Board of Building Standards

ELECTRICAL SAFETY INSPECTOR ADVISORY COMMITTEE MEETING AGENDA

DATE: JANUARY 21, 2022
TIME: 10:00 AM
LOCATION: NO MEETING THIS MONTH

Call to Order

Personnel Certification Applications

P-1 Michaels, Glenn - ESI
Cert ID:
Current Certifications: None
Staff Notes: Appears to meet criteria for certification
ESIAC Recommendations:
Committee Recommendation:

P-2 Simmons, Zachary - ESI
Cert ID: 8751
Current Certifications: None
Staff Notes: Appears to meet criteria for certification. OCILB Electrical Contractor.
ESIAC Recommendations:
Committee Recommendation:

Continuing Education Applications for Review

ER-1 DIC - Analysis of 2020 NEC Changes Training 1
5 hours, BO, MPE, BPE, BI, ESI
Staff Notes: Standard IAEI course, recommend approval, addition of EPE.
ESIAC Recommendations:
Committee Recommendation:

ER-2 DIC - Analysis of 2020 NEC Changes Training Course 2
5 hours, BO, BI, MPE, BPE, ESI
Staff Notes: Standard IAEI course. Suggest addition of EPE.
ESIAC Recommendations:
Committee Recommendation:

Old Business

New Business

Adjourn

File Attachments for Item:

P-1 Michaels, Glenn - ESI

Cert ID:

Current Certifications: None

Staff Notes: Appears to meet criteria for certification

ESIAC Recommendations:

Committee Recommendation:

Michaels — *Last Name*

Glenn — *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				

MICHAELS — *Last Name*
GLENN — *First Name*
BBS Certification ID

SECTION 3: EMPLOYMENT/EDUCATION

Formal Education	Date Graduated
LAKEWOOD HIGH SCHOOL	1972
Related Vocational or Technical Training	**Years' Experience**
IBEW/NECA TRADE SCHOOL AND APPRENCESHIP	4 YEARS
U.S. Military construction experience (MOS or other designation):	**Years' Experience**
35K20 AVIONIC MECHANIC	18 MONTHS
Place of Employment:	**Years' Employed**
IBEW LOCAL #38	41 YEARS

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)

MICHAELS GLENN

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

4 YEAR APPRETICESHIP

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)*
GREENBRIAR JR. HIGHSCHOOL, PARMA BEACHWOOD HIGHSCHOOL, BEACHWOOD LAWSONS STORES, CUYAHOGA CO. ELECTRICAL CONSTRUCTION MAY COMANY EUCLID SQUARE MALL FORD MOTOR FOUNDRY J&L STEEL UNION CARBIDE HARSHAW CHEMICAL INDUSTRIAL ELECTRICIAN CLEVELAND INT. AIRPORT Holiday INN HOTEL UNIVERSITY HOSPITAL COMMERCIAL ELECTRICIAN	EL-O ELECTRIC NLIB (NO LONGER IN BUSINESS) HARRINGTON ELECTRIC 3800 PERKINS AVE CLEVE. OH 44114 HERBST ELECTRIC 5171 GRANT AVE CLEVELAND OH 44125 DOAN ELECTRIC NLIB (NO LONGER IN BUSINESS)	FEB 1975 - AUG. 1976 - JULY 1977 - SEPT 1978 - SEPT 1980
Total Experience on This Page (In Months):		67 MONTHS

MICHAELS — *Last Name*

GLENN — *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)
LINCOLN ELECTRIC-INDUSTRIAL electrical WORK	FOWLER ELECT 26185 BROADWAY AVE. OAKWOOD OHIO 44146	DECEMBER 1980 JAN 1981-JUNE 1981
PERRY NUCLEAR POWER PLANT NUCLEAR PLANT NEW CONSTRUCTION	NLIB LK. COMSTOCK	
AIR PRODUCTS AND REPUBLIC STEEL - INDUSTRIAL ELECTRICAL	NLIB W. W. CLARK	JUN 1981- OCT 1981
PERRY NUCLEAR POWER PLANT NUCLEAR PLANT NEW CONSTRUCTION	NLIB LK COMSTOCK	JAN 1982-FEB 1985
BUILDERS SQUARE, STRONGSVILLE SEWAGE PLANT, JACOBS VISCONEY JACOBS OFFICE BLDNG INDUSTRIAL & COMMERCIAL ELECTRICAL WORK	NLIB EL-O ELECTRIC	FEB 1985 - JAN 1987
	MARTIEN ELECTRIC	JULY 1987-APR 1988
STOUFERS FOOD PLANT INDUSTRIAL ELECTRICAL WORK	NLIB	
RENAISSANCE SENIOR CENTER Electrical CONTROLS	NLIB WESTERN RESERVE ELECTRIC	NOV. 1988
REPUBLIC STEEL INDUSTRIAL Electrical WORK	NLIB WW CLARK ELECT.	DEC 1988
MCI COMPUTER CENTER, UNIVERSITY HOSPITAL, OHIO Bell, THISTLEDOWN commercial Electrical WORK	NLIB HIRSCH ELECTRIC.	JAN. 1989 - Jan 1991
SWAGELOK manufacturing INDUSTRIAL New construction	FOWLER ELECTRIC 26185 BROADWAY AVE OAKWOOD OHIO 44146	FEB 1991 - JULY 1991
J&L STEEL MILL INDUSTRIAL MAINT. Electrical/	LAKE ERIE ELECT 25730 1ST ST Westlake OH 44145	NOV. 1991
BIO MED ENG BLDG at Case Western Reserve, University, University Hospital, Mt. SINAI HOSPITAL	DOAN ELECTRIC NLIB	APRIL 1992 - APRIL 2000
GIANT EAGLE SUPERMARKET commercial and INDUSTRIAL Electrial WORK		
CLEVE CLINIC HOTEL, CLEVE CLINIC RESEARCH BLDG.	DOAN/PYRAMID LLC NLIB.	APRIL 2000 - JAN 2004
METRO HOSPITAL commerial and HOSPITAL Electrical WORK		
CLEVE CLINIC OMNI HOTEL B P office BLDG. CLEVE CLINIC SS GARAGE FIRE ALARM and Security work	NE OHIO Electric LLC 5069 CORBIN DR CLEVELAND OHIO 44128	JAN 2004 OCT 2006
CHARTER STEEL - MEDIUM VOLTAGE Terminations in TRANSFORMER YARD	BRUCE & Merrilees Elect Co 930 Cass ST New Castle PA 16101	DEC 2005
	Total Experience on This Page (In Months):	313 MONTHS

NLIB = No Longer in Business

CONSTRUCTION PROJECTS	EMPLOYER	DATES
BROOKLYN FIRE STATION NEW CONSTRUCTION ELECTRICIAN RTA RAIL JOB REWORK THE WIRING and CONTROLS CLEVE CLINIC HEART CENTER CLEVE CLINIC GLICKMAN TWR DEACONESS HOSPITAL PERRY NUCLEAR PLANT NUCLEAR Electrician for 2015 Refuel job The New Embassy in NORWAY Fire ALARM INSTALLATION CLAY CASERN AIR Base NEAR Wiesbaden, GERMANY. NEW CONSTRUCTION, DISTRIBUTION, PIPING and CONTROLS.	LONDON ROAD ELECTRIC 16109 ST. CLAIR AVE CLEVE OH 44110 ESI INCORPORATED 6161 Cochran RD #A SOLON Ohio 44139 DAY and Zimmerman 1500 SPRING Garden ST. Philadelphia PA 19130 R. M. E. Electric 19160 Smith ROAD AURORA CO. 80011	NOV. 2006 DEC 2006 - DEC 2014 JAN 2015 MAY 2015 AUG 2015 - OCT 2019 152 MONTHS
INSTRUCTOR, at The IBEW/NECA TRAINING CENTER FIRE ALARM and OSHA PART TIME	IBEW/NECA TNG. CENTER 9333 SWEET VALLEY DR Valley View OH 44125	OCT 2001 - APR 2015 PART TIME TOTAL EXPERIENCE PART TIME 14 YEARS

MICHAELS — *Last Name*
Glenn — *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: Glenn O. Michaels

Subscribed and duly sworn before me according to law, by the above named applicant this day 7th of Jan in the year 2022 at cuyahoga Broadview Heights, County of cuyahoga and State of Ohio.

Notary Public: Tracy E Selesky

Tracy E Selesky
Notary Public
State of Ohio
My Commission Expires
August 6, 2025

STATE OF OHIO

Certificate of Completion of Apprenticeship

№ 10294

ISSUED BY
THE OHIO STATE APPRENTICESHIP COUNCIL

This is to certify that: **Glenn O. Michaels**

has fulfilled the terms of the apprenticeship agreement in accordance with the registered standards and requirements, with related instruction, and is hereby recognized and qualified as a journeyperson

Electrician

together with all the rights, privileges and opportunities which everywhere pertain thereto.

In Testimony Whereof, *the Ohio State Apprenticeship Council of the Ohio Department of Industrial Relations in cooperation with the Bureau of Apprenticeship and Training, U. S. Department of Labor, do affix the Great Seal of the State of Ohio.*

Witnessed Over Our Signature and Seal:

DEPARTMENT OF INDUSTRIAL RELATIONS · STATE OF OHIO ·

Sponsored by:
ELECTRICIANS' JAC
CLEVELAND, OHIO

William J. Starkin

Given at Columbus in the State of Ohio,

this 15th *day of* February, *A. D. 19*79.

I. J. Haas
CHAIRMAN, OHIO STATE APPRENTICESHIP COUNCIL

Helen W. Evans
DIRECTOR, OHIO DEPARTMENT OF INDUSTRIAL RELATIONS

James A. Rhodes
Governor of Ohio

NLC NATIONAL LABOR COLLEGE

BUILDING-CONSTRUCTION TRADES DEPT. AFL-CIO

THE CENTER FOR CONSTRUCTION RESEARCH AND TRAINING

Extension Service West Virginia University

National Resource Center for OSHA Training

This is to certify that on August 6, 2010

Glenn Michaels

has diligently and with merit completed training in the Trainer Course in Occupational Safety and Health Standards for the Construction Industry (OSHA 500)

Executive Director

2.5 CEU's

NATIONAL INSTITUTE FOR CERTIFICATION IN ENGINEERING TECHNOLOGIES®

Providing Certification Programs Since 1961

BE IT KNOWN THAT

Glenn O Michaels

IS HEREBY AWARDED CERTIFICATION AT

LEVEL II

IN FIRE PROTECTION ENGINEERING TECHNOLOGY
FIRE ALARM SYSTEMS

BASED UPON SUCCESSFUL DEMONSTRATION OF REQUISITE KNOWLEDGE, EXPERIENCE AND WORK PERFORMANCE AS SET FORTH BY THIS INSTITUTE.

Certification Valid through February 1, 2015

CERTIFICATION NUMBER 133657

50th Anniversary
1961—2011

CHAIRMAN OF THE NICET BOARD OF GOVERNORS

A DIVISION OF THE NATIONAL SOCIETY OF PROFESSIONAL ENGINEERS

Certificate of Completion

ELECTRONIC SERVICING INSTITUTE

This Certifies that

Glenn Owen Michaels

A student of Electronic Servicing Institute
has completed the course of

Electronic Servicing

and has a thorough knowledge and proficiency in the subjects of the course and is found duly qualified and recommended.

Director of Education

Cleveland, Ohio this 28th **day of** October **19** 88

File Attachments for Item:

P-2 Simmons, Zachary - ESI

Cert ID: 8751

Current Certifications: None

Staff Notes: Appears to meet criteria for certification. OCILB Electrical Contractor.

ESIAC Recommendations:

Committee Recommendation:

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

Simmons — *Last Name*

Zachary — *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				
OHIO Electrical Contractor License			49003	10/10/19

23

Simmons
Last Name

Zachary
First Name

BBS Certification ID

SECTION 3: EMPLOYMENT/EDUCATION

Formal Education	Date Graduated
Eastern Brown High School	2006
University of Cincinnati	2015
Related Vocational or Technical Training	**Years' Experience**
Electrical Licensing of WV-Ky-Utah continuing education	3
U.S. Military construction experience (MOS or other designation):	**Years' Experience**
	0
Place of Employment:	**Years' Employed**
Superior Electrical Company LLC	3

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)

Simmons Zachary

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)*
• Fairfield Middle School Fairfield,OH. Electrical Control Systems For Building-Electrical Install H.V/L.V •Worked As Journeyman Electrician	Low Voltage Specialists Wadsworth, OH 291 Bergy st 44281 (513)680-1911	January 2017-June 2018
• Cincinnati Museum Center Cincinnati,OH Electrical Control System/Electrical Installation For Renovation •Worked As Journeyman Electrician	Low Voltage Specialists Wadsworth, OH 291 Bergy st 44281 (513)680-1911	July 2018-Feb 2019
Total Experience on This Page (In Months):		25 Months

Simons
Last Name

Zachary
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)
• Facebook Data Center Social Circle, GA. Electrical Control System /Electrical Installations of Project • Worked as Electrical Superintendent and Licensed Master Electrician Representative for Company.	Low Voltage Specialists Wadsworth,OH 291 Bergy st 44281 (513)680-1911	March 2019-December 2019
• West Virginia University Morgantown,WV Electrical Demo and New Installations •Worked As Licensed Master Electrician For Company and Lead of Crew	Eco Engineering 11815 Hey dr 600 Sharonville, OH (513)985-8300	January 2020-May 2020
• Amazon Air Hub Florence,KY. Electrical System Installations of Material Handling Systems. • Worked As Construction Manager Electrical Permit Holder And Licensed Master Electrician Representative for Project Scope.	JCKUSA 1343 Canton rd suite h Marietta,GA (770)675-9908	June 2020-Nov 2021
• Good New Gathering Center Hillsboro,OH Electircal Installtion of Entire Electrical Scope Of Project •Worked As Journeyman Electrician	Barker Electric Owensville,OH 5192 Benton rd (513)732-1784	January 2011-July 2012
	Total Experience on This Page (In Months):	49 Months

ZC

Simmons
Last Name

Zachary
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: _____

Subscribed and duly sworn before me according to law, by the above named applicant this day 17 of December in the year 2021 at 3:34 PM, County of Brown and State of Ohio.

Notary Public: _____

Roger Edward Hauke, Notary Public STATE OF OHIO

ROGER EDWARD HAUKE
NOTARY PUBLIC, STATE OF OHIO
BROWN COUNTY
My Commission Expires 5/10/2022

File Attachments for Item:

ER-1 DIC - Analysis of 2020 NEC Changes Training 1

5 hours, BO, MPE, BPE, BI, ESI

Staff Notes: Standard IAEI course, recommend approval, addition of EPE.

ESIAC Recommendations:

Committee Recommendation:

APPLICATION

FOR

Continuing Education Course Approval

Continuing education programs approved for education credit by the Ohio Board of Building Standards may be used for compliance with certification requirements related to code enforcement, plan review, and inspection responsibilities. The credit is to be used to renew the certifications issued by the Ohio Board of Building Standards pursuant to section 3781.10(E) ORC.

Board of Building Standards
6606 Tussing Road, P.O. Box 4009
Reynoldsburg, Ohio 43068-9009
(614) 644-2613 Fax: (614) 644-3147
dic.bbs@com.state.oh.us
www.com.state.oh.us/dic/dicbbs.htm

COURSE SUBMITTER: # 5068

Course Submitter: Michael Thompson
(Contact Name)

Organization: State Of Ohio Department of Industrial Compliance
(Organization/Company)

Address: 6606 Tussing Road
(Include Room Number, Suite, etc.)

City: Reynoldsburg State: _____ Zip: _____

E-Mail: michael.thompson@com.state.oh.us

Telephone: 614-728-5293 Fax: _____

Course Sponsor: # 5068

COURSE INFORMATION:

Course Title: IAEI Analysis of Changes – 2020 NEC part 1 Chapters 1-4

New Course Submittal: ■ Update Course: ☐ Prior Approval Number: _____

Purpose and Objective: Training the staff on the changes to the 2020 code for references and knowledge of the changes to this code. to hold group training and discusion for plans examiners , building official and the Electrical field inspectors.

Number of Instructional Contact Hours that can be obtained upon completion: 5 hrs

If Multi-Session, Number of Instructional Contact Hours Per Session: _____

Program Applicable for the Following Participants:

Building Official ■	Master Plans Examiner ■	Building Inspector ■	Fire Protection Inspector ☐	Mechanical Inspector ☐	
	Building Plans Exam. ✔			Plumbing Inspector ☐	
	Plumbing Plans Exam. ☐			Non-Res IU Inspector ☐	
	Electrical Plans Exam. ☐				
	Mechanical Plans Exam. ☐				
	Fire Protect. Plans Exam. ☐				
Res Building Official ☐	Res Plans Examiner ☐	Res Building Inspector ☐	Res Mechanical Inspector ☐	Res IU Inspector ☐	

Electrical Safety Inspectors [X]

Location of ESI Course: Department of Commerce Date(s) of ESI Course(s): TBD

SUBMITTAL CHECKLIST: **Make Sure** all of the Following Information is **Submitted**:		Check Off
Course Submitter:	Name of contact person and their certification numbers, organization, address, fax, phone	
	Organization sponsoring or requesting the program (if any)	
Course Title:	Name of course (related to content)	
Purpose/Objective:	Describe purpose and how course will improve competency of certification(s) listed	
Contact Hours:	Indicate instructional time and credit requested in hours (e.g.: 0.5 hr, 1 hr, 3.5 hrs)	
Participants:	Check off each certification for which credit is requested (for which course relates to certification)	
Content of Program:	Include collated agenda, time schedule, course outline; list specific sections of code, references, and topics covered	
Course Materials:	Collated workbooks, handouts, hard copy or electronic versions of program is available	
Instructor(s) Info.:	Resume of professional/educational qualifications & teaching/training experience/BBS certifications	
Test Materials:		
Completed Application:		

NOTE: The Board does NOT grant retroactive approval for courses presented prior to approval date.

INSTRUCTOR: Michael Thompson

Assistant Bureau Chief/ Electrical Supervisor for the Department of Commerce

I have 25 years' experience in training employees on the National electric code and safety. I carried contractor license in all 5 disciplines until fall of 2014. My ESI # 2705, I am also a member of the International Inspectors Association (IAEI). One of my duties with being the Supervisor is to keep our inspectors up to Standards with their code knowledge and this program is just one of others we will do to reach these goals. I can provide a complete resume upon request. Thank You.

Analysis of Changes- 2020 NEC Part 1 AGENDA

1. 8:00 am – 8:30: Introduction of class concepts and distributing the PDF handout.
2. 8:30 – 10:00 - Part 1 NEC Article 90 through Article 210
3. Break 10:00 10:10
4. 10:10 – 12:00 Part 1 NEC Article 215 through Article 250
5. 12:00 12:30 lunch
6. 12:30pm -2:20 NEC Article 300 through 490
7. Discussion 2:20 – 2:45
8. Dismissal.

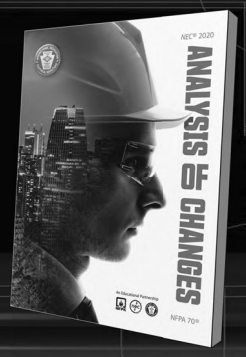
Analysis of Changes – 2020 *NEC*

Part 1 – NEC Chapters 1 through 4

Training Presentation By:
International Association of Electrical Inspectors

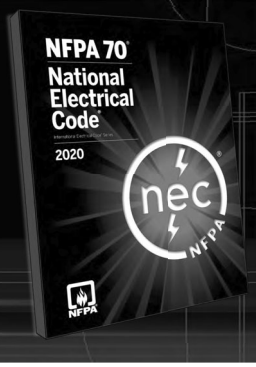
Licensing Agreement

- This program is licensed solely for the purpose of in-person electrical education and training by the licensee.
- *Analysis of Changes-NEC 2020* training presentation is prohibited from being further copied, broadcast, posted online, sublicensed, used for on-line training or in any way further distributed or displayed for any other purpose by the licensee.

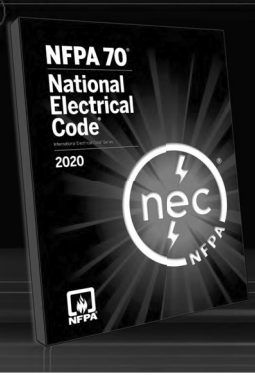


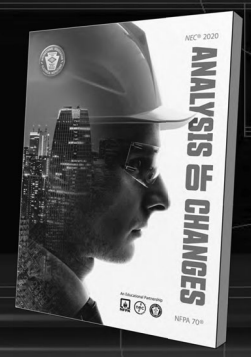
National Electrical Code® *(NEC)*

- Portions of this material are reprinted with permission from the 2020 edition of the National Electrical Code® Copyright © 2019 National Fire Protection Association. This material is not the complete and official position of the National Fire Protection Association on the reference subject which is represented solely by the standard in its entirety which can be obtained from the NFPA at www.nfpa.org and can be viewed at www.nfpa.org/70. Also available from IAEI at www.iaei.org/NEC20.
- National Electrical Code®, NFPA 70®, NEC®, and the NEC Logo™ are trademarks of the National Fire Protection Association, Quincy, MA 02169



Analysis of Changes – 2020 *NEC*





Code-Wide Changes

Code-Wide Changes

- There were a total of **3730** Public Inputs (PI) and **1930** Public Comments (PC) submitted from interested participants seeking changes to the 2020 *NEC*
- **Available Fault Current References.** Different terms like “available short-circuit current” and “short-circuit current” were previously used to describe large amounts of current capable of being delivered at a point on the system during a short-circuit condition. For the 2020 *NEC*, these large amounts of current descriptions were changed to “**available fault current**” throughout the *Code* for improved consistency
- **Reconditioned Equipment, Yes or No ?** Each Code Making Panel (CMP) was asked to review the equipment they have purview over and determine what equipment could be reconditioned and what equipment could not be reconditioned but rather replaced when necessary

Code-Wide Changes *(cont.)*

- **Definition Statements.** Two distinct statements added at XXX.2 sections of the *Code*
  - “*The definitions in this section shall apply only within this article*.”
  - “*The definitions in this section shall apply within this article and throughout the Code*.”
- **GFCI Requirements Alignment with 210.8.** Changes were proposed throughout the *Code* to align all GFCI requirements with the GFCI requirements of 210.8
- **“~~Allowable~~” Ampacity.** Several locations across the *NEC* where the term “allowable ampacity” was used and should have been simply stated as “**ampacity**” as it is the intent for those sections to determine the ampacity of a conductor based upon its conditions of use

Code-Wide Changes *(cont.)*

- **Grounding Conductor Changed to Equipment Grounding Conductor.** The term “grounding conductor” *(not a defined term)* was replaced with mainly the proper term “equipment grounding conductor,” but in some instances with the terms “grounding electrode conductor” or one of the several types of “bonding jumpers”

Code-Wide Changes

Available Fault Current References

Reconditioned Equipment (Yes or No)

XXX.2 Definitions

"The definitions in this section shall apply only within this article."

"The definitions in this section shall apply within this article and throughout the *Code*"

Definition Statements


Alignment of GFCI Requirements


Allowable Ampacity vs Ampacity


Term "Grounding Conductor" Deleted

New Articles for the 2020 *NEC*

Article 242 Overvoltage Protection (CMP-10) 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.

Article 337 Type P Cable (CMP-6) This article covers the use, installation, and construction specifications for up through 2000 volt Type P cable (armored and unarmored). Type P cable is a factory assembly of one or more insulated flexible tinned copper conductors, with associated equipment grounding conductor(s), with or without a braided metallic armor and with an overall nonmetallic jacket.

Article 311 Medium Voltage Conductors and Cable (CMP-6) This article covers the use, installation, construction specifications, and ampacities for Type MV medium voltage conductors and cable. Type MV conductor and cable requirements that were previously found in Articles 310 (Conductors or General Use) and 328 (Medium Voltage Cable) were consolidated into one article.

