency Shutoff” that can de-energize all power at each marina power outlet or enclosure that provides shore power to boats.
- An emergency disconnect within sight of the marina power outlet will provide bystanders with the ability to shut off power if a swimmer comes into contact with an energized metal boat, dock, or ladder. As this rule is implemented in marinas, it will help to eliminate electric shock drownings (ESDs).

21

555.4 Location of Service Equipment Near Docks

- Two changes in Sec. 555.4 pertaining to the location of the service equipment near docks require the service equipment to be no closer than 5 ft horizontally from the water and at least 12 in. above the electrical datum plane.

22

625.40 Electric Vehicle Branch Circuit

- A new Exception in Sec. 625.40 permits multiple units of EVSE drawing 16A or less, at 120V, to share a circuit. Some EVSE systems use load management systems that limit the combined current draw on the circuit, allowing multiple systems to be supplied by a single circuit without causing an overload.

23

625.49 Island Mode (Electric Vehicle Power Transfer System)

- Section 625.49 permits electric vehicle power export equipment (EVPE) and bidirectional EVSE that have a power export function to be part of an interconnected power system operating in island mode.

24

FOR REVIEW ONLY

680.5 GFCI and SPGFCI Protection

- Section 680.5 was revised and expanded to include special-purpose ground-fault circuit interrupters (GFCIs) and now has three subdivisions. Subdivision (A) covers the general requirements, (B) covers GFCIs for applications up to 150V to ground, and (C) covers SPGFCIs for applications over 150V to ground. The new subdivision (C) addresses SPGFCI protection for circuits over 150V to ground. The intent is to protect pool equipment in commercial installations that have higher voltages.

25

680.22 Receptacles, Luminaires, and Switches

- The requirements for GFCI protection of receptacles in (A)(4) were expanded this cycle in Sec. 680.22 to include all receptacles rated 60A or less within 20 ft of a pool wall.
- This previously only applied to 15A and 20A, 125V receptacles. This Section also required GFCI protection for specific equipment installed in the area between 5 ft and 10 ft horizontally from the inside walls of a pool. New language in (B)(4) expands the required protection by adding an SPGFCI requirement that will allow equipment operating above 150V to ground to also be protected.

26

700.3(A) Tests and Maintenance

- Revisions to Sec. 700.3(A) now require commissioning and not just testing of the emergency system.
- The term “commissioning” is defined in Art. 100, in part, as the process, procedures, and testing used to set up and verify the operation of electrical devices and equipment before being placed into active service.

27

700.11 Class-2-Powered Emergency Lighting Systems

- A new Sec. 700.11 for Class 2 wiring provides the requirements for these systems. This new Section addresses technologies such as PoE and other emergency lighting systems that utilize Class 2 power. The other rules in this Article address line voltage systems and this new Section provide requirements for low-voltage emergency systems.

28

706.7 Commissioning and Maintenance of Energy Storage Systems

- The title of Sec. 706.7 was changed to recognize performance tests and a new subdivision (A) requires ESSs to be commissioned upon installation in other than one- and two-family dwellings.
- The maintenance requirements became subdivision (B).

29

Q&A

- Contact: JDWhite@ohiocertificate.com

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30

FOR REVIEW ONLY

File Attachments for Item:

ER-15 Analysis of Changes to the 2023 NEC (IAEI Western)

All certifications (nine 2-hour sessions)

Staff Notes: "This course is based entirely on the 2023 Analysis powerpoint presentation distributed through the IAEI and consisting of 709 slides." Slides are not submitted except for six samples.

ESIAC Recommendation:

Committee Recommendation:

Application for Continuing Education Course Approval

Application for Continuing Education Course Approval

Provider Information

Name *	Organization	Email *	Phone Number *
MARK ROM	Western Reserve Division IAE	inspectormark2651@gmail.c	(216) 408-9147

Address *	City *	State *	Zip Code *
1060 EAST MENNONITE RD.	AURORA	Ohio	44202

Website	Conference Sponsor (if applicable)	Conference Email
wrd-iaei.org		

☐ Check here if Course Renewal

Prior course number(s)' (i.e. BBS2018-429)

Renewals will only be granted for identical content and hours, within the current code cycle. Attach a copy of prior course approval letter for confirmation. No further information is required

New Course Information

Course title	Course instructor
Analysis of Changes to the 2023 NEC Code (9) 2-hour classes	Donald Stalter, PE

Course description

Explanation of Code changes to the 2023 NEC Code using 709 Power Point slides purchased through the IAEI.
A certificate is issued for each class for 2 credit hours.
This course is for re-certification.
A student may take 1 or all classes.
All classes to be held at WRD IAEI MEETINGS-JAN,FEB, MARCH, APRIL, MAY, SEPT, OCT, NOV AND DEC.
2ND TUESDAY OF THE MONTH FOR THE YEAR 2024
AT FIRST ENERGY REGIONAL HDQTRS.
6896 MILLER RD, BRECKSVILLE , OH 44141

Instructional hours per session	Number of Sessions	Course Date	Course Location
2	9		6896 MILLER RD BRECKSVIL

Special Content

- ☐ Code Administration
- ☐ Existing Buildings
- ☐ Electrical Instruction
- ☐ Plumbing Instruction

Conference Course	Conference Name	Conference location

1216

☐ On Demand ☐ Webinar

Course to be offered online?

- [ ] Yes
- [x] No

Course Website

Detail online course participation confirmation method (i.e. test, quizlets, participant activity confirmation):

Course applicable for the following certifications *

- [ ] Residential Certifications Only
- [ ] Administrative Course, All Certifications
- [x] Commercial and Residential Certifications

Application materials included *

- [x] Course Outline or Course Learning Objectives
- [x] Presentation Materials/Slides (not required for roundtable courses)
- [ ] Assessment Materials (for online courses)
- [x] Presenter Bio
- [ ] Prior Course Approval Letter

Upload less than 100mb (Please attach PDF files only) *

File Name	Size
2024.classes.pdf	1.66 MB

Applicant Full Name *

MARK P. ROM

Date of Submission

11/30/2023

Instructions for new Continuing Education Approval form

Provider Information

1. Please include all contact information.
2. If course is not part of a conference, leave conference sponsor and email blank.

Course Renewal

1. Indicate if the course is being submitted for renewal. Include prior approval letter and write in prior course number.
2. Certification approval for courses has now changed: all existing courses being renewed will be approved within the new classification system.
    a. Courses previously approved for only residential certifications will be approved for all residential certifications.
    b. Courses previously approved for at least one commercial certification will now be approved for all commercial certifications and all residential certifications.
    c. Courses on required instruction topics, Ohio Ethics, Code Administration and Existing Buildings, will be noted as Administrative Courses and be approved for all certifications.
3. Courses being renewed should skip the New Course information section and are not required to submit outline, agenda, slides or other instructional materials for review.

Skip to Special Content, and mark any item that applies to the course.

New Course Information

1. Enter course title, name of instructor, and a brief description of the course content.
Learning objectives may be substituted for course description, if desired.
2. Number of instructional hours per session is the length of instructional time.
3. Number of sessions: can be 1 or the number of sessions planned.
4. Course date(s) and location: not necessary at this time, enter if known.

Special Content

1. Indicate if the course will meet instructional time in Code Administration or Existing Buildings.
2. Indicate if the course is a plumbing or electrical course, for ESIAC review and trainee course tracking.
3. If the course is associated with a conference, indicate the conference name and location, as this will allow BBS to coordinate approvals with the conference provider.
4. If the course will be offered online, specify whether it will be on demand or offered as a virtual webinar, or both. Include website where the course will be provided.

Crissinger and Darrow, Substations
Ohio Edison, First Energy Corporation
Various, Ohio
Develop electrical, grounding, bus pipe, and conduit plans for installing a new ring bus arrangement including circuit breakers, disconnect switches, potential transformers, line tuners and arresters for 138 kV systems.

Greenfield, and West Akron Substations
Ohio Edison, First Energy Corporation
Various, Ohio
Develop electrical, grounding, and conduit plans for replacing equipment including circuit breakers, disconnect switches, potential transformers, capacitor bank and arresters for 138 kV systems.

Commerce, Hale and Mill, Substations
Ohio Edison, First Energy Corporation
Various, Ohio
Develop electrical, grounding, and conduit plans for replacing voltage regulators for 12.4 kV systems.

Aurora, Jerome, Lowellville, Macedonia, Mantua, Meander Dam, Packard, Pidgeon and Shinrock, Substations
Ohio Edison, First Energy Corporation
Various, Ohio
Develop electrical, grounding, and conduit plans for replacing equipment including batteries, chargers, circuit breakers, disconnect switches, potential transformers, and arresters for 69 kV and 12.4 kV systems.

Venango Junction Substation
Penn Electric, First Energy Corporation
Venango Junction, Pennsylvania
Develop electrical, grounding, and conduit plans for adding equipment including a circuit breaker, disconnect switches, potential transformers, distribution transformer and arresters for 115 kV system.

RO Water Treatment System
Arcelor Mittal (Cliffs)
Cleveland, Ohio
Develop cable and conduit schedule for reverse osmosis water treatment system on 480V system.

ASU-2 Addition
Messer
Delta, Ohio
Develop cable and conduit plan for temporary underground construction power, develop lighting plan for cold box and partial site lighting, prepare cable and conduit schedule for new equipment at the air separator unit 2 addition for the 480V system.

Facility Engineering Projects
Energizer Battery
Westlake, Ohio
Managed facilities engineering projects for the site, 277/480V, 120/208V power systems, lighting, network cabling, security systems, presenter for emergency response team and coworkers on electrical safety, NEC, NFPA70E, and emergency response topics.

Steel Handling Machines
Krasny-Kaplan Corporation
Warrensville Heights, Ohio
Develop electrical plans for machine controls for one-off machines to handle various types of steel products like, rod, railroad beams, bar, etc.

Partner in D Stalter Electric, LLC
Vermilion, Ohio
2016 to present
Work with my brother Dan on residential projects in our spare time, evenings and weekends. Work includes panel upgrades, meter socket replacement, remodeling projects, wiring for swimming pools, etc.

**Project performed prior to joining Middough*

Donald E. Stalter, PE
Senior Electrical Engineer

Education
Bachelor of Electrical Engineering – Cleveland State University

Associate of Science – Cuyahoga Community College

Certificate in Electronic Engineering Technology (Nuclear Instrumentation) – Capital Radio Engineering Institute

Registration
State of Ohio, Professional Electrical Engineer, License #68642

Certifications
State of Ohio, Electrical Safety Inspector, License #2689

State of Ohio, Electrical Contractor, License #48003

Affiliations
Associate Member of International Association of Electrical Inspectors (IAEI)

Donald E. Stalter PE, is a competent and detailed individual, designing electrical systems for customers and utilities. Spent the early first few years designing electric controls for steel handling machines in the Cleveland area. Then, over 32 years in a facilities group for a Fortune 100 company, R&D sector of their business. Support included power distribution, lighting, HVAC, fire alarm/security, audio/video systems, UPS/generator systems, network cabling, etc. After that spent two years contracting for a major utility company designing customer "electrical service entrance" vaults and substations for their LCI Large Commercial/Industrial group. Current position at Middough for over five years includes designing for 138kV and below substation upgrades or new builds and industrial facilities electrical support projects.

Project Experience

AZ-2 Micro Mill
Commercial Metals
Mesa, Arizona
Develop electrical equipment grounding plans and one-line diagrams support for power distribution.

W41 Transformer Installation
Cleveland Public Power
Cleveland, Ohio
Provide electrical engineering support for substation 138kV, 69kV, AC & DC control power..

Rockholds, Rice, and Redbush Substations
East Kentucky Power Cooperative
Various, Kentucky
Provide electrical engineering support for new substation physical designs.

West Berea and Fawkes Substations
East Kentucky Power Cooperative
Various, Kentucky
Develop electrical plans for replacing equipment including transformers, circuit switcher, disconnect switches and circuit breakers, system 138 kV, 69 kV, and distribution 13.2 kV.

Angola, Maclean, and Richland Substations
Toledo Edison, First Energy Corporation
Various, Ohio
Develop electrical, grounding, and conduit plans for replacing equipment including circuit breakers, disconnect switches, potential transformers, line tuners and arresters for 138 kV systems.

**Project performed prior to joining Middough*

WESTERN RESERVE DIVISION IAEI
2023 NEC
18 Hour Electrical Code Course
Instructor: Don Stalter

This First Class will be held at the First Energy Hdqtrs. 6896 Miller Rd Brecksville, Ohio 44141 At our Western Reserve Division Monthly Meetings once a month, starting the Second Tuesday of the month January 2024 and each second Tuesday for 9 months. Each class will be from 6:30PM to 8:30PM a certificate for two credits will be issued after each class. No meetings for the months of June, July and August.

This course is for re-certification of **ESI, BO, RBO, RPE, MPE, and EPE**

The course is based entirely by the 2023 NEC Analysis power point presentation distributed through the IAEI. It consists of 709 Slides. The topic and goals are the explanation of changes in the 2023 NEC Articles listed below. Students are required to bring a 2023 NEC Book.

Session 1 January Meeting Review of articles 90 through 225

Session 2 February Meeting Review of articles 230 through 240

Session 3 March Meeting Review of article 250

Session 4 April Meeting Review of articles 280 through 312

Session 5 May Meeting Review of articles 314 through 338

Session 6 September Meeting Review of articles 340 through 400

Session 7 October Meeting Review of articles 404 through 422

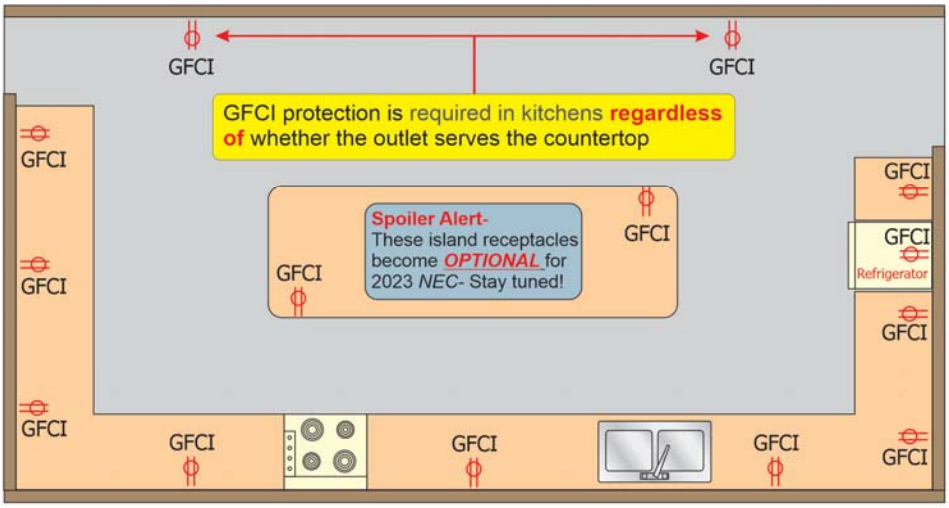
Session 8 November Meeting Review of articles 424 through 525

Session 9 December Meeting Revie of articles 550 through 830

This course is based on the Board of Building Standards guidelines. This course is split into nine two-hour classes. All students will receive a course certificate for two credits upon completion of each two-hour class with the BBS Course number. The student may attend some or all sessions to receive up to 18 hours of Contact Hours. All students will sign the Roster.

210.8(A)(6) Dwelling Unit Kitchens

Ground-fault circuit-interrupter *(GFCI)* protection required for receptacles in a kitchen
- All 125-volt through 250-volt receptacles
- single-phase branch circuits rated 150 volts or less to ground



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352.44(B) Earth Movement *(Expansion Fittings)*

Requirements were added for an expansion fitting to be installed for underground runs of direct buried PVC conduit that emerge from the ground

Earth movement resulting in PVC raceway being pulled loose from the male adapter

Photos courtesy of IAEI Archives

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IAEI's Analysis of Changes- 2023 *NEC*

Your essential guide to the most important changes in the 2023 National Electrical Code

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IAEI The Electrical Safety Leader

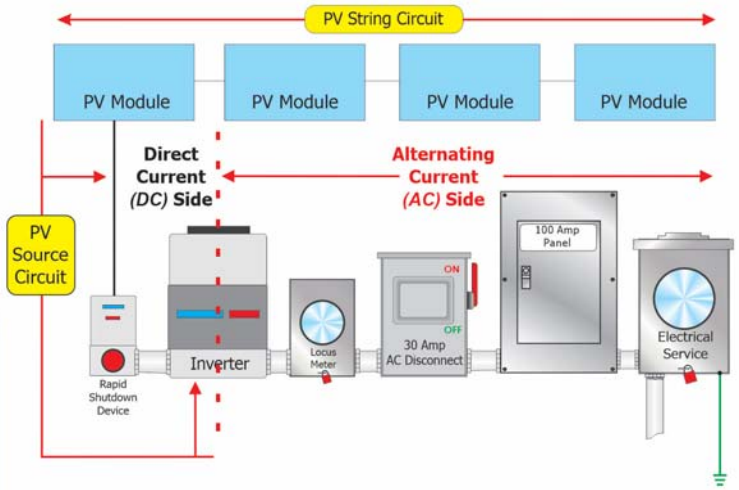
ICC INTERNATIONAL CODE COUNCIL®

Article 100- PV DC Circuit

PV System Source Circuit and PV String Circuit are subsets of a PV System DC Circuit

PV String Circuit is the series dc circuit conductors between the modules

PV Source Circuit is the series and/or parallel dc circuit conductors between the modules and combiners, inverters or PV system dc disconnect



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680.5 GFCI and SPGFCI Protection