Article 800 General Requirements for Communications Systems (CMP-16) This article covers general requirements for communications systems. These general requirements apply to communications circuits, community antenna television and radio distribution systems, network-powered broadband communications systems, and premises-powered broadband communications systems, unless modified by Articles 805, 820, 830, and or 840. **[Previous Article 800 (Communication Circuits) is now Article 805]*

Article 90 Introduction

90.2(A) Scope

- Revision clarifies that the *NEC* covers installations **supplying shore power to** ships and watercraft, including monitoring of leakage current
- 90.2(B)(1) reveals that **installations in** ships and watercraft *(other than floating buildings)* are not covered by the *NEC*
  - This does not include electrical supply system **supplying shore power to** ships and watercraft
- Change intended for ships, boats, and other watercraft covered by **Article 555**
- New provision was necessary to address potential hazards created where shore power is supplied to ships and watercraft with a significant number of fatalities from **electric shock drowning (ESD)** associated with leakage of current from watercraft connected to shore power

90.2(A) Scope

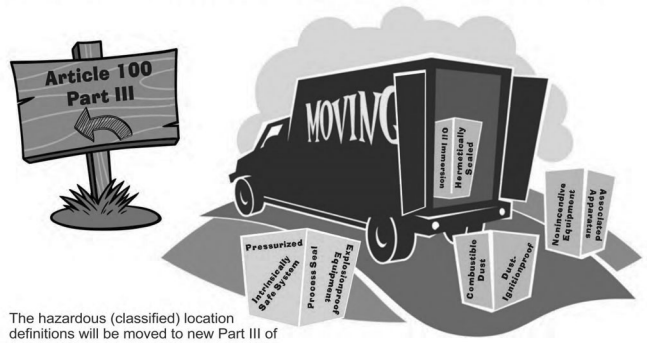
- A new (6) has been added to 90.2(A) to address installations used to **export power from electric vehicles to premises wiring**
- Bidirectional flow of power is typically accomplished using utility interactive inverters

Chapter One General

Article 100: Definitions - Scope

- Scope of Article 100 is modified to include **new Part III for Hazardous (Classified) Locations**
- During the 2017 *NEC* revision cycle, several definitions that applied to hazardous (classified) locations were relocated to Article 100 of the *NEC*
- Previously located at 500.2 *(2014 NEC)*
- Creating new Part III and the relocation of these definitions will add clarity and usability and help users of the *Code* understand that these definitions only apply to hazardous (classified) location articles located in Chapter 5

Article 100 Part III Hazardous (Classified) Locations (CMP-14)



The hazardous (classified) location definitions will be moved to new Part III of Article 100 for added clarity and usability

Article 100: Definitions – Scope *(cont.)*

- New sentence added to Scope of Article 100 to indicate that definitions can also be found at "**XXX.2 of other articles**"
- Two distinct statements added at XXX.2 sections of the *Code*
  - *"The definitions in this section shall apply only within this article*."
  - "*The definitions in this section shall apply within this article and throughout the Code*"
- This was in conjunction with an effort this *Code* cycle to make a distinction to definitions found throughout the *Code*, particularly at XXX.2 of individual articles

Article 100: Definitions - Accessible

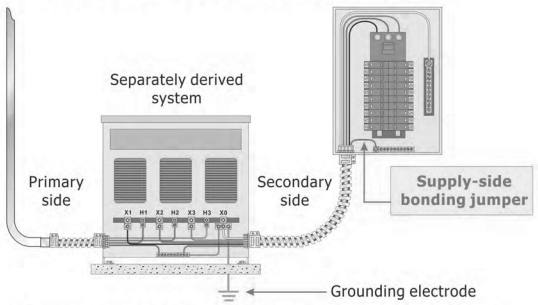
- **Accessible (as applied to equipment)**. Capable of being reached for operation, renewal, and inspection. (CMP-1)
- Definition revised for clarity and usability
- Previous definition seemed to contradict other sections of the *Code*
- By stating that equipment is not accessible, if "guarded by locked doors" was in contradiction with 110.26(F) *[electrical equipment rooms or enclosures housing electrical apparatus that are controlled by a lock(s) shall be considered accessible to qualified persons]*
- Former definition also stated that equipment could be considered not accessible by "elevation" while the *Code* demonstrates that equipment can still be considered accessible, despite being elevated *(above suspended ceiling)*

Article 100 Definitions Accessible (as applied to Equipment)

Article 100: Definitions - SSBJ

- **Bonding Jumper, Supply-Side**. 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. (CMP-5)
- Definition of a **Supply-Side Bonding Jumper** was relocated from 250.2 to Article 100
- Prior to 2011 *NEC*, the term “equipment bonding jumper” used at most locations to described a fault carrying conductor for a separately derived system
- Supply-side bonding jumper provides electrical continuity between the supply source *(such as the utility transformer enclosure)* and the various enclosures of the service equipment

Article 100 - Supply-Side Bonding Jumper



Bonding Jumper, Supply Side - 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. (CMP-5)

Article 100: Definitions – Dormitory Unit

- **Dormitory Unit.** A building or a 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. (CMP 2)
- New definition for a “Dormitory Unit” was introduced at Article 100
- Used in (4) different articles but was not defined in the *NEC*
- Without an *NEC* definition, installers and inspectors alike experience a **wide variety of interpretation** as to what constitutes a dormitory unit
- While a dormitory unit can certainly be found at a typical college campus, a dormitory unit is not limited to a learning institution

Article 100 Definitions Dormitory Unit

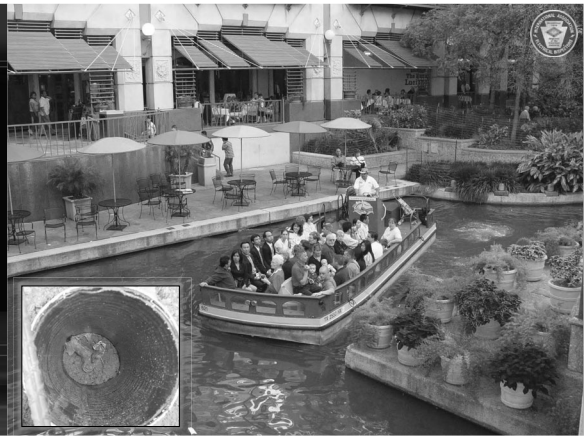
Article 100 Definitions: Dormitory Unit

Dormitory Unit. A building or a 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. (CMP 2)

Article 100: Definitions - Equipotential Plane

- **Equipotential Plane.** Accessible conductive parts bonded together to reduce voltage gradients in a designated area. (CMP-17)
- Definition for an "Equipotential Plane" *(previously defined in Article 682 Natural and Artificially Made Bodies of Water)* was modified, deleted from Article 682, and moved to Article 100 *(was also defined at 547.2)*
- Previous text concerning conductive elements in or under walking surfaces was a requirement located in a definition and was moved to 682.33(C) *(Equipotential Planes and Bonding of Equipotential Planes-Walking Surfaces)*
- Definition for "**Equipotential Plane (as applied to agricultural buildings)**" remains in Article 547 (Agricultural Buildings)

Article 100 Definitions Equipotential Plane



Article 100: Fault Current and Fault Current, Available

- New definitions of the terms **"fault current"** and **"fault current, available"** have been added to Article 100
- A **new informational note** and associated figure have been added to enhance clarity and usability
- This revision aligns with similar recent revisions in other standards that use the terms, such as NFPA 70E
- Different terms were used to describe large amount of current capable of being delivered at a point on the system during a short-circuit condition:
  - Maximum available fault current and Maximum available short-circuit current, Short circuit, fault current, available fault current, short-circuit current rating, interrupting rating, available short-circuit current, short-circuit current, available fault current

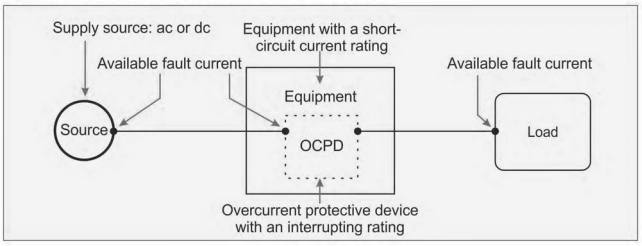
Article 100: Definitions

Fault Current. The current delivered at a point on the system during a short-circuit condition. (CMP-10)

Available Fault Current. The largest amount of current capable of being delivered at a point on the system during a short-circuit condition. (CMP-10)

Informational Note: A short-circuit can occur during abnormal conditions such as a fault between circuit conductors or a ground fault. See Informational Note Figure 100.1.

Figure Informational Note Figure 100.1 Available Fault Current.



Article 100: Definitions – Free Air

- **Free Air (as applied to conductors)**. Open or ventilated environment that allows for heat dissipation and air flow around an installed conductor. (CMP-6)
- New definition for "Free Air (as applied to conductors)" added to Article 100
- The term "free air" is used throughout the *NEC*, yet to this point, this term has not been defined in the *NEC*
- Contact or close proximity with additional conductors or other materials that could impede the flow of heat away from the conductor would not allow the use of free air ampacity ratings of the conductor ampacity tables in Article 310

Article 100 Definitions: Free Air (as Applied to Conductors)

Free Air (as applied to conductors). Open or ventilated environment that allows for heat dissipation and air flow around an installed conductor. (CMP-6)

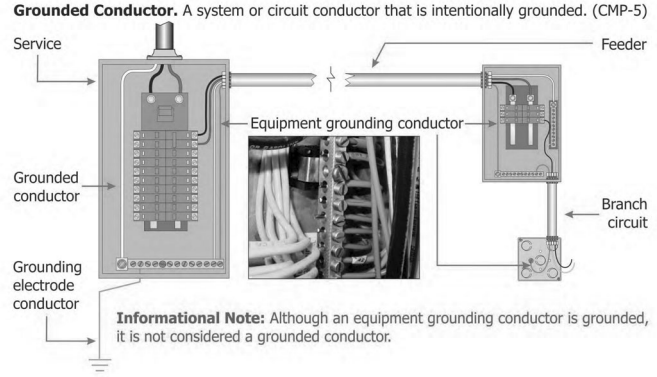
New definition should clarify that contact or close proximity with additional conductors or other materials that could impede the flow of heat away from the conductor would not allow the use of free air ampacity ratings of the conductor ampacity tables in Article 310

Article 100: Definitions – Grounded Conductor, Informational Note

- A new Informational note was added to the definition of a "Grounded Conductor" to clarify that an **equipment grounding conductor** is **not subject to** the identification and connection rules of a grounded conductor
- I-Note states that although an equipment grounding conductor is grounded, it is **not considered a grounded conductor**
- Some would argue that an EGC is an "intentionally grounded" conductor while others would say an EGC is not by definition an "intentionally grounded" conductor as it is not a "system or circuit" conductor

Article 100 Definitions: Grounded Conductor (I-Note)

Grounded Conductor. A system or circuit conductor that is intentionally grounded. (CMP-5)



Informational Note: Although an equipment grounding conductor is grounded, it is not considered a grounded conductor.

Article 100: Definitions – Habitable Room

- **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. (CMP-2)
- New definition for "Habitable Room" was added to Article 100
- Definition aligns with the same term that is used in *NFPA 5000, Building Construction and Safety Code* and promotes consistency of its use
- Adds clarity and usability to the *Code* for both the installer and AHJ in relation to sections of the *Code* that reference a "habitable room or area" *(such as 210.8 GFCI requirements for dwelling units)*

Article 100 Definitions Habitable Room

Article 100: Definitions – Island Mode

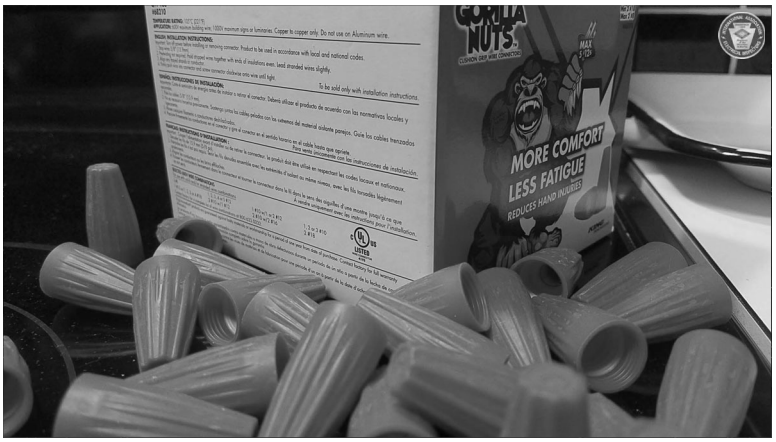
- **Island Mode.** The operational mode for stand-alone power production equipment or an isolated microgrid, or for a multimode inverter or an interconnected microgrid that is disconnected from an electric power production and distribution network or other primary power source. (CMP-4)
- **Informational Note:** Isolated microgrids are distinguished from interconnected microgrids, which are addressed in Article 705.
- New definition for “Island Mode” primarily related to microgrid systems and stand-alone systems was added to Article 100
- A stand-alone (or islanded mode) microgrid never connects to the utility grid but instead operate in an island mode at all times
- Using terms like “stand-alone mode” and “islanded mode” necessitated the need to define these terms as they are used often in in the Chapter 7 articles

Article 100: Definitions – Island Mode *(cont.)*

- Name was changed to simply “Island Mode”
- Changes were made to the definition to better clarify the use of the term and how it applies to various applications that operate in island mode
- Name was changed from “Stand-Alone (Islanded) Mode” to “Island Mode” as the changes made to the definition of “Stand-Alone System” in Article 100 and the proposed definition of “Stand-Alone (Islanded) Mode” originally slated for 710.2 caused confusion with the definition of “Microgrid System” in Article 705
- Definitions consistent with IEEE 1547-2018 - IEEE *Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces*

Article 100 Labeled

- New Informational Note added explaining that even though a section of the *NEC* may require a product to be labeled, it is common practice to have the label, symbol, or other identifying mark applied to the **smallest unit container** in which the product is packaged
- Several types of electrical equipment addressed in the *NEC* that are required to not only be “**Listed**,” but also required to be “**Labeled**”
- A typical pressure wire connector (wire nut) for splicing conductors together is required to be listed and labeled, but it is one of those products that are too small to affix a label to each individual pressure wire connector

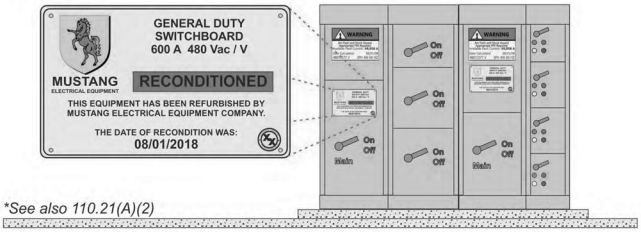


Article 100: Definitions – Reconditioned

- A new definition for "**Reconditioned**" was added to Article 100 and an **informational note** added to indicate that the term reconditioned is frequently referred to as **rebuilt**, **refurbished**, or **remanufactured**
- Several requirements added throughout the *Code* added to indicate if specific equipment **can or cannot be reconditioned** *(see receptacles, switches, panelboards, circuit breakers, etc.)*
- Definition based on a National Electrical Manufacturers Association (NEMA) document titled, "*NEMA Policy on Reconditioned Electrical Equipment*"
- Marking requirements for reconditioned, refurbished or remanufactured electrical equipment added to 110.21(A)(2) for 2017 *NEC*

Article 100 Definitions: Reconditioned

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. (CMP-10)



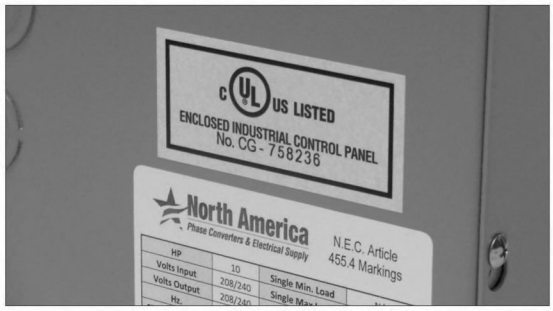
*See also 110.21(A)(2)

Informational Note: The term reconditioned is frequently referred to as rebuilt, refurbished, or remanufactured.

110.3(B) Installation and Use of Listed Equipment

- Equipment that is listed, labeled, **or both** shall be installed and used in accordance with any instructions included in the listing or labeling
- Listing requirements were **modified** for clarity and usability to address equipment that is listed, labeled, **or both**
- The words "listed" and "labeled" are often looked upon as interchangeable by installers and inspectors alike even though both of these terms are defined in Article 100
- Electrical equipment can easily be both listed and labeled
- Marking on the product is the manufacturer's substantiation that the product is in compliance with the appropriate product standard
- Only true way AHJ can determine whether the inspected product is compliant with the applicable product standard is the third-party label on the product

110.3(B) Installation and Use of Listed Equipment

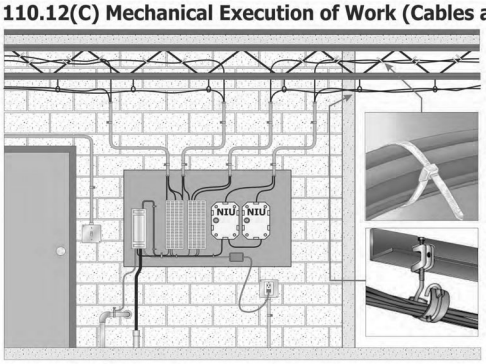


Equipment that is listed, labeled, or both shall be installed and used in accordance with any instructions included in the listing or labeling

110.12(C) Cables and Conductors

- Redundant requirements for "**Mechanical Execution of Work"** for communication cables and conductors in Chapter 7 and 8 were relocated to Article 110
- A new subdivision (C) titled "**Cables and Conductors**" has been added to 110.12 which is titled "**Mechanical Execution of Work**"
- Includes relocated requirements from the **.24 sections** from the communications articles in Chapters 7 and 8
- Conductor and cable support and concerns about damage are addressed in both 110.12(C) and in 800.24

110.12(C) Mechanical Execution of Work (Cables and Conductors)



Exposed cables and conductors to be supported by building structure to prevent damaged by normal building use

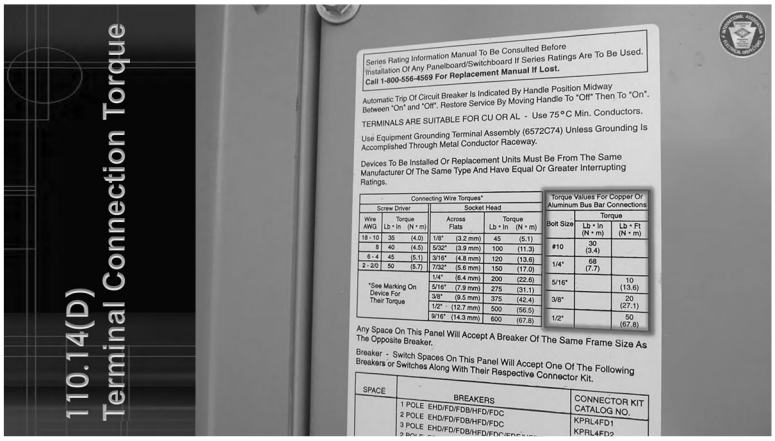
Cables and conductors to be secured by hard-ware *(straps, staples, cable ties, hangers, etc.)* designed and installed to not damage the cable

Installation to comply with 300.4 and 300.11

Nonmetallic cable ties and other nonmetallic cable accessories used to secure and support cables in environmental air spaces (plenums) must be listed as having low smoke and heat release properties

110.14(D) Terminal Connection Torque

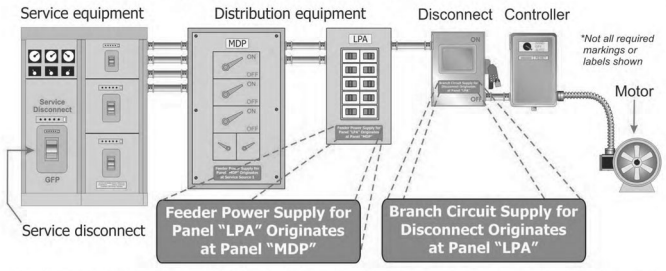
- The title of subdivision (D) has been changed from “Installation” to “**Terminal Connection Torque**”
- The term “**calibrated**” has been deleted from this section *(replaced with “approved means shall be used to achieve the indicated torque value”)*
- Three new informational notes provide practical guidance for installers and inspectors
- Proper emphasis needs to be on achieving the required torqueing values rather than the tool used to achieve such values



110.22(A) Identification of Disconnecting Means

- Disconnects are now required to **identify of the source** of the branch circuit or feeder for the disconnect at the disconnecting means enclosure *(other than one- or two-family dwellings)*
- Disconnecting means is required to be marked with a label to identify exactly what the disconnect is for
- Also required to provide identification of the circuit source that supplies the disconnecting means
- Same identification requirement for switchboards, switchgear, and panelboards *[see 408.4(B)]*
- Power supply identification practice will enhance the safety for the electrical personnel who service these disconnects

110.22(A) Identification of Disconnecting Means



Each disconnecting means shall be legibly marked to indicate its purpose unless located and arranged so the purpose is evident

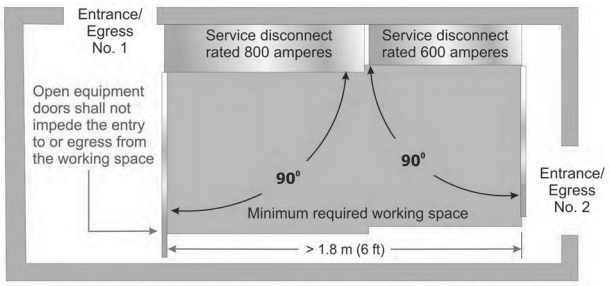
In other than one- or two-family dwellings, the marking shall include the identification of the circuit source that supplies the disconnecting means

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

110.26(C)(2) Large Equipment

- Revisions to "**Large Equipment**" working space to address the hazards presented by two or more service disconnects with combined ratings of **1200 amps or more**
- For service disconnecting means where **two or more service disconnect enclosures** are installed with combined ampere rating is 1200 amperes or more and over 1.8 m (6 ft) wide, the **"Large Equipment" rules will now apply**
- Requirements also added to prevent **open equipment doors** from impeding the entry to or egress from the working space of large equipment

110.26(C)(2) Large Equipment

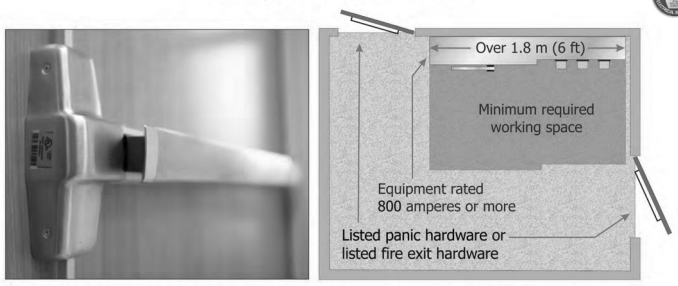


Large equipment is generally required to have an entrance/egress at each end of the working space for equipment rated 1200 amperes or more and over 1.8 m (6 ft) wide or for service disconnecting means installed in accordance with 230.71 where the combined ampere rating is 1200 amperes or more and over 1.8 m (6 ft) wide

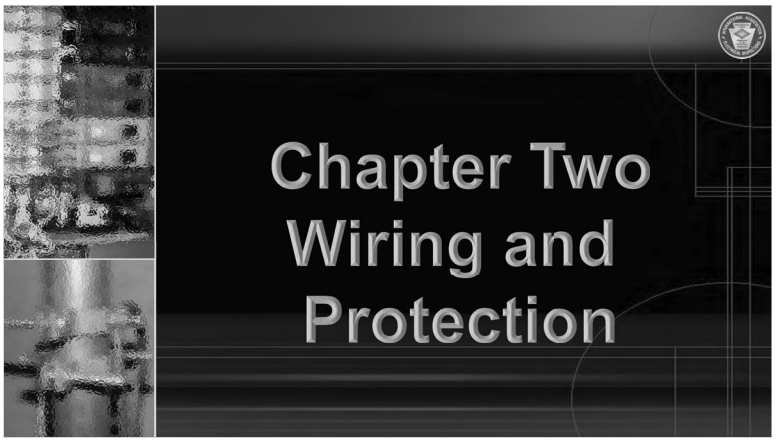
110.26(C)(3) Personnel Doors

- Revision added to clarity appropriate hardware *(equipped with listed panic hardware **or listed fire exit hardware**)* for personnel doors within 7.6 m (25 ft) from working space around electrical equipment rated 800 amperes or more
- The words **"or listed fire exit hardware"** have been added to 110.26(C)(3)
- An informational note has been added that references two UL standards that apply to the door hardware referred to in this rule
- Both panic hardware and fire exit hardware are listed to **UL 305** *(Standard for Safety for Panic Hardware)*, while fire exit hardware is tested to **UL 10C** *(Standard for Safety for Positive Pressure Fire Tests of Door Assemblies)*
- The revision differentiates **listed panic hardware** from **listed fire exit hardware**

110.26(C)(3) Personnel Doors



Where equipment rated 800 amperes or more that contains overcurrent devices, switching devices, or control devices is installed and there is a personnel door(s) intended for entrance to and egress from the working space less than 7.6 m (25 ft) from the nearest edge of the working space, the door(s) shall open in the direction of egress and be equipped with listed panic hardware or listed fire exit hardware.

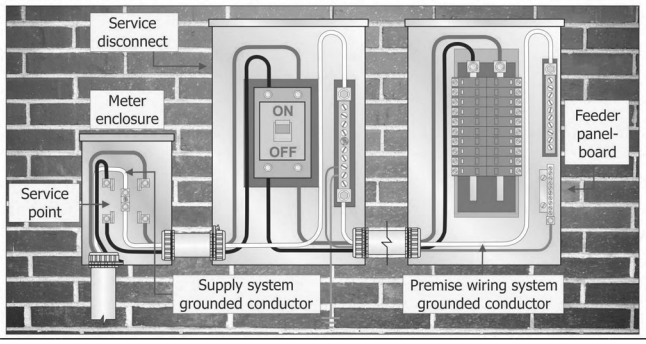


200.3 Connection to Grounded System

- Grounded conductors of premises wiring systems are required to be electrically connected to the supply system grounded conductor
- This applied to **all premises wiring** *(not just interior wiring)*
- Previous word "**interior**" implied that a grounded conductor is only required in the supply system if the premises wiring is located inside a building or structure
- Replacing "**interior**" with "**premises wiring**" makes the language easier to understand and correlates with 250.24(C) *(Grounded Conductor Brought to Service Equipment)*

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 *(applies to all premises wiring, not just interior wiring)*



200.10(B) Identification of Terminals

- Means of identification of the **grounded conductor terminals or screws** for such things as receptacles can be achieved by a metal or metal coating that is not only substantially white in color, but "**substantially silver**" in color as well
- The words "**or silver**" have been added to second level subdivision (1)
- Receptacles, polarized attachment plugs, and cord connectors for plugs and polarized plugs typically include a terminal that is **silver or chrome** in color, as compared to **brass or gold** color
- The revision reflects the **common identification means** employed by product manufacturers

200.10(B) Identification of Terminals for Receptacles, Plugs, and Connectors

Identification of the grounded conductor terminals or screws for receptacles, polarized attachment plugs, and cord connectors for plugs and polarized plugs required to be achieved by a metal or metal coating that is substantially "white or silver" in color or by the word "white" or the letter "W" located adjacent to the identified terminal

If terminal is not visible, conductor entrance hole for the grounded conductor connection required to be colored "white" or marked with the word "white" or the letter "W"

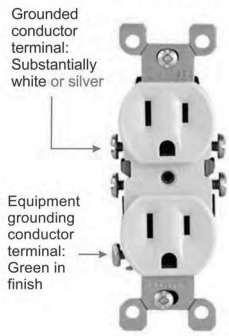
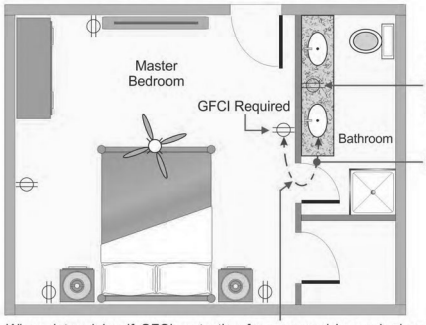


Photo courtesy of Leviton

210.8 Measurements for GFCI Protection

- When determining if GFCI protection is required and a measurement is involved, the distance from a receptacle is required to be measured as the "shortest path" the supply cord of an appliance connected to the receptacle would follow without piercing a floor, wall, ceiling, or fixed barrier, or the shortest path without passing through a ~~door, doorway, or~~ window
- Revision removed "**door**" and "**doorway**" from the list of obstacles that should not be measured through for this *Code* cycle
- A receptacle under the kitchen sink behind cabinet door for the garbage disposer will once again require GFCI protection
- All 125-volt through 250-volt receptacles installed within 1.8 m (6 ft) from the top inside edge of the bowl of a sink requires GFCI protection *(including bedroom receptacles, etc.)*

210.8 Measurements for GFCI Protection



When determining if GFCI protection for personnel is required and a measurement is involved, the distance from a receptacle is required to be measured as the shortest path the supply cord of an appliance connected to the receptacle would follow without piercing a floor, wall, ceiling, or fixed barrier, or the shortest path without passing through a ~~door, doorway, or~~ window *[210.8]*

210.8(A) GFCI Protection for Personnel

- Dwelling unit GFCI protection has been expanded to all **125-volt through 250-volt receptacles** supplied by single-phase branch circuits rated 150 volts or less to ground installed in the specified areas of 210.8(A)
  - *Previously was all **125-volt, single-phase, 15- and 20-ampere receptacles** installed in (10) specific locations (bathrooms, kitchens, laundry areas, etc.)*
- Addition of up to 250-volt receptacles and removing the amperage limitations of **15- and 20-amperes** will provide GFCI protection to most receptacles commonly used in the specified areas of 210.8(A) *(Dryer receptacle, etc.)*
- 250-volt rated receptacles present **similar shock hazards** and substantiation submitted for this change demonstrated the need for GFCI protection for greater the 125-volt rated receptacles
- Similar to 2017 *NEC* changes at 210.8(B)