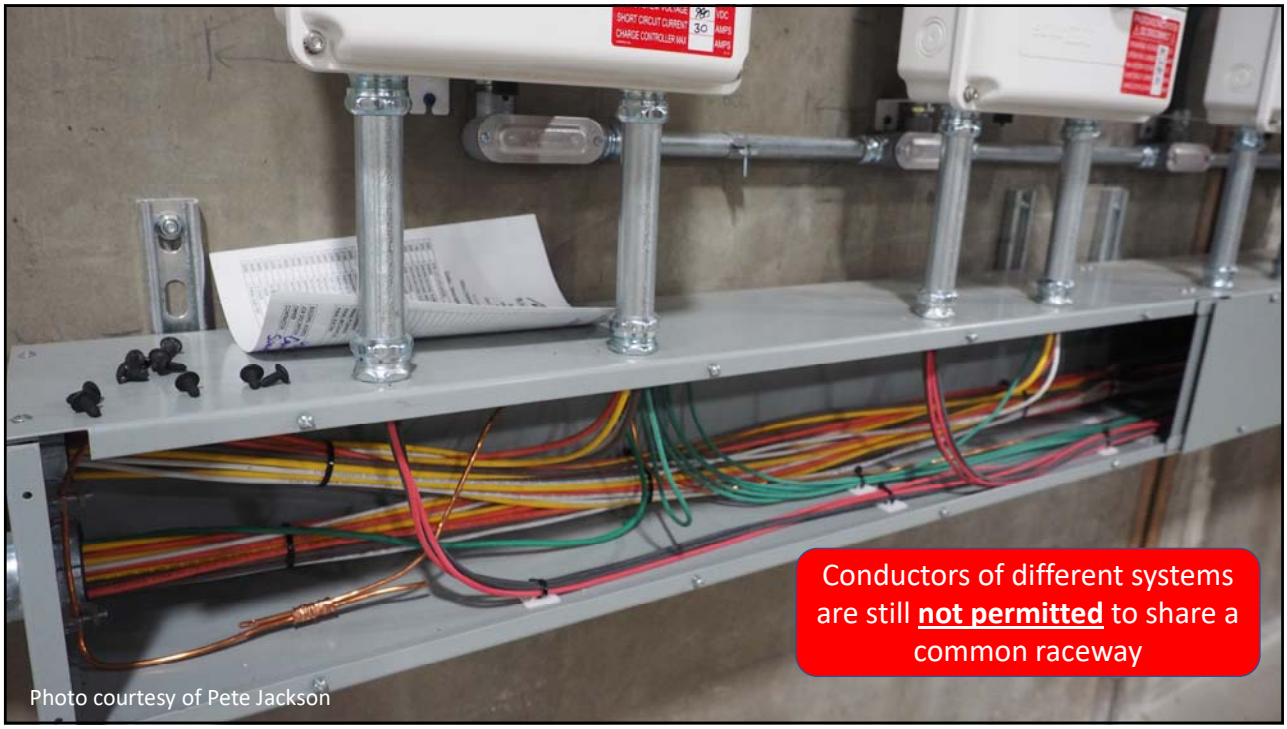
Revised and subdivided to address ground-fault circuit-interrupter *(GFCI)* protection and introduce Special Purpose Ground-Fault Circuit-Interrupter *(SPGFCI)* protection

Ground-Fault Circuit-Interrupter *(GFCI)* protection

Special Purpose Ground-Fault Circuit-Interrupter *(SPGFCI)* protection

GFCI photos courtesy of Leviton and Legrand

SPGFCI photos courtesy of Littlefuse



File Attachments for Item:

ER-16 Changes to the 2023 NEC Parts 1 and 2 (Master Electrical Contractors Association)

All certifications (5 hours each part)

Staff Notes: App and Outline will rotate right 45 degrees for viewing.

ESIAC Recommendation:

Committee Recommendation:

Ohio | Department of Commerce

Mike DeWine, Governor
Jon Husted, Lt. Governor

Sheryl Maxfield, Director

Board of Building Standards

Application for Continuing Education Course Approval

Provider Information:

Name: Laura Bachman

Organization: Master Electrical Contractors Ass.

Address: 1555 Stanley Ave Dayton OH 45404

E-mail: Mecadec Dayton@gmail.com Telephone: 9372640418

Website:

Conference Sponsor (if applicable) Conference Email:

Check here if Course Renewal: ☐ Prior course number _____ (*i.e. BBS2018-429*)

Renewals will only be granted for identical content and certifications, within the current code cycle.
Attach a copy of prior course approval letter for confirmation. No further information is required.

New Course Information:

Course title: Changes to the NEC Part 1

Course instructor: D Dwayne Jenkins

Course description: To illustrate the important changes in the 2023 NEC

Instructional hours per session: 5 Number of Sessions: 1

Course Date(s) and Location: 2/10/24 Presidential Banquet Center

Special Content:

Code Administration: ☒
Existing Buildings: ☐
Electrical Instruction: ☒
Plumbing Instruction: ☐

Conference Course:
Conference Name:
Conference location:

Course to be offered online? ☐ **On Demand** ☐ **Webinar** ☐

Course Website:

Detail online course participation confirmation method *(i.e. test, quizlets, participant activity confirmation)*:

Course applicable for the following certifications

Residential Certifications Only: 7
Administrative Course, All Certifications: 0

Commercial Certifications: 6

Application materials included:

☒ Course Outline or Course Learning Objectives
☒ Presentation Materials/Slides (not required for roundtable courses)
☐ Assessment Materials (for online courses)
☒ Presenter Bio

Please submit application and materials in .pdf format to: michael.lane@com.ohio.gov or BBS@com.ohio.gov

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The Master Electrical Contractors Association Presents:

2024 Electrical Code Seminar – Changes to the National Electrical Code 2023 Part One: Based on the 2023 NEC

Instructors:
Dewayne Jenkins – Senior Building & Electrical Inspector. Electrical Plans Examiner – City of Kettering

Date: Saturday, February 10, 2024

Time: 7:00 AM to 1:00 PM

Location: Presidential Banquet Center
4548 Presidential Way, Kettering, OH 45429

Seminar Agenda: (February 10, 2023)
7:00 AM - 7:30 AM - Registration & Breakfast
7:30 AM - 8:50 AM – Code Instruction – Article 90, Chapter 1
8:50 AM - 9:00 AM -Break
9:00 AM - 10:20 AM - Code Instruction – Chapter 2
10:20 AM - 10:30 AM - Break
10:30 AM – 11:50 AM – Code Instruction – Chapter 3
11:50 AM – 12:00 PM – Break
12:00 PM – 1:00 PM - Code Instruction – Chapter 4
1:00 PM - Certificate Distribution

Seminar Description:

Changes to the National Electrical Code 2023 Part One: This seminar is intended to illustrate the important changes on the 2023 NEC. An NFPA and Mike Holt Powerpoint© presentation will be utilized to demonstrate the updated electrical changes and how this will impact the electrical industry in Ohio with the proposed adoption of the 2023 NEC in March of 2024. This presentation is intended to be interactive and programming pace may vary based on attendee discussion.

Session one will review NEC Articles 90, Chapters 1, 2, 3 & 4.

This seminar is designed for experienced electricians, residential wiremen, electrical contractors, electrical safety inspectors, instructors, supervisors, designers and engineers and any individual looking to be more informed on the impact of these changes. The information and concepts presented is intended to be of a good value to those in the electrical industry.

Recertification Credits: O.C.I.L.B. & O.B.B.S.

Approval has been requested from: The Ohio Construction Industry Licensing Board and the Ohio Board of Building Standards for 5 hours of Electrical Code Continuation Credits.

CODE CLASSES - CONTINUING EDUCATION PROGRAM

LOCATION:	PRESIDENTIAL BANQUET CENTER
	4548 PRESIDENTIAL WAY DAYTON OHIO 45429
DATES:	FEBRUARY 10 AND FEBRUARY 17,2024
TIME:	7:00 AM – 7:30 AM – BREAKFAST
	7:30 AM - 1:00 PM – CLASS

INTRODUCTION:

THESE CLASSES WILL BE DIRECTED TO THE MEN IN THE FIELD, CONTRACTORS AND ELECTRICAL INSPECTORS.

THE CLASSES ARE APPROVED BY THE STATE OF OHIO FOR RECERTIFICATION CREDITS WHICH ARE REQUIRED FOR THE STATE REGISTRATION AND RECERTIFICATION.

CONTRACTORS CAN RECEIVE A TOTAL OF TEN (10) CREDIT HOURS APPROVED BY THE OCILB.
(PENDING ACCEPTACE OF OBBS) INSPECTORS CAN RECEIVE TEN (10) CREDIT HOURS APPROVED BY OBBS.
THIS COURSE IS APPROVED FOR CONTINUING EDUCATION CREDIT IN KENTUCKY FOR ME/EE.

TOPICS TO BE COVERED:

THESE SESSIONS WILL CONSIST OF THE CHANGES OF THE 2023 NATIONAL ELECTRIC CODE

THE INSTRUCTOR:

DEWAYNE JENKINS - ESI & EPE for the City of Kettering Ohio

ENROLLMENT –

OPEN TO MEMBERS AND NON-MEMBERS. CLASS SIZE – FIRST PAID 125 PERSONS. IF YOU ARE NOT NOTIFIED, PLEASE PLAN ON ATTENDING. (LAURA BACHMAN 937-264-0418)

FOR MORE INFORMATION:

LAURA BACHMAN - 937 264-0418 OR MECAIECDAYTON@GMAIL.COM

ATTENDEES SHOULD BRING A COPY OF THE 2023 NEC BOOK

(OVER)

REGISTRATION

DEADLINE: FEBRUARY 1, 2024

COST: FOR **PAID MEMBERS OF MECA AND THEIR EMPLOYEES**, THE 2-CLASS PRICE IS **$ 125.00 PER PERSON.** THE COST FOR **NON-MEMBERS IS $250.00 PER PERSON**, PACKAGE PRICE.

THIS PRICE INCLUDES BREAKFAST BOTH DAYS AND CLASS.NO MONEY IS REFUNDABLE.