210.8(A)(5) GFCI in Dwelling Unit Basements

- GFCI protection now required for ***ALL*** dwelling unit basements *(not just unfinished portions of basements)*
- GFCI now required for all 125-volt through 250-volt receptacles in both an **unfinished basement** and a **finished basement** intended as a habitable space
- Includes basements that are finished out to be a habitable room or space such as a bedroom, exercise room, game room, etc.
- Conductive floor surfaces may exist in finished and unfinished basements and basements *(whether finished or unfinished)* are prone to moisture including flooding
- A prevalent moisture hazard exists with a person being in contact with a damp floor, independent of flooring type, and then interacting with the electrical system

210.8(A)(5) GFCI Protection for Basements

All 125-volt through 250-volt receptacles supplied by a single-phase branch circuit rated 150 volts or less to ground installed in any and all dwelling unit basements will require ground-fault circuit-interrupter (GFCI) protection for personnel

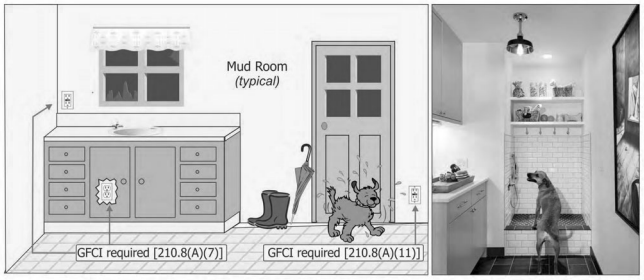
Unfinished Basement

Finished Basement

210.8(A)(11) GFCI for Indoor Damp and Wet Locations

- GFCI protection is now required at **indoor damp and wet locations** of dwelling units
- Covers areas considered a damp or wet location not within 1.8 m (6 ft) of a sink, bathtub, or shower area
- Change will require GFCI protection for all **125-volt through 250-volt receptacles** supplied by a single-phase branch circuit rated 150 volts or less to ground installed in indoor damp or wet locations regardless of the room or areas of the dwelling unit
- Includes areas such as **mud room with no sink** or an indoor area where animals like dogs are washed down

210.8(A)(11) GFCI Protection for Indoor Damp or Wet Locations



All 125-volt through 250-volt receptacles supplied by a single-phase branch circuit rated 150 volts or less to ground installed in indoor damp or wet locations require ground-fault circuit-interrupter (GFCI) protection for personnel

210.8(B) Other Than Dwelling Units

- New GFCI requirements at non-dwelling unit locations were added for:
  - Damp locations
  - Accessory buildings
  - Laundry areas
  - Areas around bathtubs and shower stalls
- **210.8(B)(6):** Indoor "**damp**" location was added to the existing GFCI requirement for indoor wet non-dwelling unit locations for clarity and consistency as shock hazard in a damp location is similar to a wet location
- **210.8(B)(8):** Non-dwelling unit **accessory buildings** added to existing GFCI provisions for garages, service bays, and similar areas *(other than vehicle exhibition halls and showrooms)*

210.8(B) Other Than Dwelling Units *(cont.)*

- **210.8(B)(8)** ***(cont.)*****:** Accessory buildings can have same degree of shock hazard as garages and vehicle service bays and deserved the same level of GFCI protection
- **210.8(B)(11):** GFCI protection added for receptacles installed in **non-dwelling unit laundry areas**
  - Laundry areas at non-dwelling units are similar to laundry areas of a dwelling unit and deserve the same GFCI protection
- **210.8(B)(12):** GFCI protection added for receptacles installed within 1.8 m (6 ft) of the outside edge of **non-dwelling unit bathtubs or shower stalls**
  - Shower stalls and bathtubs can exist in commercial and industrial locations outside of a locker room or bathroom for a variety of purposes such as decontamination, and safety applications

210.8(B) GFCI Protection for Other Than Dwelling Units

New provisions for GFCI protection were added for non-dwelling unit locations for receptacles:

Indoor Damp and Wet Locations

Garages, accessory buildings, and service bays

Laundry areas

Bathtubs and shower stalls

210.8(B)(2) GFCI for Kitchens and More

- Additional language was added to clarify that **areas not defined as a kitchen** with a sink and permanent provisions for either food preparation ***or*** cooking have the same potential for shock hazards as a kitchen
- This would include areas such as:
  - Ice cream parlors
  - Coffee shops
  - Smoothie stores
- These areas typically have stainless steel countertop and/or stainless-steel appliances but no "permanent provisions for cooking"
- These facilities have at least the same potential for shock hazards as a kitchen

210.8(B)(2) GFCI Protection for Kitchens and More

GFCI protection required for all 125-volt through 250-volt receptacles supplied by single-phase branch circuits rated 150 volts or less to ground, 50 amperes or less and all receptacles supplied by three-phase branch circuits rated 150 volts or less to ground, 100 amperes or less installed in areas defined as a "kitchen" and areas with a sink and permanent provisions for *either* food preparation *or* cooking

Coffee Shop
(no permanent provisions for cooking)

Ice Cream Parlor
(no permanent provisions for cooking)

210.8(D) GFCI Protection for Specific Appliances

- New List Item (D) correlates the requirements found in **422.5(B)** ***(Type of GFCI protection for appliances)*** and refers to the list of GFCI requirements for appliances in **422.5(A)**
- Provides continued consistency as the list of appliances requiring GFCI protection is modified in future *Code* editions
- Previous GFCI requirements for dwelling unit **dishwashers** were moved from 210.8(D) to 422.5(A)(7) ***(which now covers all dishwashers)***
- New 210.8(D) attempts to build a bridge for GFCI requirements from 210.8 to 422.5
- Where the appliance is a **vending machine** and GFCI protection is not provided as an integral part of the attachment plug or located within the supply cord not more than 300 mm (12 in.) from the attachment plug, the branch circuit(s) supplying vending machines is required to have GFCI protection

210.8(D) GFCI Protection for Specific Appliances

New text at new 210.8(D) titled, "Specific Appliances" and the move of the GFCI requirement for dishwashers correlates the requirements found in 422.5(B) (Type and Location for GFCI protection for appliances) and refers to the list of appliances requiring GFCI protection in 422.5(A)

Dishwashers GFCI protection was moved from 210.8(D) to 422.5(A)(7)

Vending machine GFCI protection cannot be factory installed within the appliance

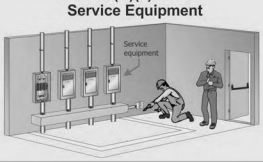
210.8(E) GFCI for Equipment Requiring Servicing

- GFCI protection now required for all **receptacles required by 210.63** for:
  - 210.63(A): HVAC equipment
  - 210.63(B)(1): Indoor service equipment
  - 210.63(B)(2): Indoor equipment requiring dedicated equipment space
- 210.63 expanded for this *Code* cycle
- These receptacles can be located up to 7.5 m (25 ft) away from equipment, use of extension cord is not uncommon *(increasing the likelihood of a shock hazard)*

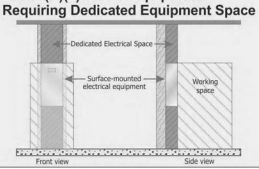
210.8(E) GFCI for Equipment Requiring Servicing

210.63(A) HVAC and Refrigeration Equipment

210.63(B)(1) Indoor Service Equipment



210.63(B)(2) Indoor Equipment Requiring Dedicated Equipment Space



GFCI protection shall be provided for the receptacles required by 210.63

A 125-volt, single-phase, 15- or 20-ampere-rated receptacle outlet shall be installed at an accessible location within 7.5 m (25 ft) of the equipment as specified in 210.63(A) and (B)

210.8(F) GFCI for Outdoor Outlets

- GFCI protection is now required on **dwelling unit outdoor outlets** supplied by single-phase branch circuit rated 150 volts or less to ground, and 50 amperes or less
- This would include 240-volt HVAC unit "outlets"
- **Exemption** provided for branch circuit dedicated to **deicing and snow-melting equipment** and **outdoor lighting outlets** other than those covered in 210.8(C) *(crawl space lighting outlets)*
- Outdoor dwelling unit outlets typically serve loads that are comprised of 240-volt motor driven pumps or compressors that are in operation for many years without maintenance

210.8(F) GFCI Protection For Outdoor Outlets

210.11(C)(3) Bathroom Branch Circuit(s)

- Additional text added clarifies that only **bathroom receptacles** required to be supplied by **20-ampere rated bathroom receptacle outlet branch circuits** are receptacle outlet(s) required by **210.52(D)** and any other receptacles installed in the bathroom that **serve a countertop or work surface**
- 210.52(D) requires at least one receptacle outlet installed within 900 mm (3 ft) of the outside edge of each basin in dwelling unit bathroom
- Previous provisions were being interpreted to mandate any receptacle(s) installed in a dwelling unit bathroom to be supplied by dedicated 20-ampere bathroom receptacle branch circuit *only [even receptacles not required by 210.52(D)]*

210.11(C)(3) Bathroom Branch Circuit(s)

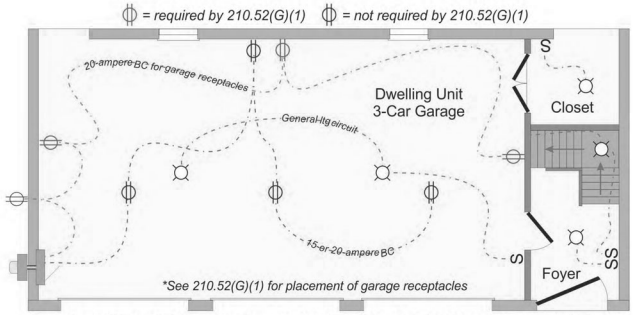
One or more 120-volt, 20-ampere branch circuit required to supply the bathroom(s) receptacle outlet(s) required by 210.52(D) and any countertop and similar work surface receptacle outlets

210.52(D): Receptacle outlet must be located within 900 mm (3 ft) of the outside edge of the basin (sink)

210.11(C)(4) Garage Branch Circuit(s)

- Garage receptacle outlet 120-volt, 20-ampere branch circuits are only required for the receptacles required by **210.52(G)(1)** for attached garages and in detached garages with electric power
- Section **210.52(G)(1)** requires at least one receptacle outlet to be installed in **each vehicle bay** of an attached garage and in each detached garage with electric power, with these required receptacle outlet(s) located not more than 1.7 m (5½ ft) above the floor
- Garage receptacle outlets *NOT* required by 210.52(G)(1) do not have to be supplied by this dedicated 120-volt, 20-ampere branch circuit(s) or even be supplied by a 20-ampere rated branch circuit *(could be a 15-ampere rated branch circuit)*

210.11(C)(4) Garage Branch Circuit(s)



At least one 120-volt, 20-ampere branch circuit shall be installed to supply receptacle outlets required by 210.52(G)(1) in dwelling unit garages *(no other outlets)*

Exception permits supply of readily accessible outdoor receptacle outlets

210.12(C) AFCI for Patient Sleeping Rooms in Nursing Homes and Limited-Care Facilities

- AFCI protection has been expanded to patient sleeping rooms in **nursing homes** and **limited-care facilities**
- AFCI protection was expanded to include **guest rooms and guest suites of hotels and motels** during the 2017 *NEC* revision cycle as these areas are similar to dwelling units
- Similar rooms with comparable uses exist at patient sleeping rooms in nursing homes and limited-care facilities
- AFCI technology will provide same protection from arcing faults to the occupants of these rooms that is afforded occupants of conventional dwelling units and guest rooms and guest suites of hotels and motels

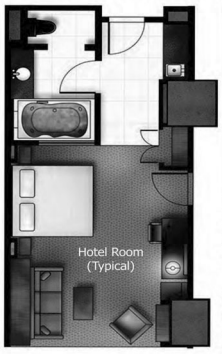
210.12(C) AFCI Protection for Nursing Homes and Limited-Care Facilities

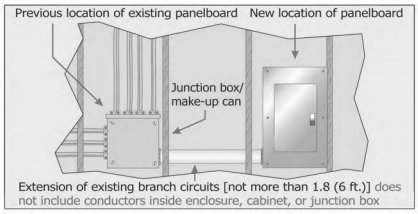
All 120-volt, single-phase, 15- and 20-ampere branch circuits supplying outlets and devices installed in guest rooms and guest suites of hotels and motels and patient sleeping rooms in nursing homes and limited-care facilities are required to AFCI protected

210.12(D) AFCI for Extensions or Modifications at Guest Rooms and Guest Suites

- **Guest rooms and guest suites of hotels and motels** have been added to the areas requiring AFCI protection for **extensions and modifications** of existing occupancies
- AFCI protection is now required at dwelling units, dormitory units, and guest rooms and guest suites of hotels and motels where branch-circuit wiring is **modified, replaced, or extended**
- All these areas are typically used and treated much like a dwelling unit
- By exception, AFCI protection not required for existing branch circuit conductors where extended **not more than 1.8 m (6 ft)** and does not include any additional outlets or devices *(other than splicing devices)*
- This measurement **does not include** the conductors inside an enclosure, cabinet, or junction box

210.12(D) AFCI Protection for Extensions/Modifications of Guest Rooms and Guest Suites of Hotels and Motels





AFCI protection required at dwelling units, dormitory units, and guest rooms and guest suites of hotels and motels where branch-circuit wiring is modified, replaced, or extended

AFCI protection not required where extension of existing branch circuit conductors is not more than 1.8 m (6 ft) in length and does not include any additional outlets or devices (other than splicing devices)

210.15 Reconditioned Equipment

- New section added prohibiting GFCI devices, AFCI devices, and ground-fault protection equipment from being reconditioned
- Several new sections were added throughout the *Code* with permission **for or against** equipment being reconditioned
- Marking requirements for reconditioned, refurbished or remanufactured electrical equipment located at 110.21(A)(2)
- Provisions of new 210.15 is the first of these new statements throughout the *Code* in reference to reconditioned equipment

210.15 Reconditioned Equipment

GFCI **GFCI/AFCI** **GFPE**

The following shall not be reconditioned:

(1) Equipment that provides ground-fault circuit-interrupter (GFCI) protection for personnel

(2) Equipment that provides arc-fault circuit-interrupter (AFCI) protection

(3) Equipment that provides ground-fault protection (GFP) of equipment

Reconditioned Equipment Sections for the 2020 *NEC*

Code Section	CMP	Equipment	Yes/No	SR/PC
210.15	CMP-2	GFCI devices, AFCI devices, and GFP equipment	No	SR 7657
240.62	CMP-10	Low-voltage fuseholders and low-voltage nonrenewable fuses	No	SR 7974, PC 981
240.88(A)(1)	CMP-10	Molded-case circuit breakers	No	DSR 8011, PC 980
240.88(A)(2)	CMP-10	Low- and medium-voltage power circuit breakers	Yes	DSR 8011, PC 980
240.88(A)(3)	CMP-10	High-voltage circuit breakers	Yes	DSR 8011, PC 980
240.88(B)(1)	CMP-10	Low-voltage power circuit breaker electronic trip units	No	DSR 8011, PC 980
240.88(B)(2)	CMP-10	Electromechanical protective relays and current transformers	Yes	DSR 8011, PC 980
240.102	CMP-10	Medium-voltage fuseholders and medium-voltage nonrenewable fuses	No	SR 8048, PC 982
406.3(A)	CMP-18	Receptacles	No	SR 8187
406.7	CMP-18	Attachment plugs, cord connectors, and flanged surface devices	No	SR 8189

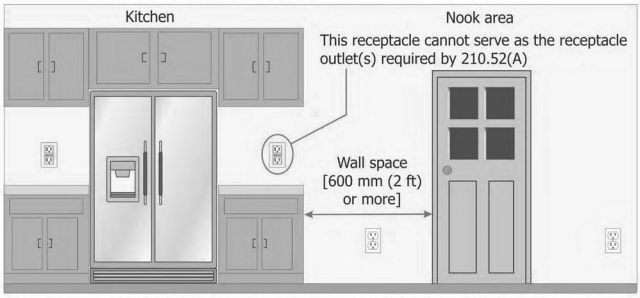
Reconditioned Equipment Sections for the 2020 *NEC*

Code Section	CMP	Equipment	Yes/No	SR/PC
408.8(A)	CMP-9	Panelboards	No	SR 8172, PC 987
408.8(B)	CMP-9	Switchboards and switchgear, or sections of switchboards or switchgear	Yes	SR 8172, PC 987
410.7	CMP-18	Luminaires, lampholders, and retrofit kits	No	SR 8162
411.4	CMP-18	Listed low-voltage lighting systems or a lighting system assembled from listed parts	No	SR 8164
490.49	CMP-9	Switchgear, or sections of switchgear	Yes	SR 8222
695.10	CMP-13	Fire pump controllers and transfer switches	No	SR 7522, PC 983
700.5(C)	CMP-13	Automatic transfer switches (Emergency Systems)	No	SR7584, PC 984
701.5(C)	CMP-13	Automatic transfer switches (Legally Required Standby Systems)	No	SR 7586, PC 985
702.5	CMP-13	Transfer switches (Optional Standby Systems)	No	SR 7588, PC 986
708.24	CMP-13	Transfer equipment (Critical Operations Power Systems)	No	Sr 7517
800.3(G)	CMP-16	Communication equipment [*must comply with 110.21(A)(2)]	Yes*	SR 7509

210.52(C) Receptacles at Countertops and Work Surfaces

- Revision clarifies that the receptacle outlets installed for countertop or work surfaces [210.52(C)] are **not permitted** to satisfy the requirement for receptacle outlet placement ***(wall spacing)*** as provided in 210.52(A)
- Section 210.52(A) pertains to the "no point measured horizontally along the floor line of any wall space is more than 1.8 m (6 ft) from a receptacle outlet" wall spacing rule
- Receptacle outlets installed to serve the countertops and work surfaces in kitchens, pantries, breakfast rooms, dining rooms, and similar areas cannot be considered as the receptacle outlets required by 210.52(A)

210.52(C) Countertops and Work Surfaces



In kitchens, pantries, breakfast rooms, dining rooms, and similar areas of dwelling units, receptacle outlets for countertop and work surfaces [300 mm (12 in.) or wider] shall be installed in accordance with 210.52(C)(1) through (C)(3)

Countertop receptacles shall not be considered as the receptacle outlets required by 210.52(A)

210.52(C)(2) Receptacles at Island and Peninsular Countertops

- For island and peninsular countertop and work surfaces, the horizontal measurement was replaced with a **square foot calculation** to determine the number of receptacles required
- Previously, a measurement was required across the countertop with at least one receptacle required to be installed at each island countertop space or peninsular countertop space with a long dimension of **600 mm (24 in.)** or greater and a short dimension of **300 mm (12 in.)** or greater
- Historically, **only one receptacle outlet** has been required at an island and peninsular countertops regardless of the size of that island or peninsular
- Changes to this section will required **more than one receptacle outlet** at larger kitchen islands and peninsulas

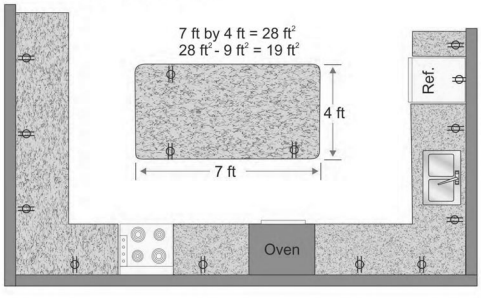
210.52(C)(2) Receptacles at Island and Peninsular Countertops *(cont.)*

- At least one receptacle is required to be provided for the **first 0.84 m² (9 ft²)**, **or fraction thereof**, of the countertop or work surface
- An additional receptacle outlet is required for every **additional 1.7 m² (18 ft²)**, **or fraction thereof**, of the countertop or work surface
- At least one receptacle outlet must be located **within 600 mm (2 ft)** of the outer end of a peninsular countertop or work surface
- A peninsular countertop measurements are taken from the **connected perpendicular wall** *(see TIA Log No. 1442)*

210.52(C)(2) Island and Peninsulars

At least one receptacle outlet shall be provided for the first 0.84 m^2 (9 ft^2), or fraction thereof, of the countertop or work surface

A receptacle outlet shall be provided for every additional 1.7 m^2 (18 ft^2), or fraction thereof, of the countertop or work surface

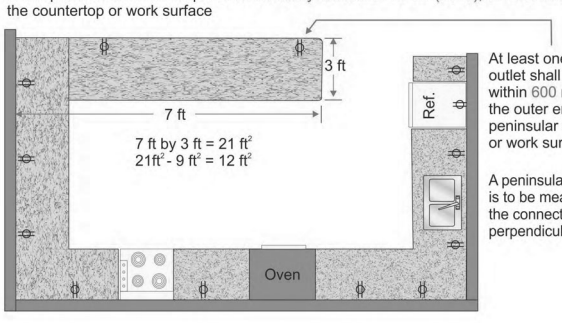


At least one receptacle outlet shall be located within 600 mm (2 ft) of the outer end of a peninsular countertop or work surface

210.52(C)(2) Island and Peninsulars

At least one receptacle outlet shall be provided for the first 0.84 m^2 (9 ft^2), or fraction thereof, of the countertop or work surface

A receptacle outlet shall be provided for every additional 1.7 m^2 (18 ft^2), or fraction thereof, of the countertop or work surface



At least one receptacle outlet shall be located within 600 mm (2 ft) of the outer end of a peninsular countertop or work surface

A peninsular countertop is to be measured from the connected perpendicular wall

210.52(C)(2) Island and Peninsulas

Examples of Minimum Number of Receptacle Outlets Required

Total Square Footage of Countertop	Minimum No. of Receptacle Outlets
8 sq. ft.	1
9 sq. ft.	1
More than 9 sq. ft. up to 27 sq. ft. [9 sq. ft. + 18 sq. ft. = 27 sq. ft.]	2
28 sq. ft. [first 9 sq. ft. (one), additional 18 sq. ft. (one) and addition fraction there of (1 sq. ft.) (one)]	3
48 sq. ft. [48 sq. ft. - 9 sq. ft. = 39 sq. ft.] [39 sq. ft. ÷ 18 sq. ft. = 2.17 sq. ft.]	4

210.52(C)(2)(a) Island and Peninsular Countertops and Work Surfaces

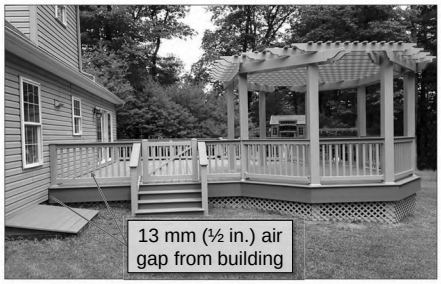
At least one receptacle outlet shall be provided for the first 0.84 m^2 (9 ft^2), or fraction thereof, of the countertop or work surface.

A receptacle outlet shall be provided for every additional 1.7 m^2 (18 ft^2), or fraction thereof, of the countertop or work surface.