PLEASE SEND A CHECK AND COMPLETED FORM TO:
MASTER ELECTRICAL CONTRACTORS ASSOCIATION
C/O ACTIVE ELECTRIC – JENNY HOLP
1885 SOUTHTOWN BLVD.
DAYTON, OHIO 45439

PAYMENT MUST BE INCLUDED WITH REGISTRATION TO HOLD A SEAT FOR THIS CLASS!
ANY QUESTIONS – PLEASE CONTACT LAURA (937) 264-0418 OR MECAIECDAYTON@GMAIL.COM

COMPANY: ____________________
ADDRESS: ____________________
CITY,STATE,ZIP: ____________________
PHONE: ____________________
EMAIL: ____________________

ENROLLEE NAME: ____________________ ESI # OR CONTRACTOR STATE ID# __________

ENROLLEE NAME: ____________________ ESI # OR CONTRACTOR STATE ID# __________

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NOTE: IT IS NECESSARY FOR AN INDIVIDUAL TO ATTEND THE ENTIRE COURSE IN ORDER TO RECEIVE CREDIT. IF SOMEONE LEAVES BEFORE THE COURSE IS COMPLETED, THAT PERSON WILL NOT RECEIVE ANY CREDIT. THE STATE REQUIRES THAT YOU SIGN IN AND OUT TO RECEIVE CREDIT. EACH SATURDAY IS ONE COURSE.
IT IS UNDERSTOOD THAT MASTER ELECTRICAL CONTRACTORS' ASSOCIATION DOES NOT GUARANTEE PROFICIENCY AS A RESULT OF THIS PROGRAM, AND NEITHER UNDERTAKES NOR ASSUMES ANY RESPONSIBILITY OF LIABILITY IN CONNECTION WITH ITS SPONSORSHIP. IN THE EVENT ANY CLAIMS ARE ASSERTED AGAINST M.E.C.A. FOR ANY LIABILITY ARISING OUT OF THIS PROGRAM, THE ENROLLEE AGREES TO HOLD THE M.E.C.A., ITS OFFICERS, TRUSTEES AND INSTRUCTORS HARMLESS AND TO INDEMNIFY IT FOR ANY COST OR EXPENSE THEREBY INCURRED.

Ohio | Department of Commerce

Mike DeWine, Governor
Jon Husted, Lt. Governor

Sheryl Maxfield, Director

Board of Building Standards

Application for Continuing Education Course Approval

Provider Information:
Name: Laura Bachman
Organization: Master Electrical Contractors Ass.
Address: 1555 Stanley Ave Dayton 01145404
E-mail: Meaiec Dayton@gmail.com Telephone: 9372640418
Website:
Conference Sponsor (if applicable) Conference Email:

Check here if Course Renewal: ☐ Prior course number _____ *(i.e. BBS2018-429)*
Renewals will only be granted for identical content and certifications, within the current code cycle.
Attach a copy of prior course approval letter for confirmation. No further information is required.

New Course Information:
Course title: Changes to the NEC Part 2
Course instructor: D Dwayne Jenkins
Course description: To illustrate the important changes in the 2023 NEC

Instructional hours per session: 5 Number of Sessions: 1
Course Date(s) and Location: 2/17/24 Presidential Banquet Center

Special Content:
Code Administration: ☒
Existing Buildings: ☐
Electrical Instruction: ☒
Plumbing Instruction: ☐

Conference Course:
Conference Name:
Conference location:

Course to be offered online? ☐ **On Demand** ☐ **Webinar** ☐
Course Website:
Detail online course participation confirmation method *(i.e. test, quizlets, participant activity confirmation)*:

Course applicable for the following certifications

Residential Certifications Only: 2
Administrative Course, All Certifications: 0
Commercial Certifications: 6

Application materials included:
☒ Course Outline or Course Learning Objectives
☒ Presentation Materials/Slides (not required for roundtable courses)
☐ Assessment Materials (for online courses)
☒ Presenter Bio

Please submit application and materials in .pdf format to: michael.lane@com.ohio.gov or BBS@com.ohio.gov

The Master Electrical Contractors Association Presents:

2024 Electrical Code Seminar – Changes to the National Electrical Code 2023 Part Two: Based on the 2023 NEC

Instructors:

Dewayne Jenkins – Senior Building & Electrical Inspector. Electrical Plans Examiner – City of Kettering

Date: Saturday, February 17, 2024

Time: 7:00 AM to 1:00 PM

Location: Presidential Banquet Center
4548 Presidential Way, Kettering, OH 45429

Seminar Agenda: (February 17, 2023)
7:00 AM - 7:30 AM - Registration & Breakfast
7:30 AM - 8:50 AM – Code Instruction – Chapter 5
8:50 AM - 9:00 AM -Break
9:00 AM - 10:20 AM - Code Instruction – Chapter 6
10:20 AM - 10:30 AM - Break
10:30 AM – 11:50 AM – Code Instruction – Chapter 7
11:50 AM – 12:00 PM – Break
12:00 PM – 1:00 PM - Code Instruction – Chapters 8 & 9
1:00 PM - Certificate Distribution

Seminar Description:

Changes to the National Electrical Code 2023 Part Two: This seminar is intended to illustrate the important changes on the 2023 NEC. An NFPA and Mike Holt Powerpoint© presentation will be utilized to demonstrate the updated electrical changes and how this will impact the electrical industry in Ohio with the proposed adoption of the 2023 NEC in March of 2024. This presentation is intended to be interactive and programming pace may vary based on attendee discussion.

Session two will review NEC Chapters 5, 6, 7, 8 & 9.

This seminar is designed for experienced electricians, residential wiremen, electrical contractors, electrical safety inspectors, instructors, supervisors, designers and engineers and any individual looking to be more informed on the impact of these changes. The information and concepts presented is intended to be of a good value to those in the electrical industry.

Recertification Credits: O.C.I.L.B. & O.B.B.S.

Approval has been requested from: The Ohio Construction Industry Licensing Board and the Ohio Board of Building Standards for 5 hours of Electrical Code Continuation Credits.

CODE CLASSES - CONTINUING EDUCATION PROGRAM

LOCATION: PRESIDENTIAL BANQUET CENTER
4548 PRESIDENTIAL WAY DAYTON OHIO 45429

DATES: FEBRUARY 10 AND FEBRUARY 17,2024

TIME: 7:00 AM – 7:30 AM – BREAKFAST
7:30 AM - 1:00 PM – CLASS

INTRODUCTION:

THESE CLASSES WILL BE DIRECTED TO THE MEN IN THE FIELD, CONTRACTORS AND ELECTRICAL INSPECTORS.

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THIS COURSE IS APPROVED FOR CONTINUING EDUCATION CREDIT IN KENTUCKY FOR ME/EE.

TOPICS TO BE COVERED:

THESE SESSIONS WILL CONSIST OF THE CHANGES OF THE 2023 NATIONAL ELECTRIC CODE

THE INSTRUCTOR:

DEWAYNE JENKINS - ESI & EPE for the City of Kettering Ohio

ENROLLMENT –

OPEN TO MEMBERS AND NON-MEMBERS. CLASS SIZE – FIRST PAID 125 PERSONS. IF YOU ARE NOT NOTIFIED, PLEASE PLAN ON ATTENDING. (LAURA BACHMAN 937-264-0418)

FOR MORE INFORMATION:

LAURA BACHMAN - 937 264-0418 OR MECAIECDAYTON@GMAIL.COM

ATTENDEES SHOULD BRING A COPY OF THE 2023 NEC BOOK

(OVER)

1233

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DEADLINE: FEBRUARY 1, 2024

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1885 SOUTHTOWN BLVD.
DAYTON, OHIO 45439

PAYMENT MUST BE INCLUDED WITH REGISTRATION TO HOLD A SEAT FOR THIS CLASS!
ANY QUESTIONS – PLEASE CONTACT LAURA (937) 264-0418 OR MECAIECDAYTON@GMAIL.COM

COMPANY: ______________________________
ADDRESS: ______________________________
CITY,STATE,ZIP: ______________________________
PHONE:______________________________
EMAIL:______________________________

ENROLLEE NAME:____________________ESI # OR CONTRACTOR STATE ID#____________

ENROLLEE NAME:____________________ESI # OR CONTRACTOR STATE ID#____________

ENROLLEE NAME:____________________ESI # OR CONTRACTOR STATE ID#____________

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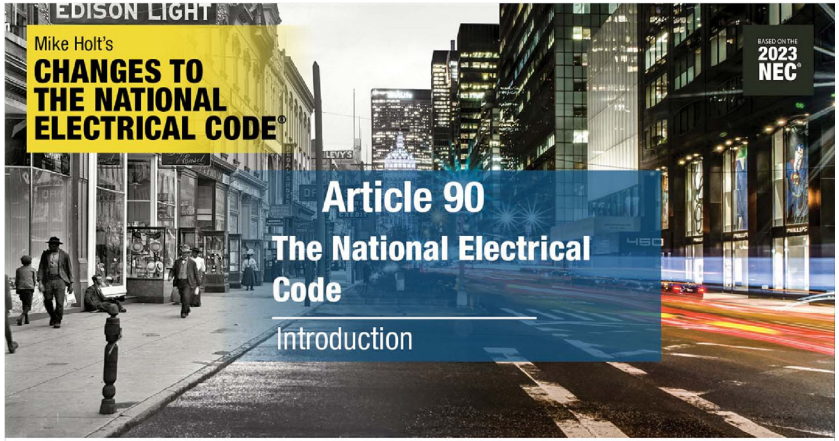
10/25/2023



Introduction to Article 90—Introduction to the National Electrical Code

- Article 90 describes when the NEC applies, when it does not, and the arrangement of the Code book. The other requirements in this article provide the reader with information essential to understanding the scope of the NEC and other important rules that set the tone for using other rules in the Code.
- Most electrical installations require you to understand the first four chapters of the NEC (which apply generally) and have a working knowledge of the Chapter 9 tables. That understanding begins with this article. Chapters 5, 6, and 7 make up a large portion of the Code book, but they apply to special occupancies, special equipment, or special conditions. Chapters 5, 6, and 7 may modify or supplement the rules in the first four chapters.
- Chapter 8 contains the requirements for communications systems such as hard-wired telephone systems, radio and television antennas, and

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Introduction to Article 90—Introduction to the National Electrical Code

- Article 90 states that the National Electrical Code (NEC/Code) is not intended as a design specification or instruction manual for untrained persons. The Code has one purpose only, and that is the "practical safeguarding of persons and property from hazards arising from the use of electricity." That does not necessarily mean the installation will be efficient, convenient, or able to accommodate future expansion; just that it is as safe as possible.
- The need to carefully study the NEC cannot be

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OVERVIEW

Scope 90.1

- This section was renamed from "Purpose" to "Scope" and contains new text to clarify the function of the section and provide a clear description of the scope of Article 90.

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NEW

Analysis

- Rules that govern how the Code is written are based on the NEC Style Manual. It requires all xxx.1 sections to contain the scope of each article. The scope defines the conditions or installations to which the rules in the article apply. In the case of Article 90, the "Scope" tells us in broad terms how the Code works and how it

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Scope 90.1

Article 90 covers the use, application, arrangement, and enforcement of this Code. It also covers the expression of mandatory, permissive, and nonmandatory text, provides guidance on the examination of equipment and on wiring planning, and specifies the use and expression of measurements.

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OVERVIEW

Use and Application 90.2

- What was 90.1 is now 90.2 with some editorial revisions to improve the usability of the NEC.

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RELOCATE

Use and Application 90.2

- The content for subdivisions (A), (B), and (E) were relocated here from 90.1 and added to the existing list in 90.2. Doing so consolidated the information related to the "Use and Application" of the NEC into a list format.
- Subdivisions (C) and (D) added the word "Installations" to the title to clearly

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Use and Application 90.2

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9

Purpose of the NEC 90.2(A)

10

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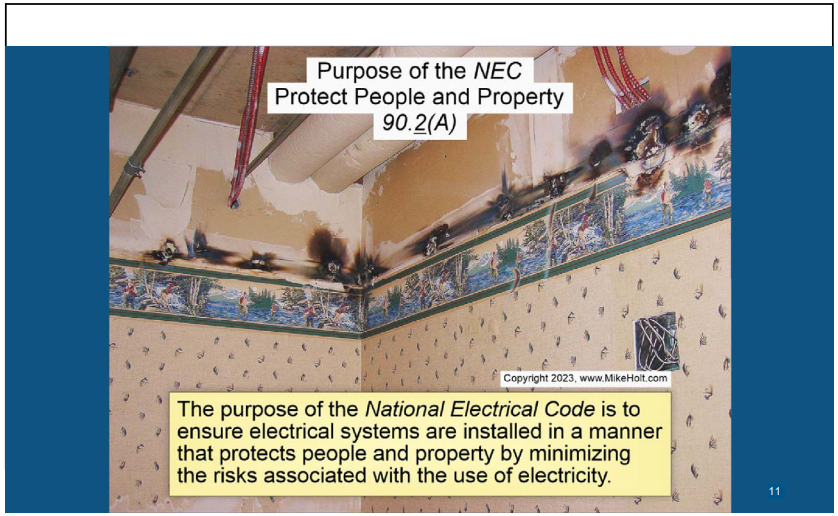
10/25/2023

10/25/2023



COMMENT

Author's Comment:

- The Code is intended to be used by those who are skilled and knowledgeable in electrical theory, electrical systems, building and electrical construction, and the installation and operation of electrical equipment.

13

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Purpose of the NEC 90.2(A)

The NEC is not a design specification standard nor is it an instruction manual for the untrained and unqualified.

12

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Essentially Safe Installation 90.2(B)

Considered Safe. The NEC contains the requirements considered necessary for safety.

Essentially Free from Hazards. Installations that comply with the Code and are properly maintained are considered essentially free from electrical hazards.

14

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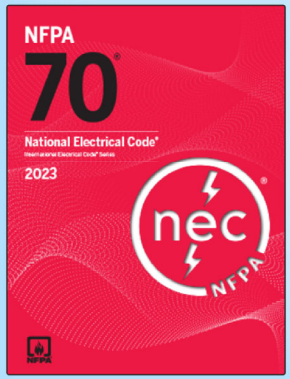
10/25/2023

Essentially Safe Installation
90.2(B)



The *NEC* contains the requirements considered necessary for safety. Installations that comply with the *Code* and are properly maintained are considered essentially free from electrical hazards.

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15

Essentially Safe Installation 90.2(B)

NEC Rules not Intended. The requirements contained in the NEC are not intended to ensure an electrical installation will be efficient, convenient, adequate for good service, or suitable for future expansion.

16

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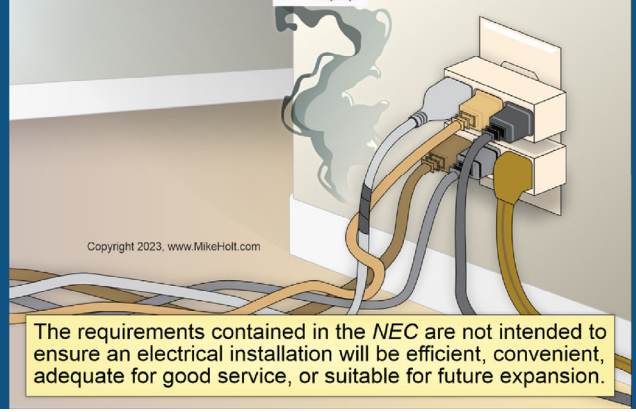
NEC Rules not Intended
90.2(B)



The requirements contained in the *NEC* are not intended to ensure an electrical installation will be efficient, convenient, adequate for good service, or suitable for future expansion.

17

Essentially Safe Installation 90.2(B)

Note: Hazards often occur because the initial wiring did not provide for increases in the use of electricity resulting in wiring systems becoming overloaded.

18

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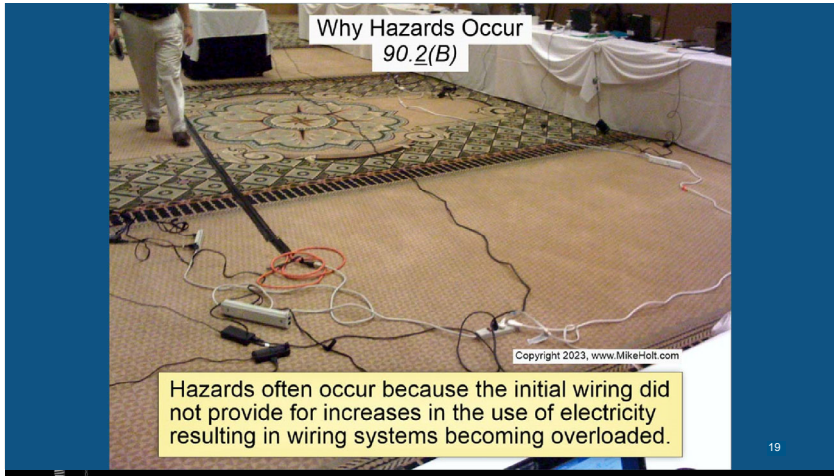
10/25/2023



COMMENT

Author's Comment:

- The NEC does not require electrical systems to be designed or installed to accommodate future loads.
- However, consideration should be given not only to ensuring electrical safety (Code compliance), but also that the electrical system meets the customers' needs, both for today and in the coming years.

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Installations Covered by the NEC 90.2(C)

The Code covers the installation and removal of electrical conductors, equipment, and raceways; limited-energy and communications conductors, equipment, and raceways; and optical fiber cables for the following:

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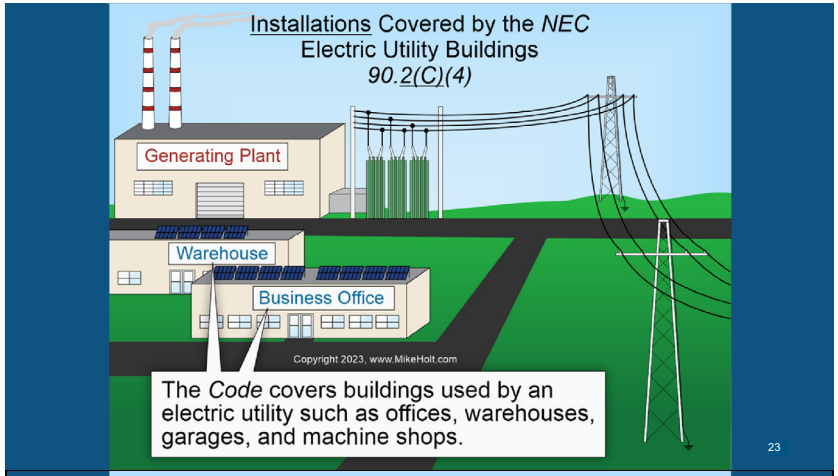
Installations Covered by the NEC
Electric Utility Buildings
90.2(C)(4)
Generating Plant
Warehouse
Business Office
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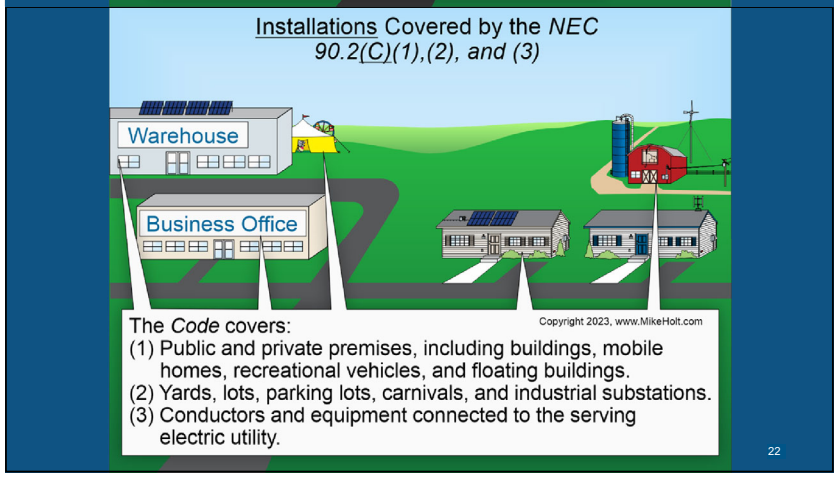
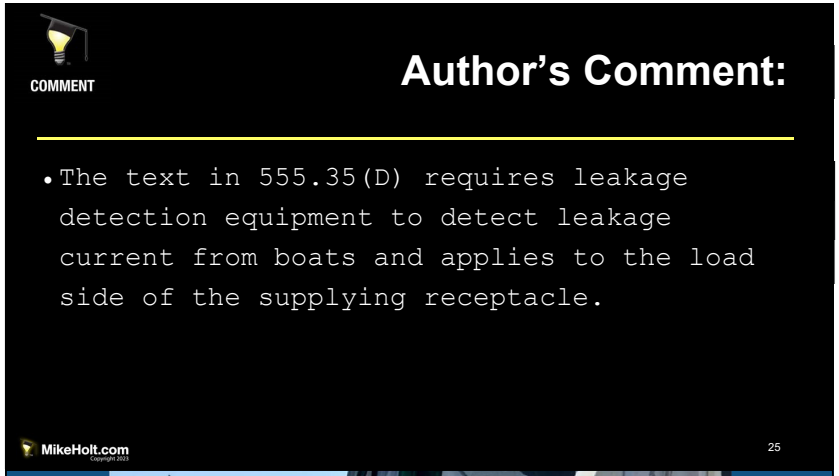
The Code covers buildings used by an electric utility such as offices, warehouses, garages, and machine shops.
23