210.52(E)(3) Receptacles at Balconies, Decks, and Porches

- The required receptacle outlet for balconies, decks, and porches is also required at decks that are installed in a **freestanding manner** where connection to the actual dwelling is not made at any point
- At least one 125-volt, 15- or 20-ampere receptacle outlet is required to be installed at every dwelling unit balcony, deck, or porch
- Many decks are installed in a cantilevered manor where connection to the actual dwelling unit building is not made at any point *(leaving an air gap to promote drainage and prevent wood decay)*
- Previous text would suggest that a receptacle is not required at this type of deck as it is technically "unattached"
- At least one receptacle outlet *(accessible from the balcony, deck, or porch)* on any balcony, deck, or porch is now required for decks that are **within 102 mm (4 in.) horizontally** of the dwelling unit

210.52(E)(3) Balconies, Decks, and Porches



At least one 125-volt, 15- or 20-ampere receptacle outlet required to be provide for all balconies, decks, and porches that are constructed within 102 mm (4 in.) horizontally of the dwelling unit

Receptacle must be located in an accessible location from the balcony, deck, or porch and not more than 2.0 m (6½ ft) above the balcony, deck, or porch walking surface

210.65 Receptacles for Meeting Rooms

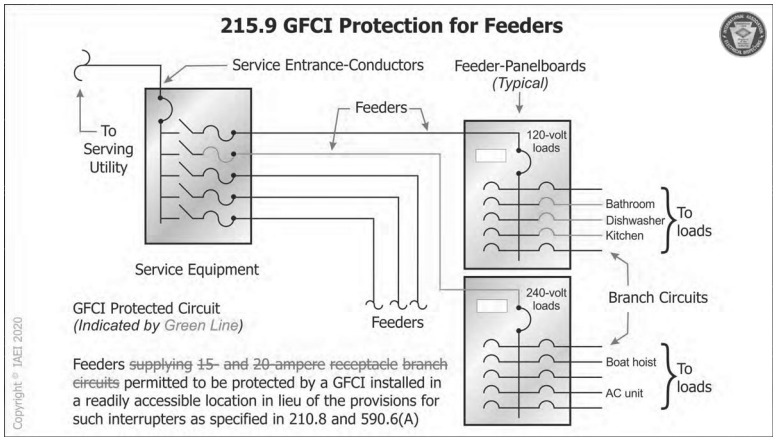
- Meeting room receptacle outlet rules received revisions and a new home at **210.65** rather than its original location at 210.71
- 210.65 provides a **better location** with other requirements for receptacle outlets for usability and uniform numbering
- Previous language at 210.71(B)(2) for floor receptacle outlets could have been interpreted to only apply to a **square or rectangle-shaped meeting rooms**
- What about a **round-shaped meeting room**?
- Revisions to 210.65(B)(2) clarifies length versus width concerns while addressing **non-rectangular meeting rooms**, such as those that are round
- Floor outlets now applies to a meeting room "**with any floor dimension**" that is 3.7 m (12 ft) or greater "**in any direction**"

210.65 Receptacles for Meeting Rooms *(cont.)*

- These revisions also allow a floor receptacle outlet *(as previously required)* or a **floor outlet to serve receptacle(s)** to accommodate hardwired desk or furniture that could have **built-in receptacle outlets**
- Requirement for at least one floor receptacle outlet, or floor outlet to serve receptacle(s), located at a distance **not less than 1.8 m (6 ft)** from any fixed wall allows for **emergency entrance/egress** to and from these meeting rooms without having to maneuver around and over extension cords and flexible powers cords for laptop computers and the like

215.9 GFCI Protection for Feeders

- Revision provides correlation with GFCI protection requirements in **210.8** by **removing** the existing limitations of a feeder to provide GFCI protection to only **15 and 20-ampere receptacle branch circuits**
- Feeders are now permitted to be protected by a ground-fault circuit interrupter (GFCI) installed in a readily accessible location which will also provide the necessary GFCI protection to any branch circuit in lieu of the provisions for such interrupters as specified in 210.8 *(GFCI protection for personnel)* and 590.6(A) *(GFCI protection for personnel for temporary wiring installations)*
- GFCI requirement at **210.8(A)** now include receptacle outlets rated **125-volt through 250-volt**
- **210.8(B)** include all 125-volt through 250-volt receptacles supplied by single-phase branch circuits rated 150 volts or less to ground, 50 amperes or less, and all receptacles supplied by three-phase branch circuits rated 150 volts or less to ground, 100 amperes or less



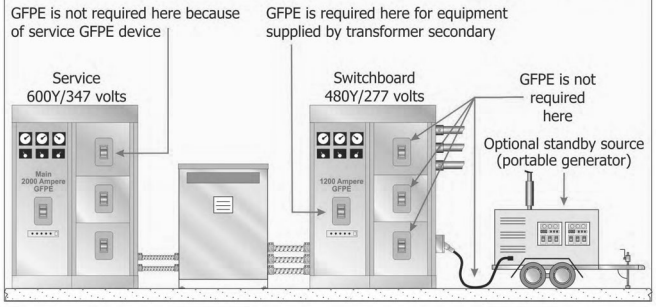
215.10, Ex. No. 3 GFP for Feeders

- New exception added to permit **temporary feeders** to be used during repair, maintenance or emergencies **without GFP of equipment**
- Time period permitted for these temporary feeders **not to exceed 90 days**
- GFP of equipment is required for each feeder disconnect rated 1000 amperes or more and installed on solidly grounded wye electrical systems of more than 150 volts to ground *(not exceeding 600 volts phase-to-phase)*
- Without this exception, the use of temporary feeders during repair, maintenance, or emergencies may present difficulties in achieving the required GFP protection
- **Example:** Portable generator connected to a facility electrical system during a loss of power due to power failure or maintenance activity

215.10 Ex. No. 3 GFP for Feeders

Ground-fault protection (GFP) for equipment not required for temporary feeder conductors that are used to connect a generator to a facility for repair, maintenance, or emergencies

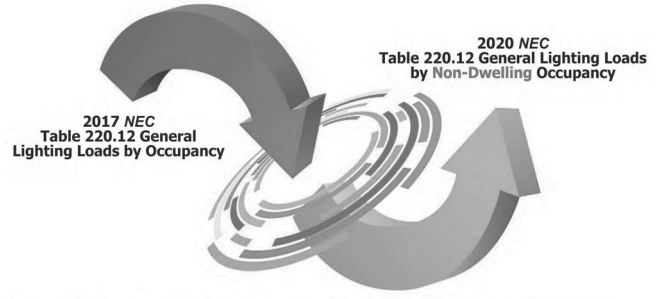
Temporary feeders only permitted for the time period necessary but cannot exceed 90 days



220.12 Lighting Load for Specified Non-Dwelling Occupancies

- Section 220.12 and Table 220.12 has been **extensively revised**
- General lighting load values for specific occupancies at Table 220.12 have received very **minimal revisions since the 1971 edition of the *NEC***
- **Reduced lighting loads** in most occupancies was achieved
- Aligns Table 220.12 with those occupancies found in **ASHRAE 90.1-2016** *(Energy Standard for Buildings Except Low-Rise Residential Buildings)* and the International Energy Conservation Code
- Dwelling and multi-family dwelling units were moved out of Table 220.12 and referenced in revised **220.14(J)**

Table 220.12 General Lighting Loads by Non-Dwelling Occupancy



Section 220.12 and Table 220.12 has been extensively revised - Reduced lighting loads in most occupancies was achieved - Dwelling and multi-family dwelling units were moved out of Table 220.12 and referenced in revised 220.14(J)

Table 220.12 General Lighting Loads by Non-Dwelling Occupancy *(Part 1)*

Type of Occupancy	Unit Load Volt-amperes/m^2	Unit Load Volt-amperes/ft^2
Automotive facility	16	1.5
Convention Center	15	1.4
Courthouse *(was Courtrooms)*	15 ~~22~~	1.4 ~~2.0~~
Dormitory	16	1.5
Exercise center	15	1.4
Fire station	14	1.3
Gymnasium[a] *(was Armories and auditoriums)*	~~18~~ ~~11~~	1.7 ~~1.0~~
Health care clinic *(was Hospitals)*	17 ~~22~~	1.6 ~~2.0~~
Hospital	17	1.6
Hotels and motels, including apartment houses without provisions for cooking by tenants[b]	18 ~~22~~	1.7 ~~2.0~~
Library	16	1.5
Manufacturing facility[c] *(was Industrial commercial (loft) bldg)*	24 ~~22~~	2.2 ~~2.0~~
Motion picture theater	17	1.6
Museum	17	1.6
Office[d] *(was Office buildings)*	14 ~~39~~	1.3 ~~3.5~~

Table 220.12 General Lighting Loads by Non-Dwelling Occupancy *(Part 2)*

Type of Occupancy	Unit Load Volt-amperes/m^2	Unit Load Volt-amperes/ft^2
Parking garage[e] *[was Garages-commercial (storage)]*	3 ~~6~~	0.3 ~~0.5~~
Penitentiary	13	1.2
Performing arts theater	16	1.5
Police station	14	1.3
Post office	17	1.6
Religious facility *(was Churches)*	24 ~~11~~	2.2 ~~1.0~~
Restaurant[f] *(was Restaurants and Clubs)*	16 ~~22~~	1.5 ~~2.0~~
Retail[g, h] *(was Barber shops and beauty parlors and Stores)*	20 ~~33~~	1.9 ~~3.0~~
School/university *(was Schools)*	33	3.0
Sports arena	33	3.0
Town hall	15	1.4
Transportation	13	1.2
Warehouse	13 ~~3~~	1.2 ~~0.25~~
Workshop	18	1.7

Table 220.12 General Lighting Loads by Non-Dwelling Occupancy *(Part 3)*

Type of Occupancy	Unit Load Volt-amperes/m^2	Unit Load Volt-amperes/ft^2
(Note at bottom of table)		

Note: The 125 percent multiplier for a continuous load as specified in 210.20(A) is included when using the unit loads in this table for calculating the minimum lighting load for a specified occupancy.

[a]Armories and auditoriums are considered gymnasium-type occupancies.

[b]Lodge rooms are similar to hotels and motels.

[c]Industrial commercial loft buildings are considered manufacturing-type occupancies.

[d]Banks are office-type occupancies.

[e]Garages — commercial (storage) are considered parking garage occupancies.

[f]Clubs are considered restaurant occupancies.

[g]Barber shops and beauty parlors are considered retail occupancies.

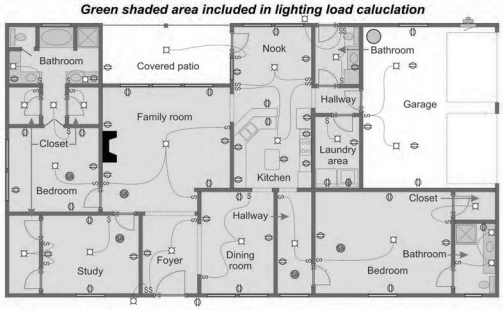
[h]Stores are considered retail occupancies.

220.14(J) and 220.11
Lighting Loads for Dwelling Units

- *NEC* calculation of **3.0 watts per square foot** for dwelling units was moved from Table 220.12 to **220.14(J)** and reference to Table 220.12 was removed from 220.14(J)
- Table 220.12 revised to only addresses non-dwelling unit *occupancies*
- New sentence added to address **motors rated less than 1/8 HP** and connected to a lighting circuit *(small motor loads will now be included in the general lighting load)*
- References to "**guest rooms or guest suites of hotels and motels**" removed and relocated to new **220.14(M)**
- Long-standing requirement for calculating the floor area of a dwelling unit to not include **open porches, garages, or unused or unfinished spaces** not adaptable for future use has been relocated from 220.12 to a **new 220.11**

220.14(J) and 220.11 Lighting Loads for Dwellings

Green shaded area included in lighting load caluclation



Calculation of general-purpose branch circuits is determined by using a unit load of 3 volt-amperes (watts) per square foot for dwelling units *[Moved from Table 220.12 to 220.14(J)]*

For dwelling units, the calculated floor area shall not include open porches, garages, or unused or unfinished spaces not adaptable for future use *[Relocated from 220.12 to new 220.11]*

220.14(J) and 220.11 Lighting Loads for Dwellings

Floor Area x 3 VA / 120 Volts = Amperes (General Purpose Lighting)

Amperes, Gen. Purpose Lighting / 15 or 20 Amp Circuits = Min. Number of Circuits

2800 sq. ft. x 3 VA (8400 VA) / 120 Volts = 70.0 Amperes

70.0 Amperes / 15 or 20 Ampere Circuits = (4.66) 5 – 15 Ampere Circuits or (3.50) 4 – 20 Ampere Circuits

Calculation of general-purpose branch circuits is determined by using a unit load of 3 volt-amperes (watts) per square foot for dwelling units *[Moved from Table 220.12 to 220.14(J)]*

For dwelling units, the calculated floor area shall not include open porches, garages, or unused or unfinished spaces not adaptable for future use *[Relocated from 220.12 to new 220.11]*

Copyright © IAEI 2020

220.42 General Lighting

- Demand factors for derating feeder and service conductors in **hospitals** were deleted
  - Now required to include **100% of total VA** of the calculated lighting load
- Demand factors for feeder and service conductors in **hotels, motels and apartment houses** without provision for cooking, were increased to correlate with revisions in Table 220.12
- **Table 220.42** still applies a demand factor to lighting loads at dwelling units, hotels and motels, and warehouses with all other occupancies required to include **100% of the total volt-amperes (VA)** of the lighting load

Table 220.42 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
~~Hospitals~~	~~First 50,000 at~~	~~40~~
	~~Remainder over 50,000 at~~	~~20~~
Hotels and Motels, (including apartment houses without provisions for cooking by tenants)*	First 20,000 at	60 ~~50~~
	From 20,001 to 100,000 at	50 ~~40~~
	Remainder over 100,000 at	35 ~~30~~
Warehouses (storage)	First 12,500 or less at	100
	Remainder over 12,500 at	50
All Others	Total volt-amperes	100

*The demand factors of this table shall not apply to the calculated load of feeders or services supplying areas in ~~hospitals,~~ hotels and motels where the entire lighting is likely to be used at one time, as in ~~operating rooms,~~ ballrooms or dining rooms.

220.53 Appliance Load - Dwelling Unit(s)

- **All fastened in place household electric cooking equipment** *(not just an electric range)* added to the list of appliances that cannot be included in the **four or more appliances** eligible for **75% derating demand factor**
- Previously permitted to apply demand factor of **75%** to nameplate rating load of **four or more appliances fastened in place** *(other than electric ranges, clothes dryers, space-heating equipment or air-conditioning equipment)*
- Appliances rated **¼ hp or greater**, or **500 watts or greater**, that are fastened in place is now the benchmark for appliances that can be included in this 75% derating rule
- This will eliminate typical bathroom exhaust fan from this derating

220.53 Appliance Load - Dwelling Unit(s)

STANDARD LOAD CALCULATION

Appliances	Quantity	VA Ungrnd	VA Neutral
Dishwasher	1	1,500	1,500
Disposal (½ hp motor)	1	1,176	1,176
Compactor	1	600	600
~~Exhaust Fans (120 VA each)~~	~~2~~	~~240~~	~~240~~
Water Heaters (4,500 VA each)	2	9,000	
Totals	**5**	**12,276**	**3,276**
4 or more Appliances Total at 75%		**9,207**	**2,457**

A demand factor of 75 percent can be applied to the nameplate rating load of four or more appliances rated ¼ 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.

This demand factor cannot be apply to:

(1) Household electric cooking equipment that are fastened in place *(was electric ranges)*

(2) Clothes dryers

(3) Space heating equipment

(4) Air-conditioning equipment

225.30(B) Number of Supplies (Feeders) Common Supply Equipment

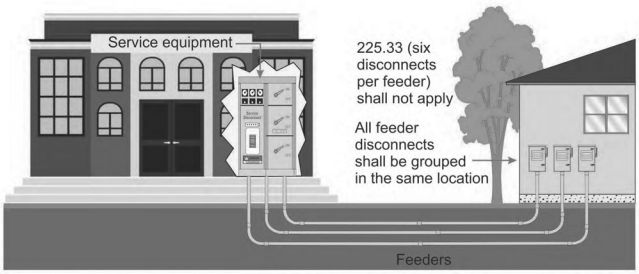
- New text added permitting **more than one feeder** *(up to six feeders)* under very limited circumstances
- Building or other structure served by an outside feeder **previously** permitted to be supplied by **only one feeder** *[unless another feeder (or branch circuit) was permitted by "special conditions" of previous 225.30(A) through (E)]*
- 225.30 "**special conditions**" can include such equipment as fire pumps, emergency systems, legally required standby systems, optional standby systems, parallel power production system
- AHJ can grant "**special permission**" for additional feeders or branch circuits for multiple-occupancy buildings where there is no space available for supply equipment accessible to all occupants or a single building or other structure "**sufficiently large**" enough to make two or more supplies essential
- "**Special conditions**" can also exist where different voltages, frequencies, or phases are involved

225.30(B) Number of Supplies (Feeders) Common Supply Equipment *(cont.)*

- New text added permitting **more than one feeder** *(up to six feeders)* under very limited circumstances *(cont.)*
- New 225.30(B) will permit **up to six feeders** to supply a building or structure under the following conditions:
  - (1) Each feeder must **originate in the same panelboard, switchboard or other distribution equipment**
  - (2) Each feeder must **terminate in a single disconnecting means**
  - (3) Where more than one feeder is installed, all feeder disconnects supplied are required to be **grouped in the same location**
  - (4) Each disconnect must be **marked to indicate the load served**
- Feeders have the added benefit of overcurrent and short circuit protection and should not be afforded the same requirements as service conductors

225.30(B) Common Supply Equipment (Feeders)

Feeders are generally limited to one feeder on the load side of the service equipment per building or structure *[see permissive conditions at 225.30(A) through (F)]*



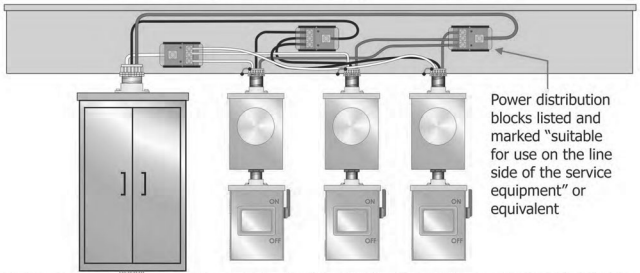
New provisions added to allow up to six feeders originating in the same panelboard, switchboard, or other distribution equipment, with each feeder terminating in a single disconnecting means

Each disconnect to be marked to indicate the load served

230.46 Splices and Tapped Conductors

- The requirement for **marking power distribution blocks** used on service conductors required to be marked "**suitable for use on the line side of the service equipment**" or equivalent was moved from 314.28(E)(1) to 230.46
- All power distribution blocks, pressure connectors, and devices for splices and taps of service conductors must be listed
- Effective **January 1, 2023**, pressure connectors and devices for splices and taps on service conductors must be marked as **suitable for use on the line side of service equipment**

230.46 Spliced and Tapped Conductors



Service-entrance conductors permitted to be spliced or tapped in accordance with 110.14, 300.5(E), 300.13, and 300.15 with power distribution blocks (PDB), pressure connectors, and devices for splices and taps required to be listed

PDBs installed on service conductors required to be marked "suitable for use on the line side of the service equipment" or equivalent with all devices used to splice service conductors required to be marked in this manner effective January 1, 2023

230.62(C) Barriers

- Previous provision for **barriers** at service panelboards, switchboards, and switchgear has been moved to Article 230 to apply to all service equipment
- Previous barrier requirements of **408.3(A)(2)** were relocated and expanded in new **230.62(C)**
- **All service equipment** is now required to be provided with **barriers** to prevent line side inadvertent contact
- This includes but is not limited to panelboards, switchboards, switchgear, motor control centers, individual circuit breaker enclosures, SUSE rated transfer switches and fused disconnects

230.62(C) Service Equipment - Barriers

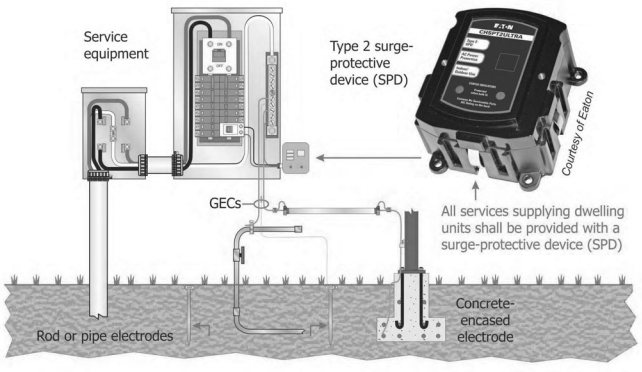
Barriers required to be placed in all service equipment such that no uninsulated, ungrounded service busbar or service terminal is exposed to inadvertent contact by persons or maintenance equipment while servicing load terminations

Service Panelboard | Transfer switches marked suitable for use as service equipment | Motor control center marked suitable for use as service equipment

230.67 Surge Protection

- New requirement added for **surge protection** on all **services at dwelling units**
- The surge protection device (SPD) must be an **integral part of the service equipment** or **located immediately adjacent to the service equipment**
- Exception permits alternate location provided an SPD is located at **each next level distribution equipment** downstream toward the load
- This SPD required to be either a **Type 1** or **Type 2** SPD
- Applies to **replacement** of residential service equipment as well

230.67 Surge Protection for Dwelling Units



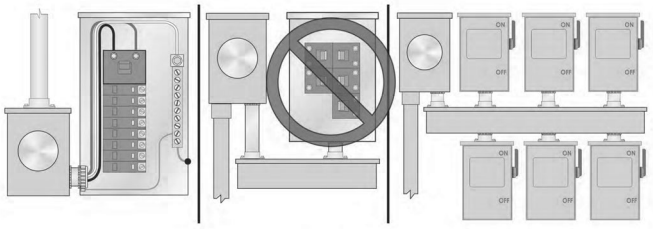
230.71 Maximum Number of Disconnects

- Revision **eliminates** more than one service disconnecting means in the **same panelboard or other enclosure**
- Continues to retain the **six service disconnect rule** for services with the up to six service disconnects required to be installed in **separate enclosures only**
- Previous provisions permitted service disconnecting mean(s) to consist of **not more than six** switches or sets of circuit breakers mounted in a **single enclosure** or in a group of **separate enclosures**
- Revision takes into consideration the challenges created for electrical workers when encountering a panelboard with more than one service disconnecting means in the same enclosure

230.71 Maximum Number of Disconnects *(cont.)*

- A **single service disconnect** within service equipment provides additional protection from electric shock hazards where **barriers are in place** over the exposed energized conductors/terminals to **eliminate any live exposed parts**
- Barriers required to be provided to eliminate live exposed parts for switchboards, switchgear and panelboards in accordance with **230.62(C)** *[was 408.3(A)(2)]*

230.71(A) and (B) Maximum Number of Disconnects



Service disconnecting means can be any of the following:

- A single "main" or...
- ~~Up to six grouped in a single enclosure~~ or...
- Up to six separate enclosures grouped in the same location or...
- In or on a switchboard or in switchgear *(see conditions)*

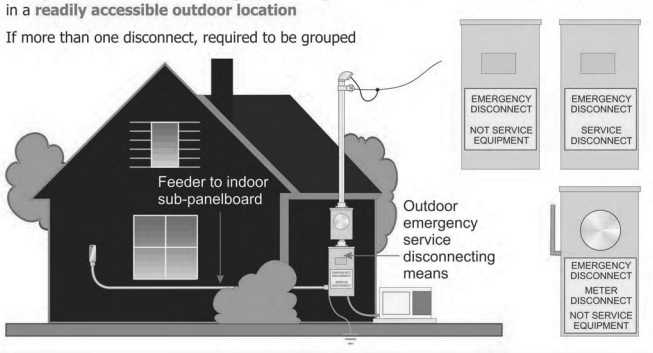
230.85 Emergency Disconnects

- New requirement added requiring an **emergency disconnect** at a **readily accessible <u>outdoor</u> location** for dwelling units
- New outdoor emergency disconnecting requirement primarily based upon providing **first responders** an outdoor accessible emergency or service disconnecting means during an **emergency situation** such as a fire, gas leak, structural damage, flooding, etc.
- Access service disconnecting means for first responders is very challenging when the service disconnect is installed in an indoor location of a dwelling unit area such as a basement
- Requiring first responders to enter a potentially hazardous environment *(such as a burning building)* to find and then activate the service disconnect(s) is not a safe practice

230.85 Exterior Emergency Disconnect(s) for Dwelling Units

All one- and two-family dwelling unit service conductors shall terminate in disconnecting means having a short-circuit current rating equal to or greater than the available fault current, installed in a **readily accessible outdoor location**

If more than one disconnect, required to be grouped



230.85 Exterior Emergency Disconnect(s) for Dwelling Units

All one- and two-family dwelling unit service conductors shall terminate in disconnecting means installed in a **readily accessible outdoor location** *(grouped if more than one disconnect)*

Each disconnect shall be one of the following:

1. Service disconnects marked as follows: EMERGENCY DISCONNECT, SERVICE DISCONNECT
2. Meter disconnects installed per 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 suitable for use as service equipment and marked as follows: EMERGENCY DISCONNECT, NOT SERVICE EQUIPMENT

240.6(C) Restricted Access Adjustable-Trip Circuit Breakers

- New provision added to recognize **modern electronic trip units** provided with a **password** to keep unauthorized users from changing the settings on a restricted access adjustable-trip circuit breaker(s)
- Adjustable settings on an adjustable-trip circuit breaker needs to be protected from **inadvertent settings** out of the desired operational settings, such as **restricted access** to the adjusting means
- Previously, restricted access could be achieved by locating an adjustable-trip circuit breaker behind one of three methods:
  - Behind removable and sealable covers
  - Behind bolted equipment enclosure doors
  - Behind locked doors accessible only to qualified persons

240.6(C) Restricted Access Adjustable-Trip Circuit Breakers *(cont.)*

- New provision added to recognize **modern electronic trip units** provided with a **password** to keep unauthorized users from changing the settings on a restricted access adjustable-trip circuit breaker(s) *(cont.)*
- Forth option added pertaining to **password protected** adjustable-trip circuit breaker, with password **accessible only to qualified personnel**
- Fully programmable models offered that enable ultimate customization and flexibility
- Equipped with the latest microprocessor technology with advanced algorithms that notify maintenance personnel when the power distribution system needs to be maintained or replaced
- Has the ability to accurately measure energy consumption with no additional meters or equipment

240.6(C) Restricted Access Adjustable-Trip Circuit Breakers

Courtesy of Eaton

Restricted access shall be achieved by one of the following methods:

(1) Located behind removable and sealable covers over the adjusting means

(2) Located behind bolted equipment enclosure doors

(3) Located behind locked doors accessible only to qualified personnel

(4) Password protected, with password accessible only to qualified personnel

240.87 Arc Energy Reduction

- An instantaneous trip setting that is less than the available arcing current is one of seven methods recognized to achieve **arc energy reduction**
- Revision to **240.87(B)(5)** clarifies that **temporary adjustment** of the instantaneous trip setting to achieve arc energy reduction **shall not be permitted**
- Arc energy reduction is designed to limit the arc-flash energy to which electrical workers or maintenance personnel could be exposed when working on the load side of an overcurrent devices that is rated or can be adjusted to **1200 amperes or higher**
- The incident energy in an arcing event is directly proportional to the time frame a fault will be permitted to persist on the electrical system

240.87 Arc Energy Reduction *(cont.)*

- The **final setting** of the instantaneous trip is what determines whether or not additional arc energy reduction techniques are required
- Not the intention of this requirement that the **minimum setting** of the instantaneous trip *(as is typically shipped from the factory)* be the determining factor on whether or not additional arc energy reduction is necessary
- **Final setting** as determined by the electrical system requirements such as **inrush characteristics** or **selective coordination** is determining factor
- Arc energy reduction is **not achieved** with an instantaneous trip being **adjusted to a lower setting** while a worker is working on the equipment, and then adjusted back to the desired setting after the work is complete

240.87 Arc Energy Reduction

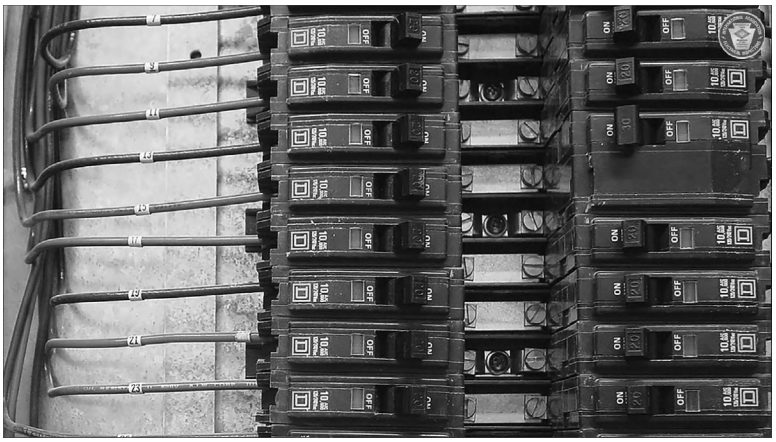
An instantaneous trip setting that is less than the available arcing current is one of seven methods recognized to achieve arc energy reduction

Courtesy of Eaton Corporation

Temporary adjustment of the instantaneous trip setting to achieve arc energy reduction does not satisfy this requirement

240.88 Reconditioned Equipment

- New section added dealing with reconditioned equipment to indicate that **molded-case circuit breakers** shall not be permitted to be reconditioned
- Each Code Making Panel (CMP) was asked to review the equipment they have purview over and determine what equipment could be reconditioned and what equipment could not be reconditioned but rather replaced when necessary
- Molded-case circuit breakers and low-voltage power circuit breaker electronic trip units cannot be reconditioned
- Low- and medium-voltage power circuit breakers, high-voltage circuit breakers, electromechanical protective relays, and current transformers **can be reconditioned**
- Marking requirement for reconditioned equipment located at **110.21(A)(2)**



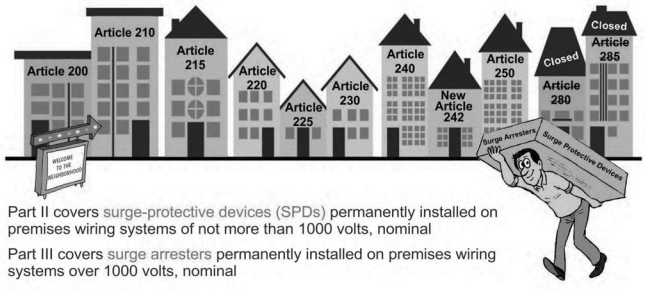
Article 242 Overvoltage Protection (New)