Installations Covered by the NEC
90.2(C)(1),(2), and (3)
Warehouse
Business Office
Copyright 2023, www.MikeHolt.com
The Code covers:
(1) Public and private premises, including buildings, mobile homes, recreational vehicles, and floating buildings.
(2) Yards, lots, parking lots, carnivals, and industrial substations.
(3) Conductors and equipment connected to the serving electric utility.
22


COMMENT
Author's Comment:
• The text in 555.35(D) requires leakage detection equipment to detect leakage current from boats and applies to the load side of the supplying receptacle.
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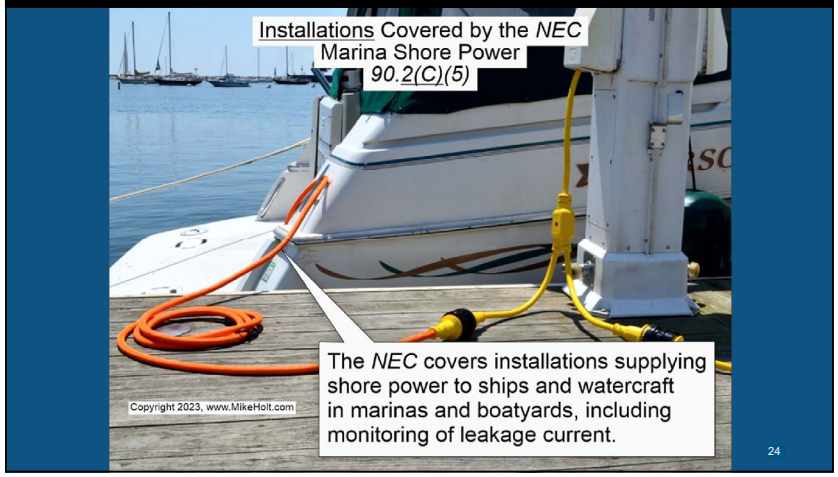
25


Installations Covered by the NEC
Marina Shore Power
90.2(C)(5)
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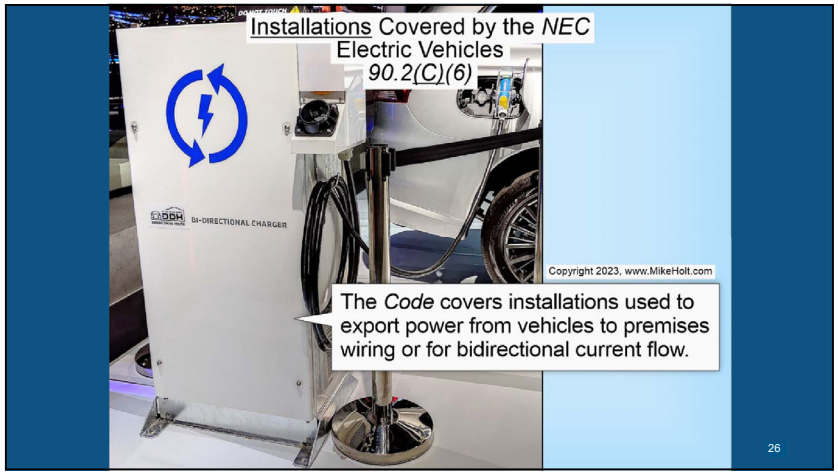
The NEC covers installations supplying shore power to ships and watercraft in marinas and boatyards, including monitoring of leakage current.
24



COMMENT

Author's Comment:

- The battery power supply of an electric vehicle can be used "bidirectionally" which means it can be used as a backup or alternate power source to supply premises wiring circuits in the event of a power failure. The rules for this application can be found in Article 625.

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Installations Not Covered by the NEC 90.2(D)

The Code does not cover installations of electrical or communications systems for:

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Transportation Vehicles 90.2(D)(1)

The NEC does not cover installations in ships, watercraft other than floating buildings, aircraft, or automotive vehicles other than mobile homes and recreational vehicles.

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COMMENT

Author's Comment:

- An automotive vehicle is any vehicle that may be transported upon a public highway. The wiring of food trucks is not required to comply with NEC, since they are considered an automotive vehicle.

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Mining Equipment 90.2(D)(2)

The Code does not cover installations in underground mines, or self-propelled mobile surface mining machinery and its attendant electrical trailing cable.

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Railways 90.2(D)(3)

The NEC does not cover installations for railway power, energy storage, and communications wiring.

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Communications Utilities 90.2(D)(4)

The Code does not apply to communications equipment under the exclusive control of the communications utility located outdoors or in building spaces used exclusively for these purposes.

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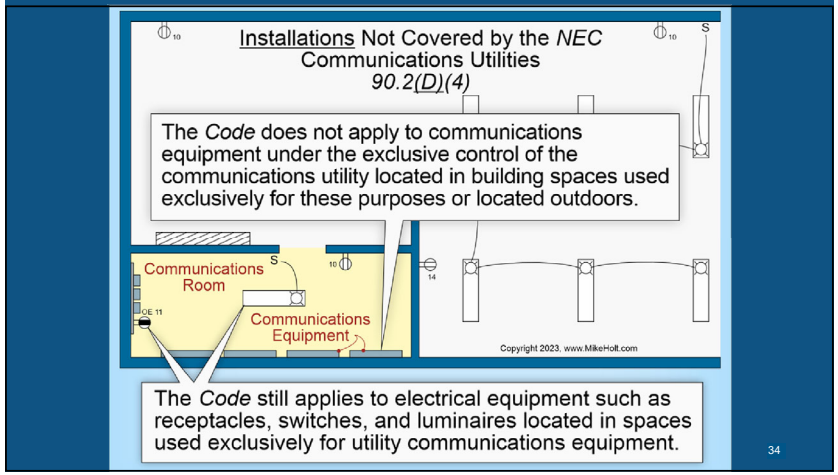

34

COMMENT

Author's Comment:

- The Code still applies to electrical equipment such as receptacles, switches, and luminaires located in spaces used exclusively for utility communications equipment.