- New article added to provide the general, installation, and connection requirements for **overvoltage protection** and **overvoltage protective devices** for clarity and usability
- Relocates previous **Articles 280** (Surge Arresters, Over 1000 Volts) and **285** (Surge-Protective Devices, 1000 Volts or Less) into a new Article 242
- More appropriately located immediately following Article 240 for overcurrent protection
- Combining previous Articles 280 and 285 in a style similar to that of Article 240 significantly improve clarity and usability

Article 242 Overvoltage Protection

New Article 242 added to provide the general, installation, and connection requirements for overvoltage protection and overvoltage protective devices

Relocates previous Articles 280 and 285 into a new Article 242



Part II covers surge-protective devices (SPDs) permanently installed on premises wiring systems of not more than 1000 volts, nominal

Part III covers surge arresters permanently installed on premises wiring systems over 1000 volts, nominal

250.25 Grounding Systems Permitted to Be Connected on the Supply Side Service Disconnect

- **New section** created to cover the requirements for grounding of supply-side disconnects permitted to be connected on the supply-side of a service
- Points user of the Code to **250.24** *(Grounding Service-Supplied Alternating-Current Systems)* for the grounding and bonding requirements for these supply-side disconnects
- **230.82** lists eleven specific items that the *Code* permits to be installed ahead of or on the line side of a service disconnecting means
- Grounding of systems such as solar, wind, fuel cells, and interconnected power production systems were not covered in detail when connected on the line side of a service disconnect

250.25 Grounding Systems Permitted to Be Connected on the Supply Side Service Disconnect

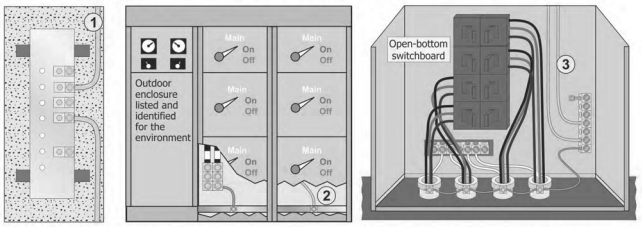
- As more and more renewable and interconnected power production sources are connected to the serving utility directly, the need for prescriptive grounding and bonding requirements for these alternative sources is even more critical
- When this equipment is installed in another enclosure and identified as not being "service equipment," requirements need to be provided on how to properly accomplish the grounding and bonding of these installations
- Since the idea is to generally treat the installation like a service *(but not call it a service)*, pointing both the installer and enforcer to the same requirements as used for the service equipment, provides the direction and a consistent installation needed

250.25 Grounding Systems Permitted to be Connected on the Supply Side of the Disconnect

250.64(A) Aluminum or Copper-Clad Aluminum GECs

- 250.64(A) formatted into a **list format** for improved clarity and usability
- Clarifies that terminations for **aluminum or copper-clad aluminum** grounding electrode conductors (GEC) located in the **interior of equipment "listed and identified for the environment"** are separated from the earth and **can be terminated** within 450 mm (18 in.) of the earth
- Section was divided into **three distinctive parts** to better distinguish what type of bare, covered, or insulated aluminum or copper-clad aluminum GECs can or cannot be terminated **within 450 mm (18 in.) of the earth**, or be installed **where subject to corrosive conditions**, or be installed **in direct contact with concrete**
- Similar changes occurred at **250.120(B)** for terminating aluminum or copper-clad aluminum EGCs within 450 mm (18 in.) of the earth

250.64(A) Aluminum or Copper-Clad Aluminum GECs

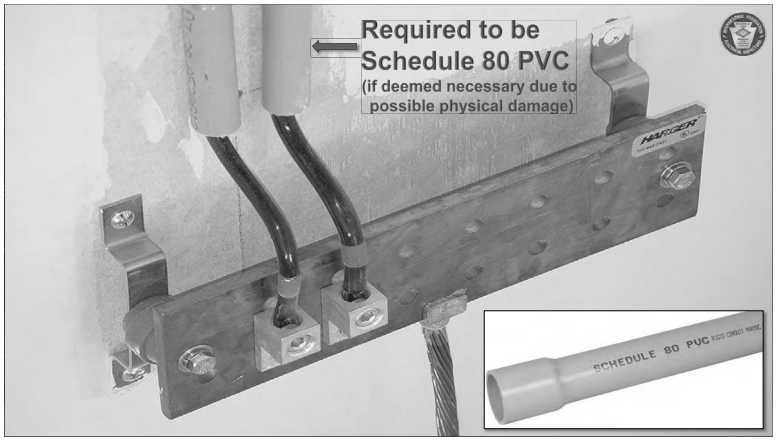


Grounding electrode conductors (GEC) of bare, covered, or insulated aluminum or copper-clad aluminum shall comply with the following:

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

250.64(B)(2) and (B)(3) GEC Installations Exposed to Physical Damage

- Revision clarifies that **Schedule 80 PVC** is required when PVC conduit is used for **protection from physical damage** for a grounding electrode conductor (GEC)
- This is **consistent with other sections of the *Code***, such as 230.50(B)(1) where Schedule 80 PVC is an option to provide protection from physical damage for service-entrance conductors
- Schedule 40 PVC does not provide the **impact and crush resistant characteristics** required for providing the protection anticipated by the *Code* and cannot be used in any location where protection from physical damage is required



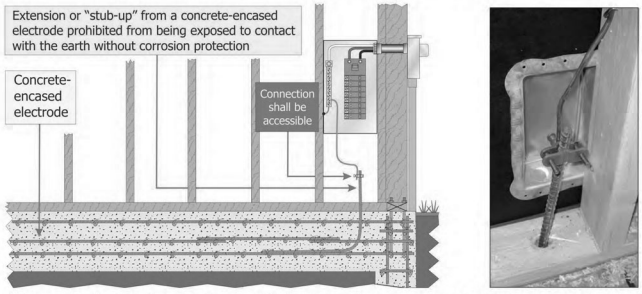
250.68(C)(3) GEC Connections to Rebar-Type Concrete-Encased Electrodes

- New provisions added to clarify that the rebar system in a footing or foundation is not suitable as the conductor to interconnect other grounding electrodes
- 250.68(C)(3), which gives the permission to use a rebar extension for connection of GECs and bonding jumpers was reformatted into a **list format**
- **Installation requirements** for the use of a rebar “stub-up” as an extension connected to a concrete-encased electrode was added
- Rebar extension must be continuous with the concrete-encased electrode rebar or it needs to be connected to the concrete-encased electrode rebar by the usual steel tie wires, exothermic welding, welding, or other effective means

250.68(C)(3) GEC Connections to Rebar-Type Concrete-Encased Electrodes *(cont.)*

- Additional language **prohibits** the rebar *(both the concrete-encased electrode rebar and the rebar extension)* from being used as a conductor to **interconnect the individual electrodes** of grounding electrode systems
- The rebar extension:
  - Must be **connected to the rebar** in the foundation or footing
  - Shall not be exposed to earth contact without **corrosion protection**
  - Shall not be used to **interconnect electrodes** of the grounding electrode system
- Same change added at **250.53(C)** for bonding jumper(s) used to connect the grounding electrodes together to form the grounding electrode system

250.68(C)(3) Concrete-Encased Electrode Extension



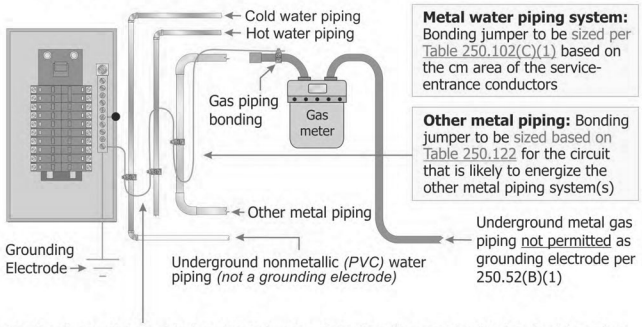
Rebar extension must be continuous with the concrete-encased electrode rebar or needs to be connected to the concrete-encased electrode rebar by the usual steel tie wires, exothermic welding, welding, or other effective means

Rebar *(both the concrete-encased electrode rebar and the rebar extension)* not permitted to be used as a conductor to interconnect the individual electrodes of grounding electrode systems

250.104(A)(1) Bonding of Metal Water Piping Systems

- Revision clarifies that **bonding jumper(s)** used to bond metal water piping system(s) together are not required to be larger than **3/0 copper** or **250 kcmil aluminum or copper-clad aluminum**
- Bonding jumper(s) used to bond metal water piping together still required to be sized based on **Table 250.102(C)(1)** but not required to be larger than 3/0 copper or 250 kcmil aluminum or copper-clad aluminum
- Changes made as a result of changing sizing reference from Table 250.66 to Table 250.102(C)(1) in the 2017 *NEC*, which resulted in an **inadvertent increase in the sizing** of bonding jumper(s) for metal water piping systems
- Same basic change occurred at **250.104(C)** for bonding of **structural metal**

250.104(A)(1) Bonding of Metal Water Piping Systems



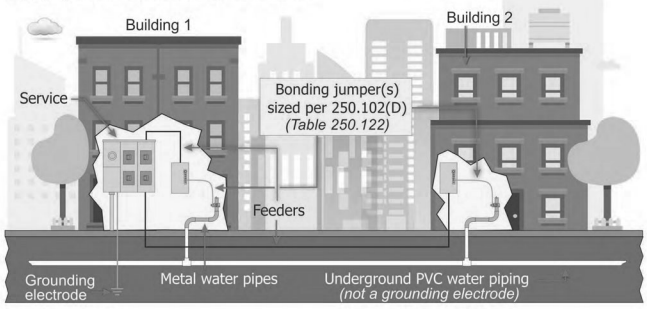
Bonding jumper(s) used to bond metal water piping together required to be sized based on Table 250.102(C)(1), but not required to be larger than 3/0 copper or 250 kcmil aluminum or copper-clad aluminum

250.104(A)(3) Buildings or Structures Supplied by Feeder(s) or Branch Circuit(s)

- Revision clarifies the **sizing requirements for bonding jumper(s)** used for bonding metal water piping systems when a building or structure is supplied by a feeder or branch circuit
- Reference changed from Table 250.102(C)(1) to **250.102(D)** ***(and Table 250.122)*** based on the largest overcurrent device supplying circuits the building or structure
- This bonding jumper sizing was changed in 2017 *NEC* to required sizing in accordance with Table 250.102(C)(1), based on the size of the feeder or branch-circuit conductors that supply the building or structure
- Feeders and branch circuits are protected by overcurrent protective devices and the size of these bonding jumpers should be based on 250.122

250.104(A)(3) Buildings or Structures Supplied by Feeder or BC

Bonding jumper(s) used for bonding metal water piping system(s) at multiple buildings or structures supplied by a feeder(s) or branch circuit(s) required to be sized based on 250.102(D) *(Table 250.122)* based on the largest overcurrent device supplying circuits to the buildings or structures



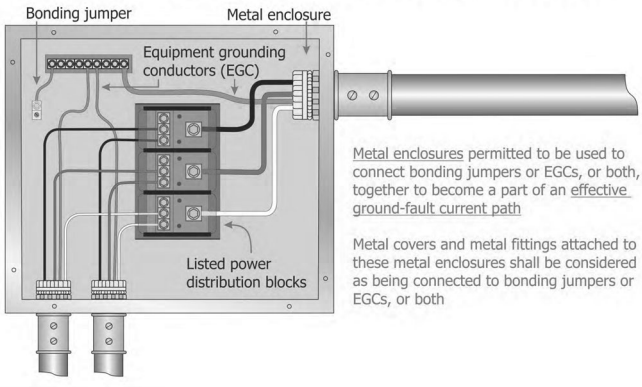
250.109 Metal Enclosures

- New section added indicating **metal enclosures** can be used to connect bonding jumpers or equipment grounding conductors, or both, together to become a part of an **effective ground-fault current path**
- Metal covers and metal fittings attached to these metal enclosures are also considered to be connected to the enclosed bonding jumpers or equipment grounding conductors, or both
- If circuit conductors are spliced within a box or terminated on equipment within or supported by a box, all EGCs associated with any of those circuit conductors are **required to be connected within the box or to the box** [250.148]
- Exposed, normally non-current-carrying metal parts of fixed equipment supplied by or enclosing conductors or components that are likely to become energized are **required to be connected to an EGC** [250.110]

250.109 Metal Enclosures *(cont.)*

- New section added indicating **metal enclosures** can be used to connect bonding jumpers or equipment grounding conductors, or both, together to become a part of an **effective ground-fault current path** *(cont.)*
- These and other ***Code*** requirements call for a connection of EGCs to metal box or metal enclosure, yet there was **no *Code* allowances** for these metal enclosures to serve as any part of an effective ground-fault current path
- Needed change to clarify that metal boxes, cabinets and other metal enclosures are **permitted to be used for grounding and bonding** of metal raceways, metal cables, and other metal equipment that is connected to the metal box, cabinet or enclosure

250.109 Metal Enclosures as an Effective Ground-Fault Path

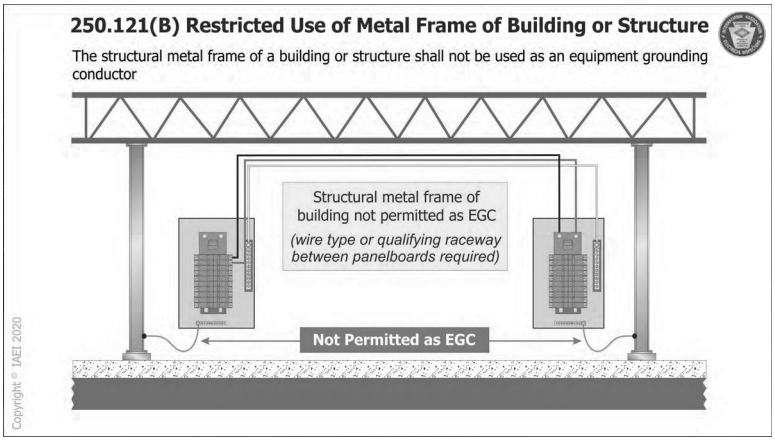


Metal enclosures permitted to be used to connect bonding jumpers or EGCs, or both, together to become a part of an effective ground-fault current path

Metal covers and metal fittings attached to these metal enclosures shall be considered as being connected to bonding jumpers or EGCs, or both

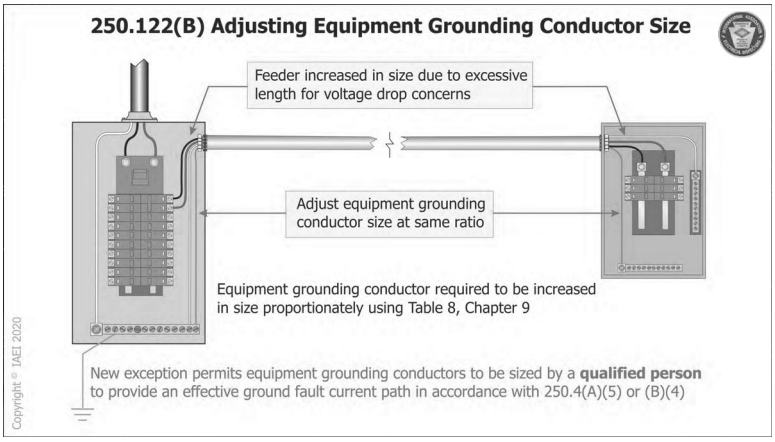
250.121(B) Restricted Use of Metal Frame of Building or Structure as EGC

- New sub-section added to prohibit the **structural metal frame of a building or structure** from being used as an **equipment grounding conductor** (EGC)
- These prohibitive EGC rules were previously found at 250.134(A) and only applied to electrical equipment secured to and in electrical contact with a metal rack or structure provided for the electrical equipment's support
- New rules apply to **all types** of equipment *(not just electrical equipment supported by a metal rack or structure)* and structural metal frames of a building or structure
- The structural metal frame of a building or structure need not serve as an EGC due to the uncertain path that ground-fault current must take in an effort to clear a fault



250.122(B) Adjustment of EGC Sizing

- Revisions clarify that **adjustment and/or correction factors** do not require an increase in the size of the equipment grounding conductor (EGC)
- If ungrounded conductors are increased in size for any reason **other than** as required in **310.15(B)** *(temperature adjustment factors)* or **310.15(C)** *(number of current-carrying conductors adjustment factors)*, wire-type EGCs, if installed, are required to be increased in size proportionately *(same ratio)* to the increase in circular mil area of the ungrounded conductors
- **New exception** added to allow the EGC to be sized by a **qualified person**, provided an effective ground fault current path can be established
- New exception will allow equipment grounding conductors to be sized by a "**qualified person**" to provide an effective ground fault current path rather than the **"ratio" method**

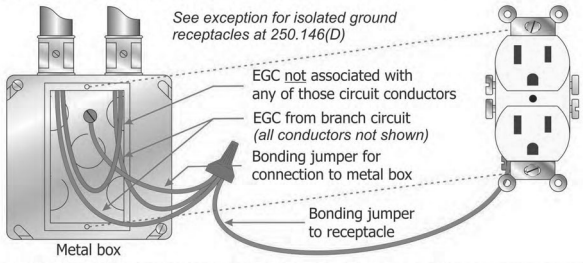


250.148 Continuity of EGCs and Attachment in Boxes

- Revision clarifies that all wire-type equipment grounding conductors (EGC) associated with any spliced circuit conductors must be connected ***within*** the box or to the box
- Revision improve readability and clarify when EGCs within a box are intended to be connected together and bonded to a metal box or device
- Title was changed from "Continuity and Attachment of Equipment Grounding Conductors to Boxes" to "**Continuity of Equipment Grounding Conductors and Attachment in Boxes"**
- Emphasis was placed on the fact that only the EGCs associated with the spliced conductors are to be connected within the box or to the box
- Connecting all EGCs together, especially if of considerably different sizes, is impractical and unnecessary

250.148 Continuity of EGCs and Attachment *in* Boxes

If circuit conductors are spliced within a box or terminated on equipment within or supported by a box, all wire-type equipment grounding conductor(s) associated with any of those circuit conductors shall be connected within the box or to the box ~~with devices suitable for the use~~ in accordance with 250.8 and 250.148(A) through (D)



A connection used for no other purpose shall be made between the metal box and the equipment grounding conductor(s) in accordance with 250.8

250.184(C), Exception – Multigrounded Neutral Systems

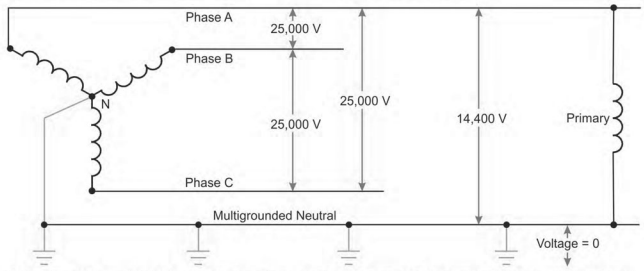
- **New exception** added to relieve bonding the neutral conductor to a grounding electrode in an **uninterrupted conductor exceeding 400 m (1300 ft)** if the only purpose for removing the cable jacket is for bonding the neutral conductor to a grounding electrode in a multigrounded neutral system
- 250.184(C)(3) requires at least one grounding electrode to be installed and connected to the multigrounded neutral conductor every 400 m (1300 ft)
- National Electrical Safety Code (NESC) allows long cable runs such as those for wind farms and solar farms to still be considered multi-point grounded but not held to distances like the 400 m (1300 ft) maximum length between bonding of the neutral conductor to a grounding electrode

250.184(C), Exception – Multigrounded Neutral Systems *(cont.)*

- **New exception** added to relieve bonding the neutral conductor to a grounding electrode in an **uninterrupted conductor exceeding 400 m (1300 ft)** if the only purpose for removing the cable jacket is for bonding the neutral conductor to a grounding electrode in a multigrounded neutral system *(cont.)*
- Removing the cable jacket only to create a point for connecting the multigrounded neutral conductor to a grounding electrode creates a **less desirable condition** than allowing further space between these connection points
- Removing the outer sheathing of the multigrounded neutral conductor cable creates a "**weak link**" in the cable that could lead to premature cable failure
- New exception in the *NEC* will align the NESC and *NEC* to avoid questions as to which standard has authority and brings consistency on this issue

250.184(C) Multigrounded Neutral Systems

Where a multigrounded neutral system is used, at least one grounding electrode shall be installed and connected to the multigrounded neutral conductor every 400 m (1300 ft)



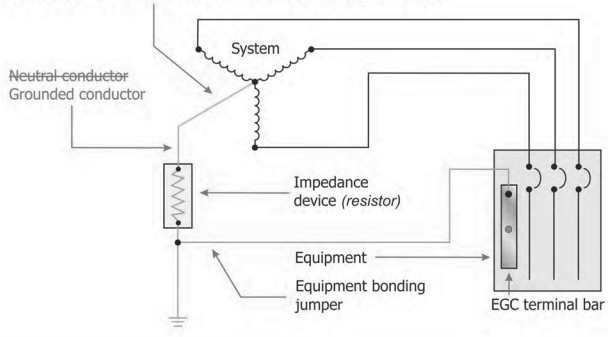
Exception: In a multipoint grounded system, a grounding electrode shall not be required to bond the neutral conductor in an uninterrupted conductor exceeding 400 m (1300 ft) if the only purpose for removing the cable jacket is for bonding the neutral conductor to a grounding electrode

250.187 Impedance Grounded ~~Neutral~~ Systems

- Revisions clarify that the conductor from the neutral point of a transformer to the grounding impedance device **does not meet the definition of neutral conductor** in Article 100 since it is not intended to carry current during normal operation
- The conductor from the neutral point of a transformer in this system to the grounding impedance device is now identified as a **grounded conductor**
- Title of **250.187(B)** was changed from "Identified and Insulated" to simply "**Insulated**" as a grounded conductor is already required to be identified or marked as a grounded conductor at **200.6**

250.187 Impedance Grounded ~~Neutral~~ Systems

The conductor from the neutral point of a transformer of an impedance grounded system to the grounding impedance device does not meet the definition of neutral conductor in Article 100 since it is not intended to carry current during normal operation



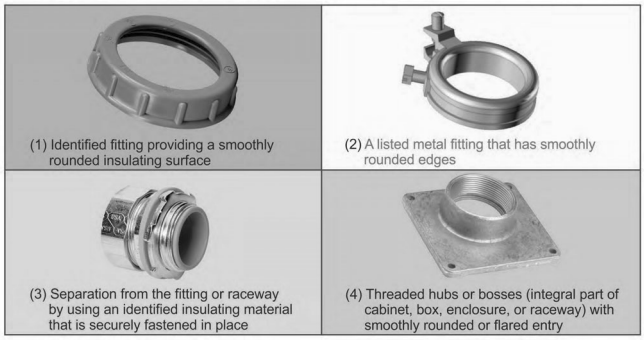
Chapter Three Wiring Methods and Materials

300.4(G) Protection Against Physical Damage - ~~Insulated~~ Fittings

- Previous *Code* text required conductors to be protected by an **identified fitting providing a smoothly rounded insulating surface** where insulated circuit conductors of **4 AWG or larger** enter a raceway in a cabinet, pull box, junction box, or auxiliary gutter
- Title of 300.4(G) was revised to remove the word "**Insulated**" to cover **alternative metal fittings** *(such as a metal grounding bushing/locknut)*
- Revised into a **list format** and text added to cover **listed metal fittings** that have **smoothly rounded edges** that will not damage the 4 AWG and larger conductors
- Previous exception for **threaded hubs or bosses** was rewritten into positive *Code* text

300.4(G) Protection Against Physical Damage - ~~Insulated~~ Fittings

Where raceways contain 4 AWG or larger insulated circuit conductors, and conductors enter a cabinet, a box, an enclosure, or a raceway, conductors shall be protected by any of the following:



(1) Identified fitting providing a smoothly rounded insulating surface

(2) A listed metal fitting that has smoothly rounded edges

(3) Separation from the fitting or raceway by using an identified insulating material that is securely fastened in place

(4) Threaded hubs or bosses (integral part of cabinet, box, enclosure, or raceway) with smoothly rounded or flared entry

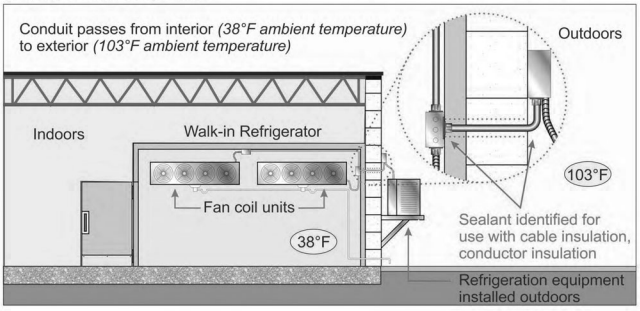
300.4(G) Protection Against Physical Damage - Fittings

300.7(A) Raceways Exposed to Different Temperatures - Sealing

- Where raceways or sleeves are known to be subjected to different temperatures, and where condensation is known to be a problem, required to be **sealed with a sealant identified for use with cable insulation, conductor insulation** *(rather than filled with an approved material)*
- Previously required the raceway or sleeve to be filled with an "**approved material**"
- Revision brings consistency and **similar language** to 300.7(A) as other raceway sealing requirements such as **225.27** for sealing an outdoor raceway entering a building

300.7(A) Raceways Exposed to Different Temperatures - Sealing

Where a raceway or sleeve are known to be subjected to different temperatures, and where condensation is known to be a problem, the raceway or sleeve is now required to be sealed with a sealant "identified for use with cable insulation, conductor insulation, a bare conductor, a shield, or other components"

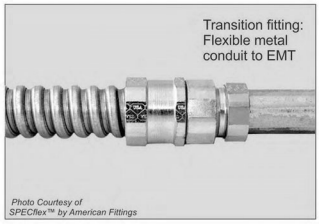


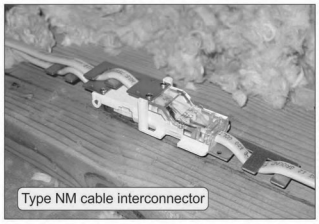
300.15(F) Boxes, Conduit Bodies, or Fittings - Where Required: Fitting

- Revisions occurred to make it clear **that listed transition fittings** and **listed interconnector devices** are permitted to be installed in **concealed locations** behind drywall and similar locations
- At each conductor splice point, outlet point, switch point, junction point, etc., a fitting **identified for the use** is permitted in lieu of a box or conduit body where conductors are not spliced or terminated within the fitting and the fitting is accessible after installation, **unless the fitting is listed for concealed installation**
- Transition fitting *(Type AC cable to EMT, etc.)* not required to be accessible after installation as they are **designed to be installed concealed**
- No different than a coupling used to join consecutive pieces of the same raceway which are not required to be accessible

300.15(F) Boxes, Conduit Bodies, or Fittings - Where Required: Fittings

At each conductor splice point, outlet point, junction point, etc., a fitting identified for the use is permitted in lieu of a box or conduit body where conductors are not spliced or terminated within the fitting and the fitting is ***accessible after installation***...





unless the fitting is listed for concealed installation

300.22(D) Wiring in Air-Handling Areas Under Raised Floors (ITE Rooms)

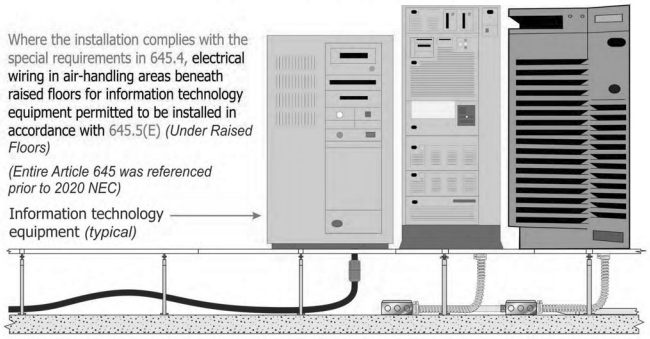
- Revision occurred to reference **645.5(E)** *(Supply Circuits and Interconnecting Cables – Under Raised Floors)* **rather than the entire Article 645** for electrical wiring in air-handling areas beneath raised floors for information technology equipment
- Installation must first meet the requirements of **645.4** *(Special Requirements for Information Technology Equipment Rooms)* so that 645.5(E) can permit the different requirements that normally would be required in 300.22(C) for wiring under raised floors

300.22(D) Wiring in Air-Handling Areas Under Raised Floors (ITE Rooms)

Where the installation complies with the special requirements in 645.4, electrical wiring in air-handling areas beneath raised floors for information technology equipment permitted to be installed in accordance with 645.5(E) *(Under Raised Floors)*

(Entire Article 645 was referenced prior to 2020 NEC)

Information technology equipment *(typical)*



300.22(D) Wiring In Air-handling Areas Beneath Raised Floors For Information Technology Equipment

300.25 Exit Enclosures (Stair Towers)

- New section added pertaining to the **allowable electrical wiring methods** serving electrical equipment in **exit enclosures** *(stairways)*
- Where an exit enclosure is required to be **separated from the building**, only electrical wiring methods serving **equipment permitted by the authority having jurisdiction in the exit enclosure** shall be installed within the exit enclosure
- Equipment deemed necessary to be contained in a stair tower could be such things as **fire sprinkler equipment**, **security systems**, **public address systems**, and **fire department emergency communications devices**
- Consistent with information found in NFPA 101 *(Life Safety Code-2018 edition)*

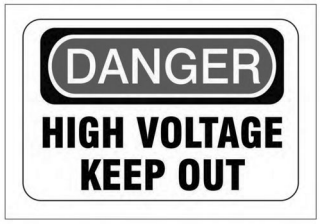
300.45 ~~Warning~~ Danger Signs

- **Editorial revisions** for signs required to be posted at points of access to conductors for raceway and cable systems of over 1000 volts replacing the word "~~Warning~~" with the word "**Danger**"
- Sign or label required to convey the following wording: **DANGER—HIGH VOLTAGE—KEEP OUT** !
- Previous title and *Code* requirement were inconsistent
- This sign is actually ANSI Z535 danger signs rather than warning signs
- Reference to **110.21(B)** *(Equipment Markings- Field-Applied Hazard Markings)* was also added to 300.45 triggering other important **marking requirements** for these signs

300.45 ~~Warning~~ Danger Signs

For systems of over 1000 volts, nominal, danger signs are required to be conspicuously posted at points of access to conductors in all raceway systems and cable systems

Sign(s) are required to comply with 110.21(B), be readily visible, and state the following:



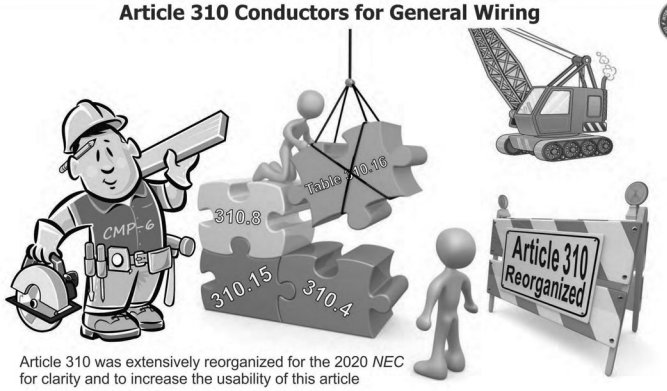
DANGER—HIGH VOLTAGE—KEEP OUT

300.45 ~~Warning~~ Danger Signs

Article 310 Reorganized

- Article 310 was **extensively reorganized** to increase the usability of the article
- The ampacity tables in Article 310 will simply be titled as **Table 310.16** through Table 310.21
- The scope of Article 310 is limited to **not more than 2000 volts**
- Requirements and ampacity tables for conductors **over 2000 volts** have been incorporated into **new Article 311**
- Copper-clad aluminum conductors must meet the material requirements of Section 310.3(B)

Article 310 Conductors for General Wiring



Article 310 was extensively reorganized for the 2020 *NEC* for clarity and to increase the usability of this article

Article 310 Conductors for General Wiring
Comparison Chart (2017 *NEC* to 2020 *NEC*)

2020 *NEC*	Topic	2017 *NEC*
Part I	General	Part I
310.1	Scope	310.1
~~310.2~~	~~Definitions~~	310.2
310.3	Conductors	310.106
310.3(A)	Minimum Size of Conductors	310.106(A)
310.3(B)	Conductor Material	310.106(B)
310.3(C)	Stranded Conductors	310.106(C)
310.3(D)	Insulated	310.106(D)
Part II	Construction Specifications	Part III
310.4	Conductor Constructions and Applications	310.104
Table 310.4(A)	Conductor Applications and Insulations Rated 600 Volts	Table 310.104(A)
Table 310.4(B)	Thickness of Insulation for Nonshielded Types RHH and RHW Solid Dielectric Insulated Conductors Rated 2000 Volts	Table 310.104(B)
310.6	Conductor Identification	310.110
310.6(A)	Grounded Conductors	310.110(A)
310.6(B)	Equipment Grounding Conductors	310.110(B)
310.6(C)	Ungrounded Conductors	310.110(C)

Article 310 Conductors for General Wiring
Comparison Chart (2017 *NEC* to 2020 *NEC*)

2020 *NEC*	Topic	2017 *NEC*
310.8	Marking	310.120
310.8(A)	Required Information	310.120(A)
310.8(B)	Method of Marking	310.120(B)
310.8(B)(1)	Surface Marking	310.120(B)(1)
310.8(B)(2)	Marker Tape	310.120(B)(2)
310.8(B)(3)	Tag Marking	310.120(B)(3)
310.8(B)(4)	Optional Marking of Wire Size	310.120(B)(4)
310.8(C)	Suffixes to Designate Number of Conductors	310.120(C)
310.8(D)	Optional Markings	310.120(D)
Part III	Installation	Part II
310.10	Uses Permitted	310.10
310.10(A)	Dry Locations	310.10(A)
310.10(B)	Dry and Damp Locations	310.10(B)
310.10(C)	Wet Locations	310.10(C)
310.10(D)	Locations Exposed to Direct Sunlight	310.10(D)
~~310.10(E)~~	~~Shielding~~	310.10(E)
310.10(E)	Direct-Burial Conductors	310.10(F)

Article 310 Conductors for General Wiring
Comparison Chart (2017 *NEC* to 2020 *NEC*)

2020 *NEC*	Topic	2017 *NEC*
310.10(F)	Corrosive Conditions	310.10(G
310.10(G)	Conductors in Parallel	310.10(H)
310.10(G)(1)	General	310.10(H)(1)
310.10(G)(2)	Conductor and Installation Characteristics	310.10(H)(2)
310.10(G)(3)	Separate Cables or Raceways	310.10(H)(3)
310.10(G)(4)	Ampacity Adjustment	310.10(H)(4)
310.10(G)(5)	Equipment Grounding Conductors	310.10(H)(5)
310.10(G)(6)	Bonding Jumpers	310.10(H)(6)
310.12	Single-Phase Dwelling Services and Feeders	310.15(B)(7)
310.12(A)	Services	310.15(B)(7)(1)
310.12(B)	Feeders	310.15(B)(7)(2)
310.12(C)	Feeder Ampacities	310.15(B)(7)(3)
310.12(D)	Grounded Conductors	310.15(B)(7)(4)
Table 310.12	Single-Phase Dwelling Services and Feeders	Table 310.15(B)(7) *[2011 NEC]*
310.14	Ampacities for Conductors Rated 0-2000 Volts	310.15
310.14(A)	General	*310.15(A)*

Article 310 Conductors for General Wiring
Comparison Chart (2017 *NEC* to 2020 *NEC*)

2020 *NEC*	Topic	2017 *NEC*
310.14(A)(1)	Tables or Engineering Supervision	310.15(A)(1)
310.14(A)(2)	Selection of Ampacity	310.15(A)(2)
310.14(A)(3)	Temperature Limitation of Conductors	310.15(A)(3)
310.14(B)	Engineering Supervision	NEW
310.15	Ampacity Tables	310.15(B)
310.15(A)	General	310.15(B)(1)
310.15(B)	Ambient Temperature Correction Factors	310.15(B)(2)
310.15(B)(1)	General	310.15(B)(2)
310.15(B)(2)	Rooftop	310.15(B)(3)(c)
Table 310.15(B)(1)	Ambient Temperature Correction Factors Based on 30°C (86°F)	Table 310.15(B)(2)(a)
Table 310.15(B)(2)	Ambient Temperature Correction Factors Based on 40°C (104°F)	Table 310.15(B)(2)(b)
310.15(C)	Adjustment Factors	310.15(B)(3)
310.15(C)(1)	More than Three Current-Carrying Conductors	310.15(B)(3)(a)
Table 310.15(C)(1)	Adjustment Factors for More Than Three Current-Carrying Conductors	Table 310.15(B)(3)(a)

Article 310 Conductors for General Wiring
Comparison Chart (2017 *NEC* to 2020 *NEC*)

2020 *NEC*	Topic	2017 *NEC*
310.15(C)(2)	Raceway Spacing	310.15(B)(3)(b)
310.15(D)	Bare or Covered Conductors	310.15(B)(4)
310.15(E)	Neutral Conductor	310.15(B)(5)
310.15(F)	Grounding or Bonding Conductor	310.15(B)(6)
310.16	Ampacities of Insulated Conductors in Raceway, Cable, or Earth (Directly Buried) (86°F)	NEW
310.17	Ampacities of Single-Insulated Conductors in Free Air (86°F)	NEW
310.18	Ampacities of Insulated Conductors in Raceway or Cable (104°F)	NEW
310.19	Ampacities of Single-Insulated Conductors in Free Air (104°F)	NEW
310.20	Ampacities of Conductors Supported on a Messenger (104°F)	NEW
310.21	Ampacities of Bare or Covered Conductors in Free Air (104°F)	NEW
Table 310.16	Ampacities of Insulated Conductors Not More Than Three Current-Carrying Conductors in Raceway, Cable, or Earth (Directly Buried) (86°F)	Table 310.15(B)(16)
Table 310.17	Ampacities of Single-Insulated Conductors in Free Air (86°F)	Table 310.15(B)(17)
Table 310.18	Ampacities of Insulated Conductors Not More Than Three Current-Carrying Conductors in Raceway or Cable (104°F)	Table 310.15(B)(18)

Article 310 Conductors for General Wiring
Comparison Chart (2017 *NEC* to 2020 *NEC*)

2020 *NEC*	Topic	2017 *NEC*
Table 310.19	Ampacities of Single-Insulated Conductors in Free Air (104°F)	Table 310.15(B)(19)
Table 310.20	Ampacities of Conductors Supported on a Messenger (104°F)	Table 310.15(B)(20)
Table 310.21	Ampacities of Bare or Covered Conductors in Free Air (104°F)	Table 310.15(B)(21)
~~310.60~~	~~Conductors Rated 2001 to 35,000 Volts~~	Moved to new Article 311

Article 310 Ampacity Tables

- The ampacity tables will simply be titled as Table 310.16 through Table 310.21 *(Example: **Table 310.15(B)(16) will now be simply Table 310.16**)*
- New sections were added at 310.16 through 310.21 that now refer to the ampacity tables and contain conditions of use previously found in the table headings
- The ampacity table headings were shortened and a note referring to the section language was added to each table
- All of the notes to the tables were retained at the bottom of the ampacity tables

Table 310.16 ~~310.15(B)(16)~~ *(in part)*

Table 310.16 ~~310.15(B)(16) Allowable~~ Ampacities of Insulated Conductors ~~Rated Up to and Including 2000 Volts, 60°C Through 90°C (140°F Through 194°F),~~ Not More Than Three Current-Carrying Conductors in Raceway, Cable, or Earth (Directly Buried), ~~Based on Ambient Temperature of 30°C (86°F)~~*

	Temperature Rating of Conductor [See Table 310.104(A)]						
	60°C (140°F)	75°C (167°F)	90°C (194°F)	60°C (140°F)	75°C (167°F)	90°C (194°F)	
Size AWG or kcmil	Types TW, UF	Types RHW, THHW, THW, THWN,XHHW, XHWN, USE, ZW	Types TBS, SA, SIS, FEP, FEPB, MI, PFA, RHH, RHW-2, THHN, THHW, THW-2, THWN-2, USE-2, XHH, XHHW, XHHW-2, XHWN, XHWN-2, XHHN, Z, ZW-2	Types TW, UF	Types RHW, THHW, THW, THWN, XHHW, XHWN, USE	Types TBS, SA, SIS, THHN, THHW, THW-2, THWN-2, RHH, RHW-2, USE-2, XHH, XHHW, XHHW-2, XHWN, XHWN-2, ZW-2, XHHN	Size AWG or kcmil
	COPPER			ALUMINUM OR COPPER-CLAD ALUMINUM			
18*	—	—	14	—	—	—	—
16*	—	—	18	—	—	—	—
14*	15	20	25	—	—	—	—
12*	20	25	30	15	20	25	12*
10*	30	35	40	25	30	35	10*
8	40	50	55	35	40	45	8
6	55	65	75	40	50	55	6
4	70	85	95	55	65	75	4
3	85	100	115	65	75	85	3
2	95	115	130	75	90	100	2
1	110	130	145	85	100	115	1
1/0	125	150	170	100	120	135	1/0
2/0	145	175	195	115	135	150	2/0
3/0	165	200	225	130	155	175	3/0
4/0	195	230	260	150	180	205	4/0

1. Section 310.16 shall be referenced for conditions of use.
2. Section ~~Refer to~~ 310.15(B)~~(2)~~ shall be referenced for the ampacity correction factors where the ambient temperature is other than 30°C (86°F).
3. Section 310.15(C)(1) ~~Refer to 310.15(B)(3)(a)~~ shall be referenced for more than three current-carrying conductors.

*~~Refer to~~ Section 240.4(D) shall be referenced for conductor overcurrent protection limitations, except as modified elsewhere in the *Code*.

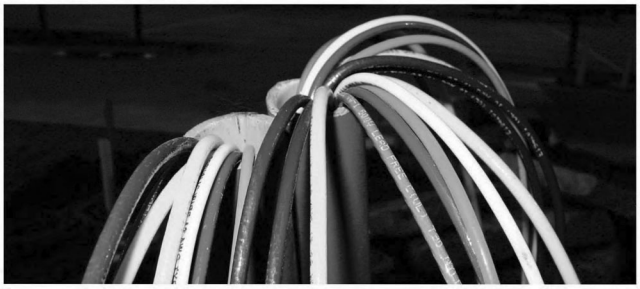
Reproduction of NEC Table 310.16 (in part)

Article 310 Allowable Ampacity for Conductors

- Revision occurred throughout Article 310 removing the term "**allowable**" from ~~**allowable**~~ **ampacities for conductors**
- "Allowable" removed from Article 310 **thirteen** times throughout the article
- "**Ampacity**" is defined in Article 100 as "the maximum current, in amperes, that a conductor can carry continuously under the conditions of use without exceeding its temperature rating"
- Proper term used throughout Article 310 should be "**ampacity**" and not "**allowable ampacity**" as it is the intent for this section to determine the ampacity of the conductor based upon its **condition of use**
- The use of the word "allowable" did not add any clarity and was deleted in several locations

Article 310 ~~Allowable~~ Ampacity for Conductors

Revision occurred throughout Article 310 by removing the term "allowable" from ~~allowable~~ ampacities for conductors



Ampacity: The maximum current, in amperes, that a conductor can carry continuously under the conditions of use without exceeding its temperature rating.

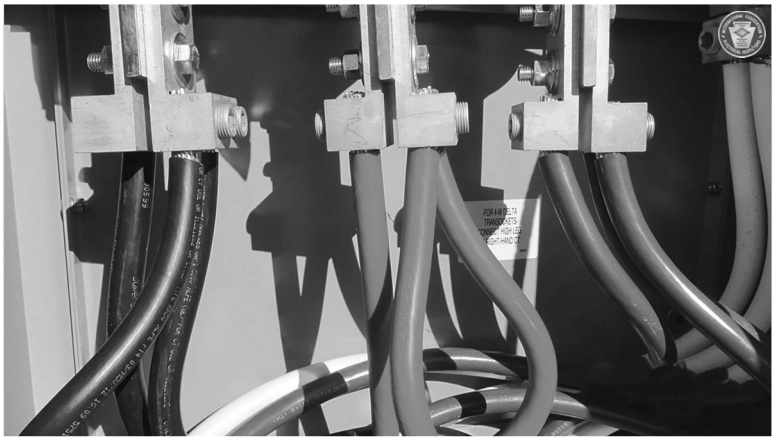
310.10 and Ampacity Tables – Conductor Types Added

- Type **XHHN**, **XHWN**, and **XHWN-2** were added to the "**Uses Permitted**" locations and the ampacity tables based on appropriate temperature ratings
- These three types of conductor insulations were recognized by the 2017 *NEC* at Table 310.104(A) *[now Table 310.4(A)]*
- Inadvertently left out of the Article 310 ampacity tables for 2017 *NEC*
- Type XHHN, XHWN, and XHWN-2 insulated conductors were added to the insulated conductors and cables that can be used in **dry and damp locations** at 310.10(B)
- Types XHWN and XHWN-2 conductors were added to the list of acceptable types of conductors for a **wet location**

310.10 and Ampacity Tables - Conductor Types Added

** Rendering of a Type XHWN-2 conductor*

Type **XHHN**, **XHWN**, and **XHWN-2** were added to the 310.10 "Uses Permitted" locations and the ampacity tables based on appropriate temperature ratings



310.12 Single-Phase Dwelling Services and Feeders

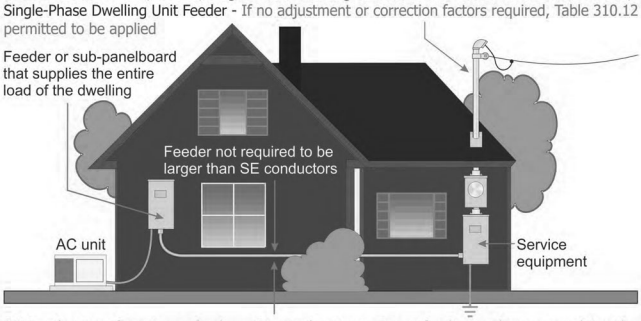
- **New dwelling unit service ampacity table** from Informative Annex D, Example D7 added at **310.12** *[formerly Table 310.15(B)(7)]*
- Text added indicating Table 310.12 permitted to be used if there are **no temperature correction or adjustment factors needed**
- This dwelling unit table and/or information has been a part of the *Code* since the **1956** ***NEC*** *(until the 2014 NEC)*
- These higher ampacity allowances permitted primarily due to the **diversity loads** associated with dwelling units
- Removed from the *Code* in the 2014 *NEC* and replaced with an ampacity reduction of not less than **83 percent** of the service or feeder rating of the ampacity values of then Table 310.15(B)(16)

310.12 Single-Phase Dwelling Services and Feeders *(cont.)*

- **New dwelling unit service ampacity table** from Informative Annex D, Example D7 added at **310.12** *[formerly Table 310.15(B)(7)] (cont.)*
- Reintroduced to the *Code* for the 2017 *NEC*, but it was located in **Informational Annex D**, following Example D7
- For ease of use, putting this sixty-three-year-old table back in Article 310 makes sense and compliments the reorganization of Article 310 for the 2020 *NEC* revision cycle

310.12 Permitted to be Used

310.12 - 120/240-Volt, 3-Wire, Single-Phase Dwelling Unit Service or Feeder or a 208Y/120-Volt, Single-Phase Dwelling Unit Feeder - If no adjustment or correction factors required, Table 310.12 permitted to be applied



83% reduction of service or feeder rating applies to service or feeder conductors supplying the entire load associated with the dwelling unit

Table 310.12 Single-Phase Dwelling Services and Feeders

For one-family dwellings and the individual dwelling units of two-family and multifamily dwellings, service and feeder conductors supplied by a single-phase, 120/240-volt system shall be permitted to be sized in accordance with 310.12(A) through (D). [Single-phase feeder conductors consisting of two ungrounded conductors and the neutral conductor from a 208Y/120 volt system permitted to be sized in accordance with 310.12(A) through (C)]

Service or Feeder Rating (Amperes)	Conductor (AWG or kcmil)	
	Copper	Aluminum or Copper-Clad Aluminum
100	4	2
110	3	1
125	2	1/0
150	1	2/0
175	1/0	3/0
200	2/0	4/0
225	3/0	250
250	4/0	300
300	250	350
350	350	500
400	400	600

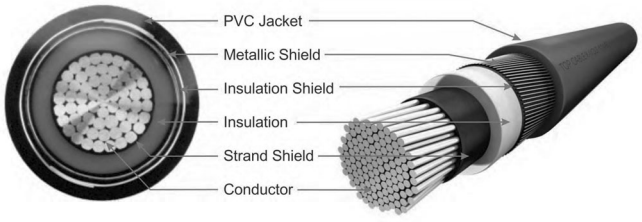
Note: If no adjustment or correction factors are required, this table shall be permitted to be applied.

Article 311 Medium Voltage Cable (New)

- In order to consolidate the **medium voltage requirements** previously found in **Articles 310** *(Conductors or General Use)* and **Article 328** *(Medium Voltage Cable)*, and to improve the usability of the *Code*, the requirements are combined into a **new Article 311**
- New article will cover the use, installation, construction specifications and ampacities for medium voltage conductors and cable (Type MV)
- Part of the **Article 310** reorganization included moving the Type MV cable requirements into new **Article 311** which also included moving the Type MV cable requirements out of **Article 328** and deleting that article entirely
- Prior to this new article, it was difficult to gather all necessary information pertaining to Type MV conductors and cables as they were scattered within the Article 310 ampacity tables for cables up to 2000 volts

Article 311 Medium Voltage Cable

Medium voltage cable: A single or multiconductor solid dielectric insulated cable rated 2001 volts up to and including 35,000 volts, nominal.

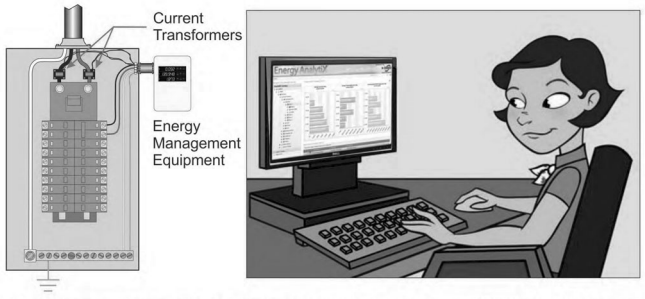


Medium voltage requirements previously found in Articles 310 and Article 328 have be combined into new Article 311 to improve the usability of the *Code*

312.8(B) Power Monitoring or Energy Management Equipment

- The term "**Energy Management Equipment**" added to equipment permitted within the wiring space of enclosures for switches or overcurrent devices along with power monitoring equipment
- Wiring space within enclosures such as a panelboard cabinet for switches or overcurrent devices permitted to contain "**other wiring and equipment**" with limited percentage (40% and 75%) of the cross-sectional area of the space
- Listed energy management equipment's primary function is to monitor, measure and control circuits by automatic means within the wiring space of a cabinet, cutout box or a meter socket enclosure and is **similar in nature to that of power monitoring equipment**
- New list Item (3) was added for conductors used exclusively for control or instrumentation circuits

312.8(B) Power Monitoring or Energy Management Equipment



The term "Energy Management Equipment" added to equipment permitted within the wiring space of enclosures for switches or overcurrent devices along with power monitoring equipment

New list Item (3) was added for conductors used exclusively for control or instrumentation circuits

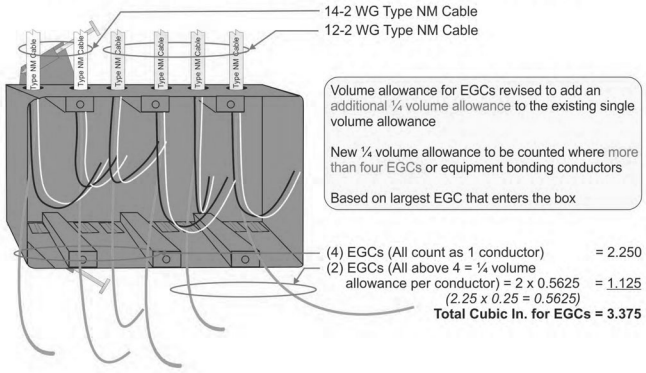
314.16(B)(5) EGC Box Fill Calculations

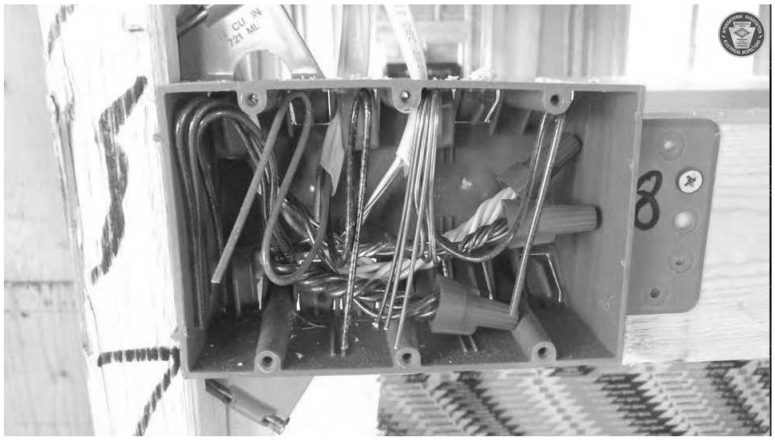
- Volume allowance for equipment grounding conductors (EGC) and equipment bonding jumpers was revised to add an **additional ¼ volume allowance** to the existing single volume allowance
- New ¼ volume allowance to be counted in installations with **more than four EGCs** or equipment bonding conductors
- All boxes (enclosures) must be large enough to provide for **sufficient free space** for all conductors and devices that will be enclosed within them to prevent overcrowding and possible physical damage when the devices or conductors are installed and completed
- Table 314.16(B) list the volume allowance as a function of conductor size