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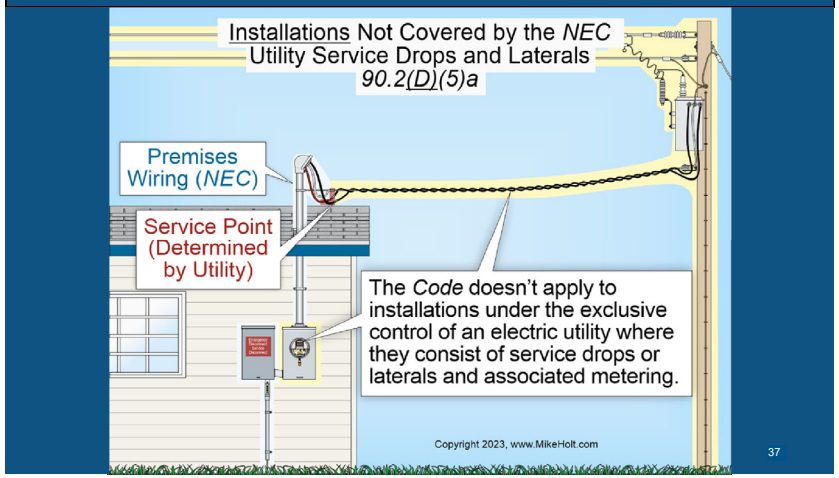
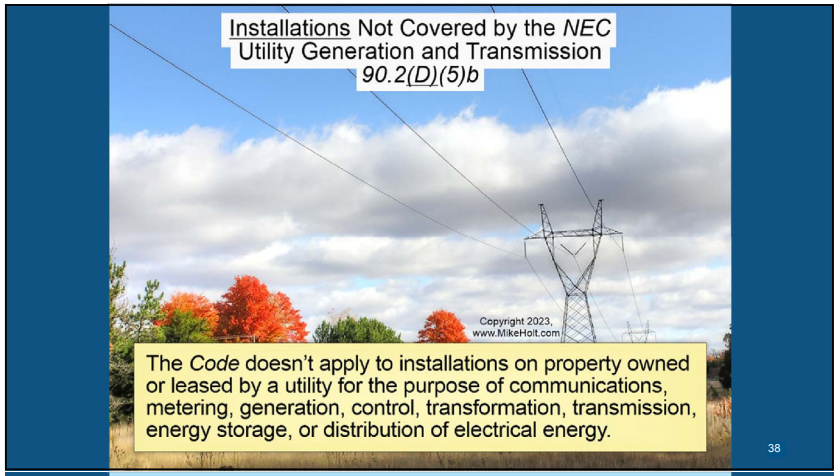
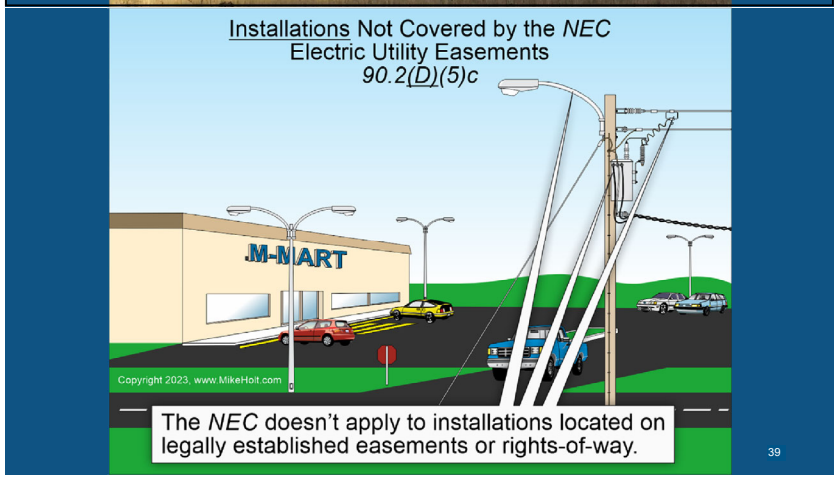
Electric Utilities 90.2(D)(5)

The NEC does not cover installations under the exclusive control of a serving electric utility where such installations:

36







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Relation to International Standards 90.2(E)

Note: IEC 60364-1, Low-Voltage Electrical Installations—Part 1: Fundamental Principles, Assessment of General Characteristics, Definitions, Section 131, contains fundamental principles of protection for safety that encompass protection against electric shock, protection against thermal effects, 41

Relation to International Standards 90.2(E)

The requirements of the NEC address the fundamental safety principles contained in the International Electrotechnical Commission (IEC) Standard IEC 60364-1, Low-Voltage Electrical Installations—Part 1: Fundamental Principles, Assessment of General Characteristics, Definitions.

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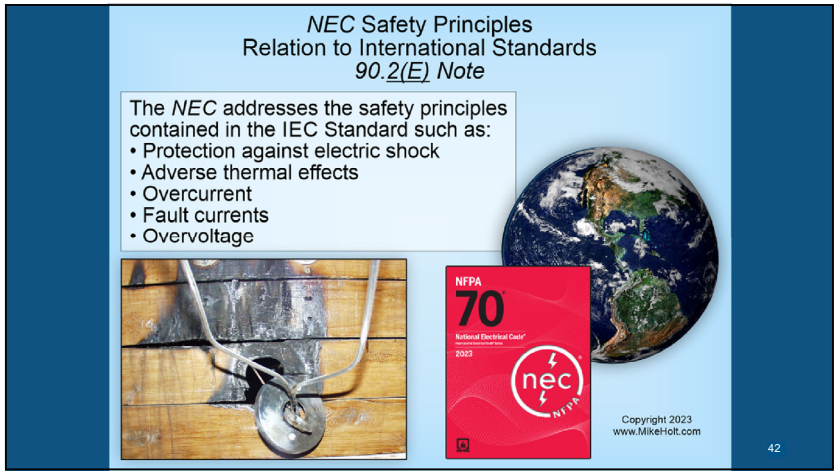

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Code Arrangement 90.3

General Requirements. The NEC consists of an introduction and nine chapters followed by informative annexes. The requirements contained in Chapters 1, 2, 3, and 4 apply generally to all electrical installations.

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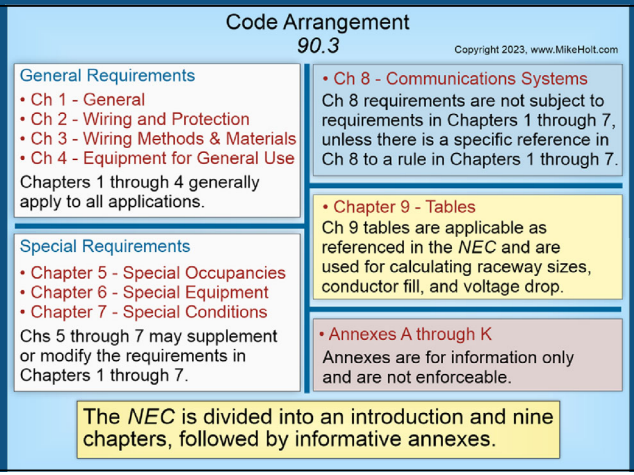

Code Arrangement 90.3

The requirements contained in Chapters 5, 6, and 7 apply to special occupancies, special equipment, or other special conditions, which may supplement or modify the requirements contained in Chapters 1 through 7; but not Chapter 8. Chapter 7 wiring systems covered in this material include:

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Code Arrangement 90.3

Article 722—Cables for Power-Limited Circuits and Optical Fiber

Article 724—Class 1 Power-Limited Circuits

Article 725—Class 2 Power-Limited Circuits

Article 760—Fire Alarm Circuits

Article 770—Optical Fiber Circuits

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Code Arrangement 90.3

Chapter 9 consists of tables that apply as referenced in the NEC. The tables are used to calculate raceway sizing, conductor fill, the radius of raceway bends, and conductor voltage drop.

Annexes are not part of the requirements of the Code but are included for informational

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Code Arrangement 90.3

Chapter 8 covers communications systems and is not subject to the requirements contained in Chapters 1 through 7 unless specifically referenced in Chapter 8.

Chapter 8 wiring systems covered in this material include:

Article 800—General Requirements for Communications Systems

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Code Arrangement 90.3

- Annex A. Product Safety Standards
- Annex B. Application Information for Ampacity Calculation
- Annex C. Conduit, Tubing, and Cable Tray Fill Tables for Conductors and Fixture Wires of the Same Size
- Annex D. Examples

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Code Arrangement 90.3

- Annex F. Availability and Reliability for Critical Operations Power Systems (COPS), and Development and Implementation of Functional Performance Tests (FPTs) for Critical Operations Power Systems
- Annex G. Supervisory Control and Data Acquisition (SCADA)
- Annex H. Administration and EnforcementAnnex I. Recommended Tightening Torque Tables from UL Standard 486A-486BAnnex J. ADA Standards for Accessible Design

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OVERVIEW

Enforcement 90.4

- Along with the rest of Article 90, this section was reorganized for ease of use. That's a plus for all of us.

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REORGANIZE

Enforcement 90.4

- There were no changes to the text or its meaning in this section. However, the section was reorganized into four subdivisions with titles for improved usability.

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NEC Enforcement 90.4

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Suitable for Application 90.4(A)

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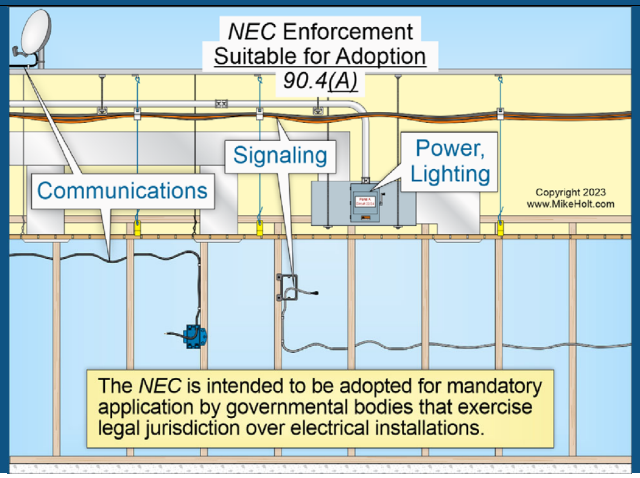

55

COMMENT

Author's Comment:

- Once adopted (in part, wholly, or amended), the National Electrical Code becomes statutory law for the adopting jurisdiction and is thereby considered a legal document.

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AHJ Responsibility 90.4(B)

The enforcement of the NEC is the responsibility of the authority having jurisdiction, who is responsible for interpreting NEC requirements, approving equipment and materials, and granting special permission.

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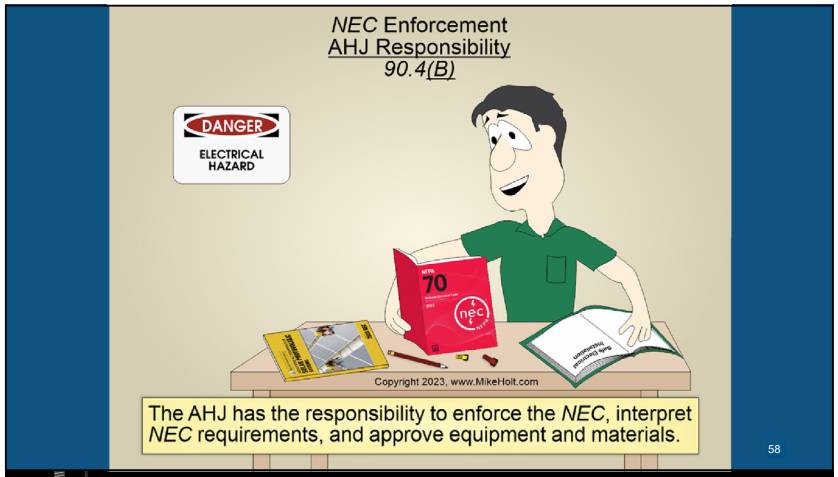

COMMENT

Author's Comment:

- "Authority Having Jurisdiction" is defined in Article 100 as the organization, office, or individual responsible for approving equipment, materials, an installation, or a procedure. See 90.4 and 90.7 for more information.
- "Approved" is defined in Article 100 as acceptable to the authority having jurisdiction, usually the electrical inspector.