314.16(B)(5) EGC Box Fill Calculations *(cont.)*

- A **single volume allowance** has been required for all equipment grounding conductors within a box since the 1971 *NEC*
- Single volume deduction based on the **largest equipment grounding conductor** or equipment bonding jumpers present in the box
- In multiple gang boxes, taking only one volume allowance based on the largest EGC is not always adequate resulting in **significant undue crowding** of conductors and not enough free space to allow heat to dissipate from the contained conductors
- Requiring all EGCs to meet **300.14** ***[at least 150 mm (6 in.) of free conductor for each conductor]*** and applying only a single volume allowance was problematic in past editions of the *Code*

314.16(B)(5) Box Fill Calculations - EGC Conductor Fill





314.27(C) Boxes at Ceiling-Suspended (Paddle) Fan Outlets

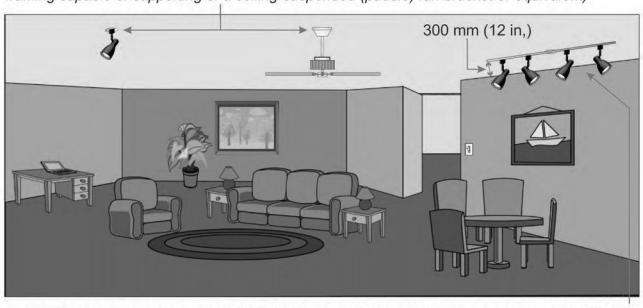
- Revision will now generally require **all outlet boxes** mounted in a location acceptable for the installation of a ceiling-suspended (paddle) fan in the ceilings of habitable rooms of dwelling units to be **listed for the sole support of ceiling-suspended (paddle) fan**
- Previously, outlet boxes or outlet box systems were required to be listed for sole support of a ceiling-suspended (paddle) fan where a **"spare," separately switched, ungrounded conductor** was provided to a ceiling-mounted outlet box, in a location acceptable for a ceiling-suspended (paddle) fan in dwellings
- An outlet box complying with the applicable requirements of 314.27 and providing access to structural framing capable of supporting of a ceiling-suspended (paddle) fan bracket or equivalent is permissible as well

314.27(C) Boxes at Ceiling-Suspended (Paddle) Fan Outlets *(cont.)*

- Revision will now generally require **all outlet boxes** mounted in a location acceptable for the installation of a ceiling-suspended (paddle) fan in the ceilings of habitable rooms of dwelling units to be **listed for the sole support of ceiling-suspended (paddle) fan** *(cont.)*
- This new requirement will predicate the installation of an outlet box listed for the sole support of a ceiling-suspended (paddle) fan at most dwelling unit ceiling-mounted luminaire locations regardless of the existence of a "spare" separately switched ungrounded conductor or not
- Many ceiling-suspended (paddle) fans are now **remote-controlled** requiring only a two-wire installation

314.27(C) Boxes at Ceiling-Suspended (Paddle) Fan Outlets

All outlet boxes mounted in ceilings of habitable rooms of dwelling units required to be listed for the sole support of a ceiling-suspended (paddle) fan *(or outlet box providing access to structural framing capable of supporting of a ceiling-suspended (paddle) fan bracket or equivalent)*



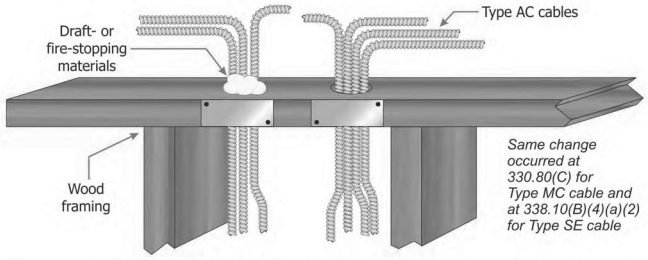
Applicable only in locations acceptable for the installation of a ceiling-suspended (paddle) fan

314.27(C) Boxes at Ceiling-Suspended (Paddle) Fan Outlets

320.80(A) Type AC Cable Ampacity – Thermal Insulation

- Type AC cable is now required to comply with adjustment factors of **Table 310.15(C)(1)** *[previously T. 310.15(B)(3)(a) (More Than Three-Current-Carrying Conductors)]* when installed without maintaining spacing
- Similar to 334.80 for Type NM cable
- Where **more than two** Type AC, Type MC, Type NM, or Type SE cables containing **two or more current-carrying conductors** in each cable are installed in contact with thermal insulations, caulk, or sealing foam **without maintaining spacing** between cables, the ampacity of each conductor are required to be adjusted in accordance with Table 310.15(C)(1)
- Same cable installation restrictions implemented for metal-clad cable (**Type MC cable**) at **330.80(C)** and for service-entrance cable (**Type SE cable**) at **338.10(B)(4)(a)(2)**

320.80(A) Type AC Cable Ampacity-Thermal Insulation



Where more than two Type AC cables containing two or more current-carrying conductors in each cable are installed in contact with thermal insulation, caulk, or sealing foam without maintaining spacing between cables, the ampacity of each conductor shall be adjusted in accordance with Table 310.15(C)(1)

Note: Table 310.15(C)(1) is previous Table 310.15(B)(3)(a) *(Adjustment Factors for More Than Three Current-Carrying Conductors)*

330.130 Type MC-HL Cable in Hazardous (Classified) Locations

- New requirements added for Type MC cable with a designation of "**MC-HL**" installed in a hazardous (classified) location
- Type MC-HL cable shall be listed and shall have a gas/vapor tight continuous corrugated metallic sheath, an overall jacket of suitable polymeric material, and a separate equipment grounding conductor
- Prior to the 2020 *NEC*, there were no specific requirements for Type MC-HL cable in Article 330
- Type MC-HL cable with an interlocked metallic sheath provides a more flexible cable while still providing an overall jacket of suitable polymeric material
- Same change implemented for power and control tray cable (**Type TC cable**) with a designation of "TC-ER-HL" at **336.130**

330.130 Type MC-HL in Hazardous (Classified) Locations

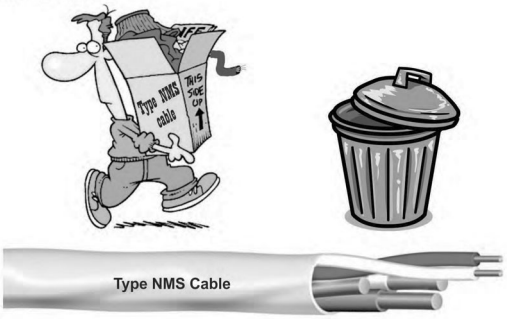
Type MC-HL cable required to be listed and have: (1) a gas/vapor tight continuous corrugated metallic sheath, (2) an overall jacket of suitable polymeric material, and (3) a separate EGC

334.2 Nonmetallic-Sheathed Cable – Type NMS Deleted

- All references to **Type NMS** cable has been **deleted** from Article 334 as this cable construction is no longer manufactured
- Type NMS was defined as "insulated power or control conductors with signaling, data, and communications conductors within an overall nonmetallic jacket"
- This cable was intended to be used with "**smart house**" circuits back in the late 1980's and 90's
- Type NMS cable was manufactured specifically to accommodate this type of new technology by combining power conductors with signal conductors all in one cable
- The 1990's short-lived "smart home" concept should not be confused with today's successful home automation, the Internet of Things (IoT), and the connected home concepts

334.2 Nonmetallic-Sheathed Cable - Type NMS Deleted

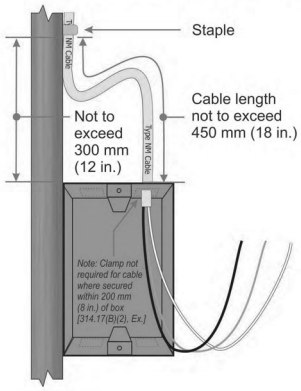
All references to Type NMS cable has been deleted from Article 334 as this cable construction is no longer manufactured



334.30 Securing and Supporting of Type NM Cable

- Revision will clarify how Type NM cable should be measured from the enclosure to the securing method with the **cable length** between the cable entry and the closest cable support not exceeding **450 mm (18 in.)**
- Previously, support method (staple) could be installed within 300 mm (12 in.) of a box and have a 4 ft, 6 ft, or even a 30 ft, loop of nonmetallic-sheathed cable between the staple and the box
- The "intent" was to limit the amount of cable between the securing method (staple) and the box to no more than 300 mm (12 in.)
- Other places in the *Code*, such as **314.17(C), Exception** indicate that this measurement should be "**measured along the sheath**" of the cable in question
- The extra length ***[450 mm (18 in.)]*** was provided in consideration of conductor length for repair *(if needed)*

334.30 Securing and Supporting of Type NM Cable



Nonmetallic-sheathed cable required to be supported and secured at intervals not exceeding 1.4 m (4½ ft) and within 300 mm (12 in.) of every cable entry into enclosures such as outlet boxes, junction boxes, cabinets, or fittings

300 mm (12 in.) measurement is still measured from the box to the securing method (staples; cable ties, straps, hangers, etc.), but cable length between the cable entry and the closest cable support must not exceed 450 mm (18 in.)

Article 337 Type P Cable (New)

- A new article was added covering the use, installation, and construction specifications for **Type P cable**
- Based on cable performance and requirements for some land-based operations (drilling rigs), Type P cable was originally **proposed** to be added to the 2020 *NEC* for **hazardous area applications only**
- Final 2020 *NEC* language **does not restrict** the use of Type P cable to hazardous (classified) locations
- Type P cable is a flexible and rugged and highly suitable for petrochemical applications resistant to various chemicals, abrasives, and petroleum-based additives
- Has the ability to resist damage from vibration, shaking, and movement that occurs in many processes

Article 337 - Type P Cable

A new article was added covering the use, installation, and construction specifications for Type P cable

Type P Cable: A factory assembly of one or more insulated flexible tinned copper conductors, with associated equipment grounding conductor(s), with or without a braided metallic armor and with an overall nonmetallic jacket.

338.2 Definitions - Service-Entrance Cables

- New definition for "**Service-Entrance Conductor Assembly**" added to differentiate between service-entrance cables and assemblies of single-insulated USE conductors
- Existing definition for "**Service-Entrance Cable**" was revised to reflect added definition for "Service-Entrance Conductor Assembly"
- Type SE cables (SER and SEU) and Type USE cables all have an overall polymeric covering of some type
- Assemblies of single-conductor insulated Type USE conductors do not have an overall covering and treated like direct-burial conductors and are not subject to any ampacity limitations beyond the normal Article 310 and other *Code* rules

338.2 Definitions - Service-Entrance Cables

Service-Entrance Cable. A single conductor or multiconductor ~~assembly~~ cable provided with ~~or without~~ an overall covering, primarily used for services, and of the following types:

Type SE. Service-entrance cable having a flame-retardant, moisture-resistant covering.

Type USE. Service-entrance cable, identified for underground use, having a moisture-resistant covering, but not required to have a flame-retardant covering.

Service-Entrance Conductor Assembly. Multiple single-insulated conductors twisted together without an overall covering, other than an optional binder intended only to keep the conductors together.

Service-Entrance Cable

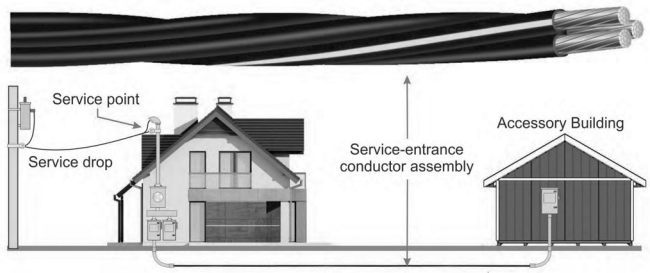
Service-Entrance Conductor Assembly

338.100 Construction of Service-Entrance Cables

- All conductors of a cabled assemblies of multiple single-conductors of a **Type USE cable** are now required to be **insulated**
- Type SE or USE cable with an **overall covering** containing two or more conductors are permitted to have one conductor uninsulated
- To coincide with the revision to the definition of "Service-Entrance Cable" and the new definition of "Service-Entrance Conductor Assembly," the phrase "**with an overall covering**" was added to **338.100(B)**
- Section divided into **two separate sub-sections** to aid the user of the *Code* in identifying the relevant requirements for each:
  - (A) Assemblies
  - (B) Uninsulated Conductors

338.100 Construction of Service-Entrance Cables

All conductors of a cabled assemblies of multiple single-conductors of a direct buried Type USE cable are now required to be insulated



Type SE or USE cable with an overall covering containing two or more conductors permitted to have one conductor uninsulated

342.10(E) IMC Subject to Severe Physical Damage

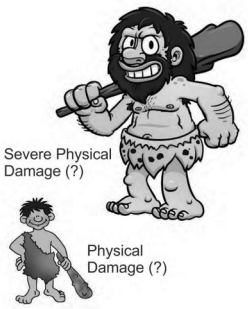
- New sub-section (E) clarifies that intermediate metal conduit (**Type IMC**) is permitted to be installed where **subject to severe physical damage**
- "Physical damage" or "severe physical damage" are **not defined** in the *NEC (determined by AHJ)*
- Confusion exist amongst installers and inspectors pertaining to which wiring methods are acceptable for areas subject to severe physical damage
- **UL 1242** and **342.10(A)** permit IMC to be used in all atmospheric conditions *(including severe physical damage)*
- Same change occurred for rigid metal conduit (**Type RMC**) at **344.10(E)**
- Similar change occurred at **358.10(E)** for electrical metallic tubing (**EMT**) where language was added to allow **steel and stainless steel EMT** to be installed where subject to **physical damage** *(not severe physical damage, but physical damage)*

342.10(E) IMC Subject to Severe Physical Damage

New 342.10(E) clarifies that intermediate metal conduit (Type IMC) is permitted to be installed where subject to severe physical damage

* *Same change occurred at 344.10(E) for Rigid Metal Conduit (RMC)*

Intermediate Metal Conduit



342.14 Dissimilar Metals – Type IMC

- Revision added to make it clear that **stainless steel fittings**, and enclosures can be used with **galvanized steel IMC** but **galvanized fittings** should not be used with **stainless steel IMC**
- Dissimilar metals and alloys have different electrode potentials
- To address dissimilar metals with conduit and raceway systems, the 2017 *NEC* was revised to clarify the acceptable fittings that can be used with these different types of conduits or raceways, based on galvanic compatibility
- Further revision occurred for the 2020 *NEC* to provide additional clarity on what fittings are acceptable for use with stainless steel IMC, RMC and EMT
- Same revisions occurred at **344.14** for **rigid metal conduit** and at **358.14** for electrical metallic tubing (**EMT**)

342.14 Dissimilar Metals: Type IMC

Where practicable, dissimilar metals in contact anywhere in the system shall be avoided to eliminate the possibility of galvanic action

Stainless steel and aluminum fittings and enclosures shall be permitted to be used with galvanized steel IMC where not subject to severe corrosive influences.

Stainless steel IMC shall only be used with the following:

(1) Stainless steel fittings
(2) Stainless steel ~~outlet~~ boxes and enclosures
(3) Steel (galvanized, painted, powder or PVC coated, and so forth) boxes and enclosures when not subject to severe corrosive influences
(4) Stainless steel, nonmetallic, or approved accessories

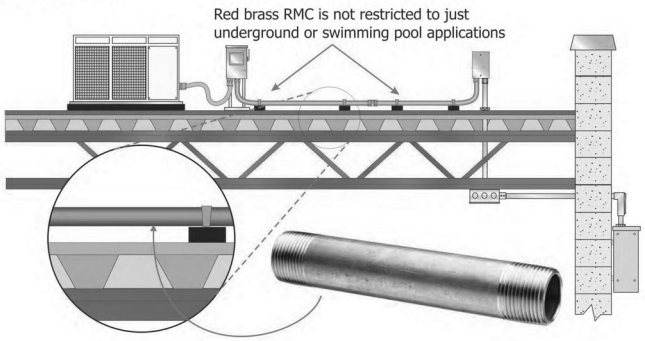
Note: *Same requirements added at 344.14 for RMC and 358.14 for EMT*

344.10(A) Galvanized Steel, Stainless Steel, and Red Brass RMC

- Revision to clarify that **red brass RMC** is not restricted to just underground or swimming pool applications
- Previous **344.10(A)(2)** stating that red brass RMC is permitted to be installed for direct burial and swimming pool applications has been **deleted** *(not the only application for red brass RMC)*
- Red brass RMC is typically made up of approximately 85% copper, 5% tin, 5% lead, and 5% zinc
- Galvanized steel, stainless steel, and red brass RMC permitted under all atmospheric conditions and occupancies
- Red brass is one of four materials designated for rigid metal conduit at **344.100** and it meets all the requirements of RMC
- Red brass is **highly resistant to corrosion**, making it a viable wiring method for many applications, desired for visual appealing purposes in exposed applications

344.10(A) Galvanized Steel, Stainless Steel, and Red Brass RMC

Galvanized steel, stainless steel, and red brass RMC permitted under all atmospheric conditions and occupancies

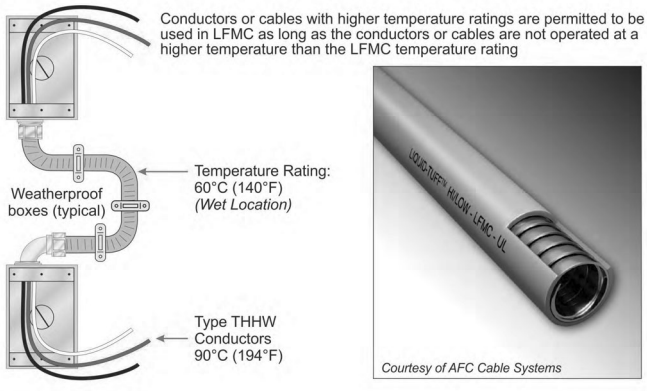


350.10(4) Uses Permitted for Type LFMC

- Conductors or cables with **higher temperature ratings** permitted to be used in LFMC as long as the conductors or cables are **not operated at a higher temperature than the LFMC temperature rating**
- Same provisions allowed for PVC and ENT related to allowing conductors or cables with a rated temperature higher than the listed temperature rating of the raceway to be installed in these type raceways
- Numerous conductors and multiconductor cables with higher temperature ratings than the LFMC listed temperature rating
- Same change occurred for liquidtight flexible nonmetallic conduit (**LFNC**) at **356.10(8)**

350.10(4) Uses Permitted for LFMC

Conductors or cables with higher temperature ratings are permitted to be used in LFMC as long as the conductors or cables are not operated at a higher temperature than the LFMC temperature rating



370.20 Conductor Size and Termination (Cablebus)

- Two **new informational notes** were added to 370.20 related to conductor sizing and terminations for cablebus
- Two new informational notes point to **110.14(C)** for conductors operating **up to 2000 volts** and **110.40** for medium voltage conductors operating **above 2000 volts to 35,000 volts**
- New I-Notes designed to provide direction regarding termination information for the full range of voltages, which can be encountered with cablebus
- Termination temperatures are an important safety concern for electrical installations
- Location of these I-Notes follow 370.20(B), which deals directly with terminations
- Users of Article 370 may not be aware that 110.14(C) and 110.40 apply when the conductors terminate on equipment with a **termination temperature limitation**

370.20 I-Notes Added Cablebus Conductor Sizing and Terminations

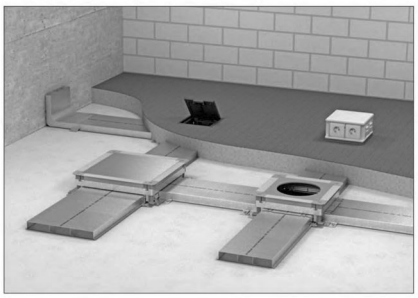
Photo Courtesy of Power Bus Way

374.6 Listing Requirements - (Cellular Metal Floor Raceways)

- New provision added to require **cellular metal floor raceways** shall be **listed**
- Cellular metal floor raceways consist of the hollow spaces in cellular metal floors and associated fittings that serve as enclosures for wires and cables
- This requirement follows a pattern in recent *Code* cycles requiring electrical equipment to be listed
- Many AHJs rely heavily on labeling of equipment under the program of a qualified electrical products testing laboratory
- One of the primary roles of the inspector is to ensure that listed products are installed in accordance with the manner the product has been tested or evaluated and to ensure proper installation and use

374.6 Listing Requirements for Cellular Metal Floor Raceways

A new 374.6 was added to Article 374 requiring all cellular metal floor raceways to be listed



Cellular Metal Floor Raceway

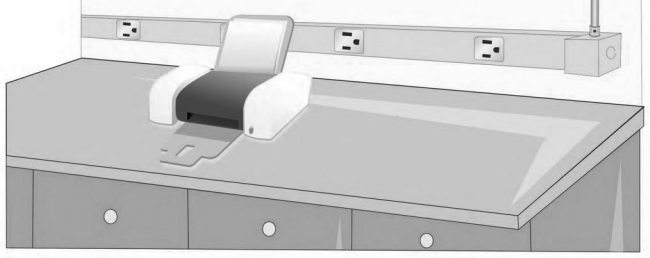
380.12(7) Uses Not Permitted – Multioutlet Assemblies

- New text added **prohibiting** a **multioutlet assembly** from being **cord and plug connected**
- Multioutlet assemblies intended for **permanent connection only** with a branch circuits *(prohibited from employing a cord and plug connection)*
- A multioutlet assembly is "a type of surface, flush, or freestanding raceway designed to hold conductors and receptacles, assembled in the field or at the factory" *(see Article 100)*
- "Multioutlet assemblies" provided with a cord-and-plug connection are readily available, but these devices are not listed as a multioutlet assembly
- This new prohibition is an attempt to make users of the *Code* aware of the product standard **"permanently installed" wiring method** and draw attention to a multioutlet assemblies **listing requirements**

380.12(7) Multioutlet Assembly - Uses Not Permitted

A new List Item (7) was added to 380.12 prohibiting a multioutlet assembly from being utilized with a cord-and-plug connection

Intended for permanent connection only *(per its listing)*

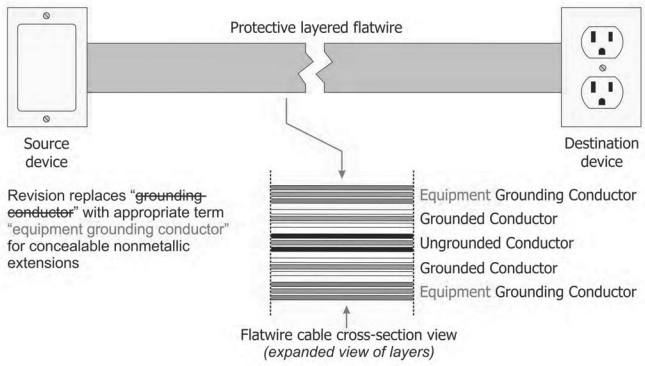


380.12(7) Multioutlet Assembly – Uses Not Permitted

382.104(C) Flat Conductor EGC for Nonmetallic Extensions

- Revision replaces "grounding conductor" with appropriate term "**equipment grounding conductor**" for concealable nonmetallic extensions
- For a nonmetallic extension, the "equipment grounding conductor" must consist of two overall sectioned conductors that enclose the grounded conductor and ungrounded conductor(s)
- The "EGC" layers have to be identified by one of four methods
- The road to proper interpretation and application of *Code* rules is using proper terminology
- "Grounding conductor" and its related definition was removed from the 2008 edition of the *NEC*

382.104(C) Flat Conductor EGC for Nonmetallic Extensions

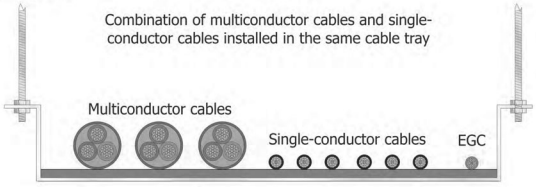


392.10 Single Conductor Cables in Cable Trays

- Revision provides clarity relative to the limitations of **single conductor applications** in cable tray systems
- A reference to **392.10(B)(1)** was added to the parent text of 392.10
- Single-conductor cables are required to be sized at 1/0 AWG or larger and be of a type listed and marked on the surface for use in cable trays
- Where 1/0 AWG through 4/0 AWG single-conductor cables are installed in ladder cable tray, the maximum allowable rung spacing for the ladder cable tray can be no more than 225 mm (9 in.)
- Single conductors used as equipment grounding conductors are required to be insulated, covered, or bare, and they must be sized at 4 AWG or larger

392.10 Single-Conductor Cables in Cable Trays

Single insulated conductors shall be permitted in cable tray only when installed in accordance with 392.10(B)(1)



Single-conductor cables are required to be:

- sized at 1/0 AWG or larger
- of a type listed and marked on the surface for use in cable trays

Where 1/0 AWG through 4/0 AWG single-conductor cables are installed in ladder cable tray, the maximum allowable rung spacing not more than 225 mm (9 in.)

Single conductors equipment grounding conductors required to be insulated, covered, or bare, and sized at 4 AWG or larger

392.30(B)(4) Cable Ties Used for Securement and Support in Cable Trays

- New provision added identifying **cable ties** used to secure and support conductors and cables in a cable tray as an **acceptable means of securement** when identified for securement and support in a cable tray
- Similar to existing requirements already in the *Code* for listing requirements for cable ties *[see 300.22(C)(1), 800.24]*
- If a cable tie is listed to **UL 1565** *(Positioning Devices)* under UL Product Spec category ZODZ, the cable tie has been identified for "**limited support**"
- If a cable tie is listed to **UL 62275** *(Cable management Systems-Cable Ties for Electrical Installations)*, cable tie retains 100% of its declared loop tensile strength (cable ties) or declared mechanical strength (fixing devices)

392.30(B)(4) Cable Ties For Securement and Support in Cable Trays

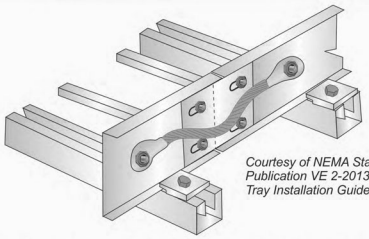
Cable ties used to secure conductors and cables in cable trays required to "be listed and identified for the application and for securement and support"

392.44 Expansion Splice Plates for Cable Trays

- New section added for **expansion splice plates** to address thermal expansion and contraction due to temperature variations for cable trays
- Important that cable tray installations incorporate features which provide adequate compensation for their **thermal contraction and expansion**
- The **length of a straight cable tray run** and the temperature differential will play a vital role in determining the number of expansion splice plates required
- Similar to existing requirements for **raceways** required to be provided with expansion, expansion-deflection, or deflection fittings where necessary to compensate for thermal expansion, deflection, and contraction ***[see 300.7(B)]***
- Expansion joint splice plates and bonding jumpers available from all major cable tray manufacturers

392.44 Expansion Splice Plates For Cable Trays

Expansion splice plates for cable trays required to be provided where necessary to compensate for thermal expansion and contraction



Courtesy of NEMA Standards Publication VE 2-2013 Cable Tray Installation Guidelines

Reproduction of Figure 3-38 Expansion Splice Plate Attachment
(NOTE: In Figure 3-38, a bonding jumper is not required for fiberglass cable tray systems.)