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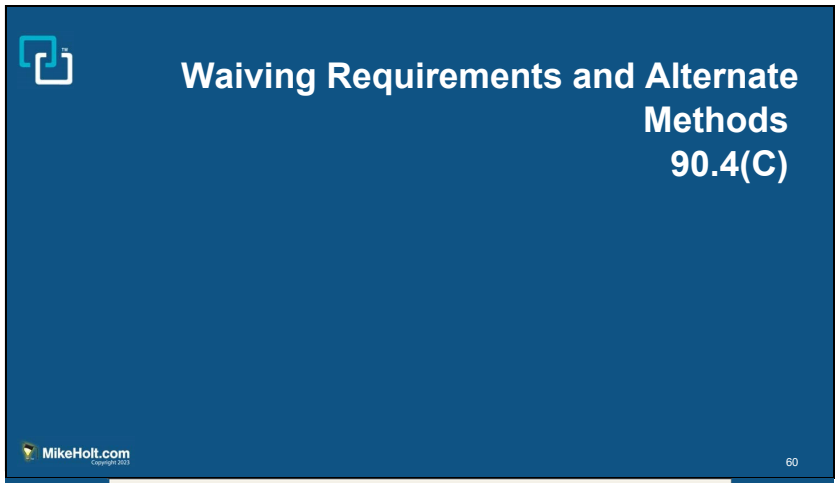

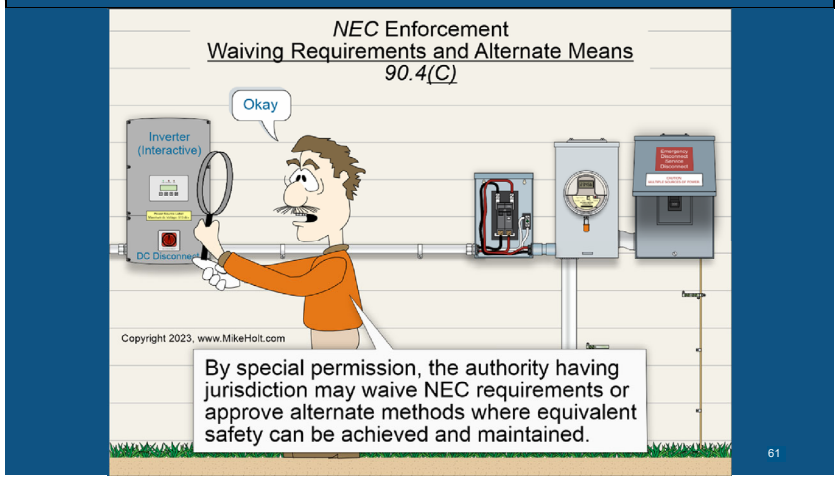

COMMENT

Author's Comment:

- "Special Permission" is defined in Article 100 as the written consent of the AHJ.
- According to the 90.4(B), the authority having jurisdiction determines the approval of equipment. This means he or she can reject an installation of listed equipment and can approve the use of unlisted equipment. Given our highly litigious

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Waiver of Product Requirements 90.4(D)

If the Code requires products, constructions, or materials that are not yet available at the time the NEC is adopted, the authority having jurisdiction can allow products that were acceptable in the previous Code that was adopted in the jurisdiction to continue to be used.

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COMMENT

Author's Comment:

- Typically, the AHJ will approve equipment listed by a product testing organization such as Underwriters Laboratories, Inc. (UL). The NEC does not require all equipment to be listed, but many state and local authorities having jurisdictions do. See 90.7, 110.2, and 110.3 and the definitions for "Approved," "Identified," "Labeled," and "Listed" in Article 100.
- Sometimes it takes years for testing

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OVERVIEW

Mandatory Rules, Permissive Rules, and Explanatory Material, 90.5

- This change clarifies that references to other standards are not required to indicate the date if the most current reference is to be used. Another revision clarifies that the Informative Annex material is not enforceable as a requirement.

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CLARIFY

Analysis

- Historically, standards other than the NEC were referenced throughout the Code. These references usually included the date or edition of the reference. A jurisdiction may, however, adopt a newer edition of that standard than the one referenced in the NEC which caused confusion. To resolve this issue, it is now optional to include the date, and the absence of a date indicates the latest edition of the reference.
- Another clarification that is sure to cause waves

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Mandatory Requirements and Explanatory Material

90.5

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Mandatory Requirements 90.5(A)

The words "shall" or "shall not" indicate a mandatory requirement.

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COMMENT

Author's Comment:

- For greater ease in reading this material, we will use the word "must" instead of "shall," and "must not" will be used instead of "shall not."

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Permissive Requirements 90.5(B)

The phrases "shall be permitted" or "shall not be required" indicates the action is permitted, but not required, or that there are other options or alternatives permitted. Permissive rules are often contained in exceptions to the general requirement.

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COMMENT

Author's Comment:

- For greater ease in reading, the phrase "shall be permitted" (as used in the NEC) has been replaced in this material with "is permitted" or "are permitted."

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Explanatory Material 90.5(C)

Explanatory material referencing other standards, referencing related sections to an NEC rule, or just providing information related to a rule, is included in this Code in the form of informational notes or informative annexes and are not enforceable as NEC requirements.

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Unless the standard reference includes a

COMMENT

Author's Comment:

- A Note, while not enforceable itself, may reference an enforceable Code rule elsewhere in the NEC.
- For convenience and ease in reading this material, "Informational Notes" will simply be identified as "Note."

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COMMENT

Author's Comment:

- **Caution:** Informational notes are not enforceable but notes to tables are. Within this material, we will call notes contained in a table a "Table Note."

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Informative Annexes 90.5(D)

Nonmandatory information relative to the use of the NEC is provided in informative annexes.

These annexes are not enforceable as requirements of the NEC but are included for informational purposes only.

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Examination of Equipment for Safety 90.7

Product evaluation for Code compliance, approval, and safety is typically performed by a qualified electrical testing laboratory (QETL) in accordance with the listing standards.

Except to detect alterations or damage, listed factory-installed internal wiring of

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Examination of Equipment for Safety 90.7

Note 1: The requirements contained in Article 300 do not apply to the integral parts of electrical equipment [300.1(B)]; see 110.3 for guidance on safety examinations.

Note 2: "Listed" is defined in Article 100 as equipment or materials included in a list published by an organization acceptable to the authority having jurisdiction. The listing

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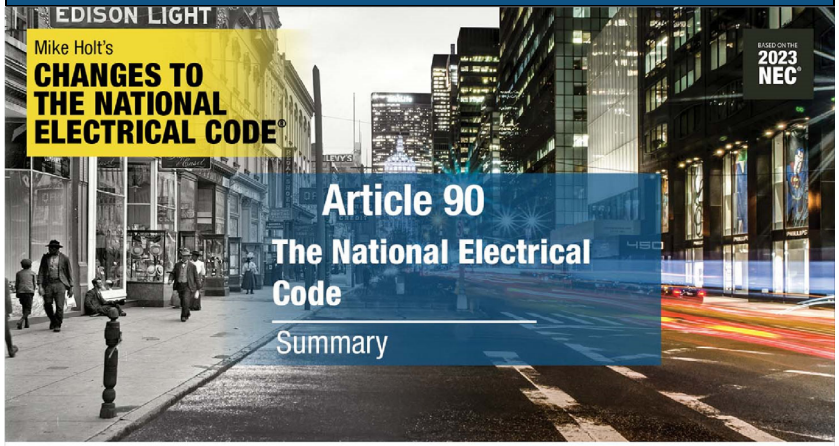

Daniel Dewayne Jenkins

Dewayne started his career in the electrical field in August of 1982 in Dayton, Ohio and has over 40 years' experience in the electrical industry both as a contractor and inspector. He served 4 years in an electrical apprenticeship program and has over 8 years in the field as a journeyman electrician and he has 4 years, to his credit, as an electrical estimator and project manager.

Dewayne has been a licensed electrical contractor and a certified electrical safety inspector since 1996. He also holds Ohio certifications as building inspector (1998), electrical plans examiner (2006) and residential building official (2007) and chief building official (2008). He is currently employed by the City of Kettering in the position as an electrical plans examiner, electrical safety inspector and building inspector for the past 24 years.

Dewayne is an adjunct lecturer II for Sinclair Community College in the electrical trades for the past 22 years. A technical presenter for the Ohio Board of Building Standards (OBBS), International Association of Electrical Inspectors (IAEI), Master Electrical Contractors Association (MECA), Adequate Wiring Committee (AWC) & Greater Cincinnati Electrical Association (GCEA). He has served as President for the Ohio Chapter IAEI (2010). Dewayne has also serves as President of the Southwest Division of IAEI (2018-2023) and President of the Miami Valley Building Officials Council (2002 & 2003). He also serves on the Electrical Safety Inspector Advisory Committee (ESIAC) for the Ohio Board of Building Standards.

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