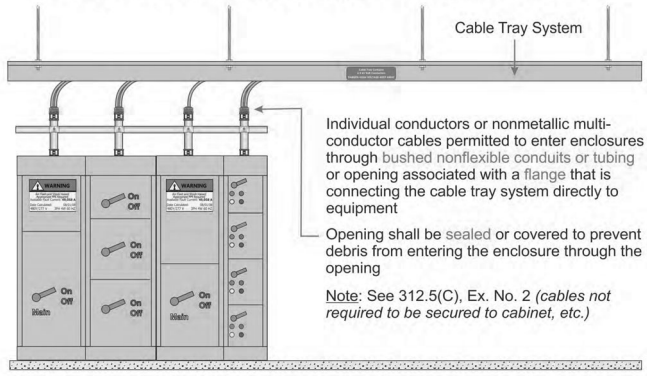
392.46 Bushed Conduit and Tubing at Cable Trays

- New *Code* language added giving permission for individual conductors or multi-conductor cables to enter enclosures through **bushed nonflexible conduits or tubing or opening associated with a flange** that is connecting the cable tray system directly to equipment
- Bringing cables and individual conductors into equipment from a cable tray through bushed conduit and tubing is a common practice with installers
- Without new Code text, there was some confusion in the industry as to whether this practice was *Code* compliant
- A companion change occurred at new **312.5(C), Exception** to clarify where cabinets are involved, the 450 mm (18 in) minimum length for short sections of raceways (nipples) does not apply to 392.46

392.46 Bushed Conduit and Tubing at Cable Trays *(cont.)*

- New *Code* language added giving permission for individual conductors or multi-conductor cables to enter enclosures through **bushed nonflexible conduits or tubing or opening associated with a flange** that is connecting the cable tray system directly to equipment *(cont.)*
- Limited to "**individual conductors or multiconductor cables with entirely nonmetallic sheaths**" as other wiring methods with metallic sheaths such as Type MC cable requires a listed connector to protect the internal conductors from abrasion where the cable is terminated or transitions to another wiring method
- **Sealing requirements** are involved with both 392.46(A) and (B), which calls for require sealing of the conduit or tubing or sealing or covering the opening

392.46 Bushed Conduit, Tubing, and Flanges at Cable Trays



392.46 Bushed Conduit and Tubing for Cable Trays

Chapter Four
Equipment for General Use

400.12 Uses Not Permitted (Flexible Cords and Flexible Cables)

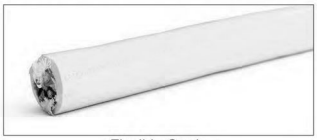
- Revisions were made to include "**flexible cords**" in the "Uses Not Permitted" section along with flexible cables, cord sets, and power supply cords
- During the 2017 *NEC* revision cycle, the rules for "Uses Not Permitted" for flexible cords and cables was revised
- Title of the article was expanded to "**Flexible Cords and Flexible Cables**"
- Section revised to put emphases on both flexible cords and flexible cables
- For the 2017 *NEC* revision, the terms "flexible cables, flexible cord sets, and power supply cords" was used, with "flexible cords" inadvertently left out
- Revised language makes it clear that cord sets (any length) and power-supply cords are not permitted to be used in any of the manners specified at 400.12 *(run through holes in walls, structural ceilings, suspended ceilings, dropped ceilings or floors, run through doorways windows etc.)*

400.12 Uses Not Permitted (Flexible Cords and Flexible Cables) *(cont.)*

- A reference to **590.4** was added to **400.12(4), Exception to (4)**
- Section 590.4 *(Temporary Installations)* permits multiconductor cords or cables of a type identified in Table 400.4 for hard usage or extra-hard usage to be used as temporary feeders by 590.4(B) and as temporary branch circuits by 590.4(C)
- Part of their required conditions for use as a construction job site-type temporary branch circuit or feeder requires the cable assemblies, flexible cords, or flexible cables to "**not be installed on the floor or on the ground**"
- New reference added to the exception will allow temporary flexible cords and flexible cables to be used for temporary installation *(during construction)*, indoors or outdoors, to prevent cord damages by being supported or attached to a building surface

400.12 Uses Not Permitted - Flexible Cords and Flexible Cables

Unless specifically permitted in 400.10, flexible cords, flexible cables, cord sets, and power supply cords shall not be used as specified by 400.12 *(substitute for the fixed wiring, run through holes in walls, run through doorways and windows, where subject to physical damage, etc.)*



Flexible Cords

Flexible Cables

Cord Sets

Power Supply Cords

Table 402.3 Fixture Wires

- A new type of heat-resistant rubber-covered fixture wire **(FFHH-2)** was **added** to Table 402.3
- Fixture wire is covered by **Article 402**, **UL Product Spec Category ZIPR**, and investigated under **UL Product Standard 66**
- Type FFHH-2 fixture wire has a flexible stranding with a maximum operating temperature of **90°C (194°F)**
- Insulation consists of heat-resistant rubber or cross-linked synthetic polymer
- Type FFHH-2 fixture wire comes in sizes **18-16 AWG**

Table 402.3 Fixture Wires *(in part)*

Name	Type Letter	Insulation	AWG	Thickness of Insulation mm	Thickness of Insulation mils	Outer Covering	Max. Operating Temperature	Application Provisions
Heat-resistant rubber-covered fixture wire - flexible stranding	FFH-2	Heat-resistant rubber or	18-16	0.76	30	Nonmetallic covering	75°C (167°F)	Fixture wiring
	FFHH-2	~~Cross~~ cross-linked synthetic polymer	~~18-16~~	~~0.76~~	~~30~~		90°C (194°F)	
ECTFE-solid or 7-strand	HF	Ethylene chloro-trifluoroethylene	18-14	0.38	15	None	150°C (302°F)	Fixture wiring
ECTFE-flexible stranding	HFF	Ethylene chlorotrifluo-roethylene	18-14	0.38	15	None	150°C (302°F)	Fixture wiring
Tape insulated fixture wire - solid or 7-strand	KF-1	Aromatic polyimide tape	18-10	0.14	5.5	None	200°C (392°F)	Fixture wiring -limited to 300 volts
	KF-2	Aromatic polyimide tape	18-10	0.21	8.4	None	200°C (392°F)	Fixture wiring
Tape insulated fixture wire-flexible stranding	KFF-1	Aromatic polyimide tape	18-10	0.14	5.5	None	200°C (392°F)	Fixture wiring -limited to 300 volts
	KFF-2	Aromatic polyimide tape	18-10	0.21	8.4	None	200°C (392°F)	Fixture wiring

**Insulations and outer coverings that meet the requirements of flame retardant, limited smoke, and are so listed, shall be permitted to be marked for limited smoke after the Code type designation.*

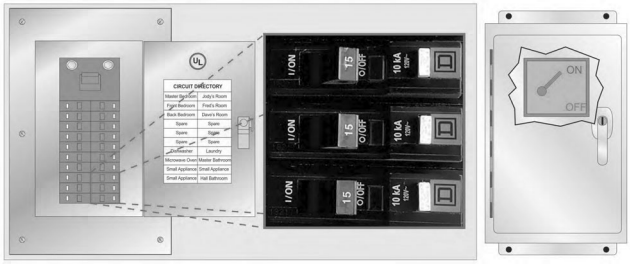
Reproduction of NEC Table 402.3 (in part)

404.7 Indicating Requirements for Switches

- Revisions clarifies that switches and circuit breakers indication must be visible **without opening the enclosure** to see the open/closed indication
- General-use switches and motor-circuit switches, circuit breakers, and molded case switches now required to indicate whether they are in the open (off) or closed (on) position in a **location that is visible when accessing the external operating means**
- Indicating provisions can apply to a circuit breaker located **behind the operable lid** of a panelboard and still comply with this rule
- Indication only applies after the cover is opened or accessed, unless the enclosure is equipped with an external operator
- Revision clarifies that the indication must be visible **when and after accessing the operating means**

404.7 Indicating Requirements for Switches

General-use switches and motor-circuit switches, circuit breakers, and molded case switches required to ~~clearly~~ indicate whether they are in the open (off) or closed (on) position in a location that is visible when accessing the external operating means



"Up" position of the handle generally required to be the closed (on) position

404.9 General-Use Snap Switches, Dimmers, and Control Switches

- Revisions were made to include **other switches with comparable control functions** *(not just snap switches)* in requirements for faceplates, grounding, and construction
- Over the last decade or so, there has been numerous "**control devices**" that are replacing the typical "snap switch" for operating lighting loads
- These other switching control devices must meet and satisfy these faceplate requirements just like a snap switch
- Snap switches, dimmers and control switches required to be **connected to an "equipment grounding conductor"** and a means to connect metal faceplates to the EGC *(whether or not a metal faceplate is installed)* must be provided *(previous rule stated metal faceplate was required to be "grounded")*
- Same basic changes also were implemented at **404.10** for "Mounting of General-Use Snap Switches, Dimmers, and Control Switches"

404.9 General-Use Snap Switches, Dimmers, and Control Switches

Faceplates provided for snap switches, dimmers, and control switches mounted in boxes and other enclosures required to be installed so as to completely cover the opening and, where the switch is flush mounted, seat against the finished surface

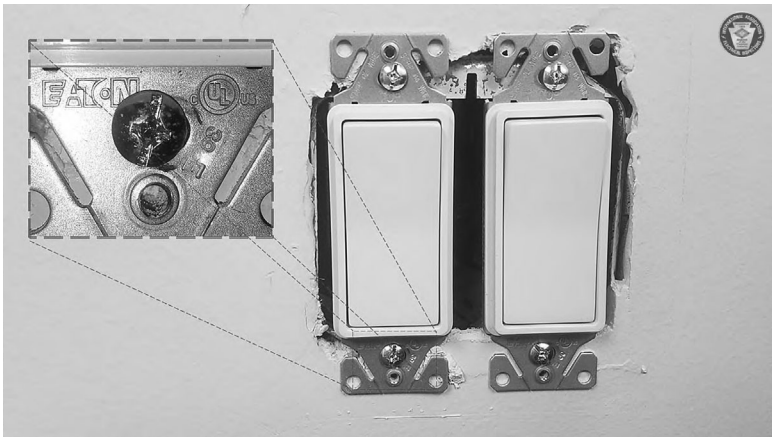
Metal faceplates are required to be bonded to an equipment grounding conductor (EGC)

Listed kits or listed assemblies are not required to be connected to an EGC if (4) conditions are met, including if the device is provided with a nonmetallic faceplate and the device is designed such that no metallic faceplate replaces the one provided

Snap Switches | Dimmers | Control Switches

404.14 Rating and Use of Switches

- Switches will now be required to be **listed** and used within their ratings
- Switches of the types covered in **404.14(A) through (E)** are limited to the control of loads as specified accordingly
- Switches used to control **cord-and-plug-connected loads** are limited as covered in **404.14(F)**
- Equipment used in electrical installations should be listed or labeled by a qualified, third-party electrical products testing laboratory
- **UL 20** (Standards for General-Use Snap Switches) and **UL 1472** (Solid-State Dimming Controls) are among the switching device standards that provide the identified construction, performance, and marking requirements for switching devices to be used in accordance with the *NEC*

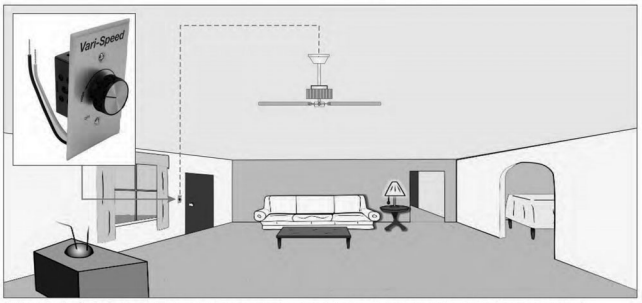


404.22 Electronic ~~Lighting~~ Control Switches

- Revision removes the word "**lighting**" from the phrase "electronic lighting control switches" as these switches may supply **non-lighting loads**
- Many electronic control switches are used in applications well beyond just simply lighting
- These electronic control devices may be used for fan speed control, receptacle control, appliance control, etc.
- The applicable product standards such as **UL 1472** (Solid-State Dimming Controls) describes these devices as simply "electronic control switches"

404.22 Electronic ~~Lighting~~ Control Switches

Electronic ~~lighting~~ control switches are generally prohibited from introducing current on the equipment grounding conductor during normal operation *(future effective date of January 1, 2020)*

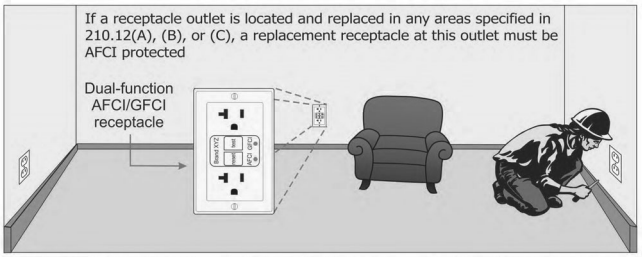


Electronic ~~lighting~~ control switches are required to be listed *(not just lighting controls)*

406.4(D)(4) Requirement Receptacles (AFCI)

- Previous Ex. No. 1 to AFCI replacements was **deleted** *(no longer relevant)*
- Commercially obtainable devices *(such as a dual-function AFCI/GFCI receptacle outlet)* are **readily available** that can satisfy the main rule rendering the exception irrelevant
- Previous Ex. No. 1 exempted AFCI protection where all the following applied:
  - (1) The replacement complies with 406.4(D)(2)(b)
  - (2) It is impracticable to provide an EGC as provided by 250.130(C)
  - (3) Listed combination type AFCI circuit breaker not commercially available
  - (4) GFCI/AFCI dual function receptacles are not commercially available

406.4(D)(4) Replacement Receptacles (AFCI)



Ex. No. 1: ~~AFCI protection not required where all of the following apply: (1) Replacement complies with 406.4(D)(2)(b) *(two-wire system-GFCI)*, (2) Impracticable to provide an EGC as provided by 250.130(C), (3) Listed combination type AFCI circuit breaker not commercially available, (4) GFCI/AFCI dual function receptacles not commercially available~~

Previous Ex. No. 1 to AFCI replacements was deleted as it is no longer relevant and products that comply with the main requirement are readily available

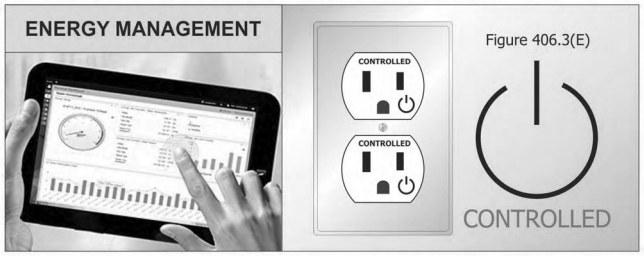
406.4(D)(7) Requirement of Automatically Controlled Receptacles

- Automatically controlled receptacles are now required to be replaced with **equivalently controlled receptacles**
- Section **406.3(E)** provides **identification marking requirements** of controlled receptacle *(marked with the word "Controlled" on the controlled receptacle along with a controlled receptacle symbol)*
- Receptacle(s) managed by an **energy management system** that are replaced will now be required to be replaced with equivalently controlled receptacles
- If a remodel or renovation results in the automatically controlled receptacle **no longer being required to be automatically controlled**, the receptacle and any associated receptacle markings would be required to be replaced with a receptacle and faceplate not marked in accordance with 406.3(E)

406.4(D)(7) Replacement of Automatically Controlled Receptacles

Automatically controlled receptacles to be replaced with equivalently controlled receptacles

If automatic control is no longer required, receptacles and associated 406.3(E) receptacle markings to be replaced with a receptacle and faceplate not marked in accordance with 406.3(E)



All nonlocking-type, 125-volt, 15- and 20-ampere receptacles controlled by an automatic control device, energy management, or building automation shall be marked with the "Controlled Receptacle Marking Symbol" from Figure 406.3(E) and the word "CONTROLLED" *[see 406.3(E)]*

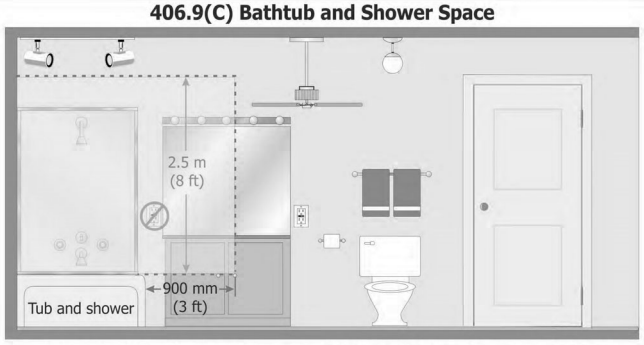
406.5(G)(2) Receptacle Mounting Under Sinks

- Receptacle outlets are now **prohibited** from being installed in the area **beneath a sink** in the **face-up position**
- Receptacle outlets have been prohibited for being installed in the face-up position in or on **countertop surfaces or work surfaces** since the **2002 *NEC*** *(dwelling units)* and all countertops and work surfaces since the **2014 *NEC***
- Common sight to see plumbing pipes connecting to a sink (supply and drain) leaking from time-to-time under a sink area such as a kitchen sink
- Receptacle for such things as a garbage disposer installed in the face-up position under the sink is subject to water entering the **polarized slots of the receptacle** creating a hazardous condition
- New language will help mitigate a **potential hazard**

406.9(C) Bathtub or Shower Stall Restricted "Zone" (Receptacles)

- Receptacle outlet(s) located in the area around a **bathtub or shower stall** have been revised to include a **restricted "zone"** similar to luminaires in said areas with an exception added for smaller space bathrooms
- Receptacles are now prohibited from being installed within a zone measured **900 mm (3 ft) horizontally** and **2.5 m (8 ft) vertically** from the top of the bathtub rim or shower stall
- In bathrooms with dimensions less than the required zone, receptacle(s) are permitted to be installed opposite the bathtub rim or shower stall threshold on the **farthest wall within the room**
- Previous language at 406.9(C) stated that receptacles were not be installed "within or directly over a bathtub or shower stall"
- This language was **vague** leading to **confusion** and **inconsistent interpretation** as to what defined the bathtub or shower stall "area"

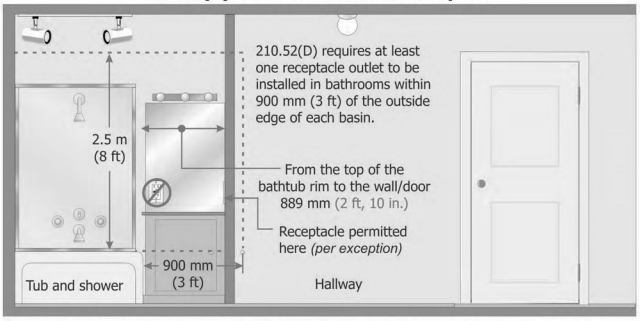
406.9(C) Bathtub and Shower Space



Receptacles shall not be installed within a zone measured 900 mm (3 ft) horizontally and 2.5 m (8 ft) vertically from the top of the bathtub rim or shower stall threshold.

Exception: In bathrooms with less than the required zone the receptacle(s) permitted to be installed opposite the bathtub rim or shower stall threshold on the farthest wall within the room.

406.9(C) Bathtub and Shower Space



Receptacles shall not be installed within a zone measured 900 mm (3 ft) horizontally and 2.5 m (8 ft) vertically from the top of the bathtub rim or shower stall threshold.

Exception: In bathrooms with less than the required zone the receptacle(s) permitted to be installed opposite the bathtub rim or shower stall threshold on the farthest wall within the room.

406.12 Tamper-Resistant Receptacles

- Requirements for **tamper-resistant (TR) receptacles** were **expanded**
- New areas include: **(1)** Attached and detached garages and accessory buildings of dwelling units, **(2)** Common areas of multifamily dwelling units, **(3)** Common areas of and hotels and motels, and **(4)** Assisted living facilities
- Attached and detached garages and accessory buildings to dwelling units are subject to the same TR receptacle requirements of the main dwelling unit
- At 406.12(4), the word "**elementary**" was **removed** leaving the term "**preschools and education facilities**" as places requiring TR receptacles
- Difficult for the AHJ to determine what age group of students will be utilizing the space

406.12 Tamper-Resistant Receptacles *(cont.)*

- The word "**waiting**" was changed to "**awaiting**" at 406.12(6) to match the wording used at **518.2** for examples of assembly occupancies where the term "**Places of awaiting transportation**" is used
- 406.12(6) now includes "places of awaiting transportation, gymnasiums, skating rinks, and auditoriums" that require TR receptacles
- The word "**Dormitories**" was changed to "**Dormitory units**" at 406.12(7) to match the newly defined term now found in Article 100
- **Assisted living facilities** are becoming commonplace around the country, which are essentially dwelling units but typically don't qualify as a dwelling unit as they **typically cannot meet the definition of a dwelling unit** as defined in Article 100 *(no permanent provision for cooking)*

406.12 Tamper-Resistant Receptacles

TR receptacles requirements or clarification was expanded to the following areas:

Attached and detached garages and accessory buildings to dwelling units

Common areas of multifamily dwellings and common areas of guest rooms and guest suites of hotels and motels

Assisted living facilities as small children can be present in these facilities as well

406.12 Tamper-Resistant Receptacles

TR receptacles requirements or clarification was expanded to the following areas:

Attached and detached garages and accessory buildings to dwelling units

Common areas of multifamily dwellings and common areas of guest rooms and guest suites of hotels and motels

Assisted living facilities as small children can be present in these facilities as well

406.13 Single-Pole Separable-Connector Type

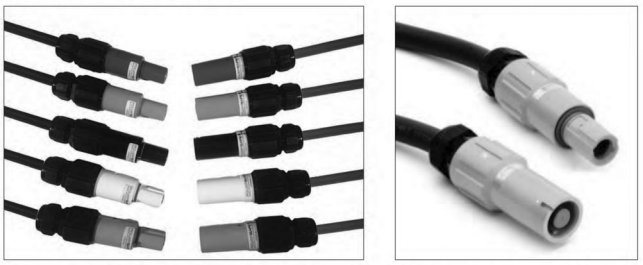
- New requirements were added to Article 406 pertaining to "**single-pole separate connectors**"
- Single-pole separable-connector are addressed in Article 520 *(Theaters, Audience Areas of Motion Picture and Television Studios, Performance Areas, and Similar Locations)* and Article 530 *(Motion Picture and Television Studios and Similar Locations)*
- A "Single-Pole Separable Connector" is defined as "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."
- Common industry practice to provide paralleled inputs of single-pole separable connectors on equipment so that paralleled sets of single conductor feeders may be used for powering high amperage equipment

406.13 Single-Pole Separable-Connector Type *(cont.)*

- New requirements were added to Article 406 pertaining to "**single-pole separate connectors**" *(cont.)*
- Article 406 contained requirements for a variety of different types of plugs and receptacles such as receptacle with USB charger, tamper-resistant receptacles and weather-resistant receptacles, but article did not address single pole separable connectors
- New section covers listing and labeling, locking or latching type connectors, marking requirements, proper identification of the grounded circuit conductor (white-colored housing) and connectors designated for connection to the EGC (green-colored housing), interchangeability for ac or dc use or for different current ratings or voltages, and identification of the proper connection and disconnection sequence necessary for the safe use of these devices

406.13 Single-Pole Separable-Connectors

New section added to Article 406 at 406.13 titled, "Single-Pole Separable-Connector Type" covering the construction as well as the performance and marking requirements for listed single-pole separable-connectors

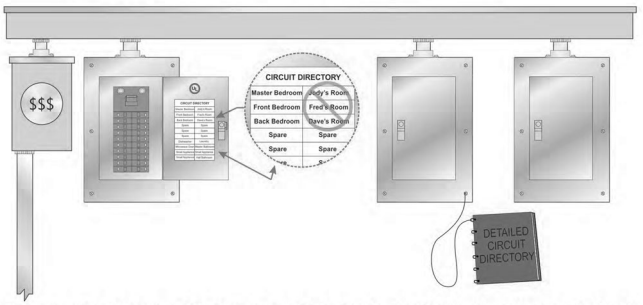


Single-Pole Separable Connector. A device that is installed at the ends of portable, flexible, single-conductor cable that is used to establish connection or disconnection between two cables or one cable and a single-pole, panel-mounted separable connector.

408.4(A) Circuit Directory or Circuit Identification

- Revisions were made to allow the circuit directory for a panelboard to be located in an "**approved location adjacent**" to the panelboard door
- Previous requirement only allowed circuit directory to be located **on the face or inside of the panel door** in the case of a panelboard
- All panelboard circuits and any circuit modifications are required to be legibly identified as to its clear, evident, and specific purpose or use with an approved degree of detail to distinguish each circuit from all others
- This adjacent location could include a **prominently labeled notebook** of circuit directories for adjacent panelboards that might even include graphics
- Only so much "**real estate**" inside of a panelboard lid or door
- New allowance of an adjacent location for the circuit directory supports the concept that the **more detail that is provided in a circuit directory the better** in terms of meeting the safety objectives of 408.4

408.4(A) Circuit Directory or Circuit Identification



Every circuit and circuit modification required to be legibly identified as to its clear, evident, and specific purpose or use

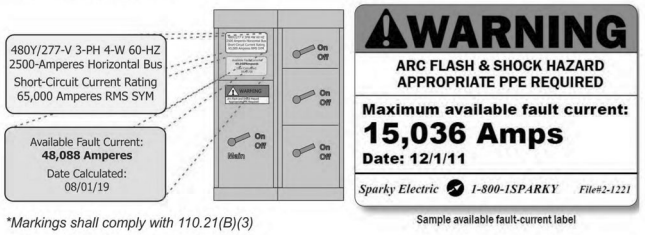
Identification required to be included in a circuit directory that is located on the face, inside of, or in an approved location adjacent to the panel door in the case of a panelboard

408.6 Short-Circuit Current Rating for *Switchboards, Switchgear, and Panelboards*

- New requirement added for **available fault current** and **date calculation performed** to be **field marked** on the enclosure at the point of supply for switchboards, switchgear, and panelboards *(other than dwelling units)*
- All switchboards, switchgear, and panelboards *(including panelboards at dwelling units)* are required to have a short-circuit current rating not less than the available fault current
- Enforcement community has a difficult time enforcing proper fault current ratings on such equipment as switchboards, switchgear, and panelboards without the knowledge of the available fault current
- Equipment is usually properly marked with the **short-circuit current rating** by the manufacturer, but there is typically no information on the jobsite as to the **available fault current at the equipment**
- *NEC* clearly addresses short-circuit current ratings for specialized equipment such as industrial control panels in **409.22**, elevators in **620.16** and industrial machinery in **670.5**

408.6 Short-Circuit Current Rating for Switchboards, Switchgear, and Panelboards

Switchboards, switchgear, and panelboards must have a short-circuit current rating not less than the available fault current



**Markings shall comply with 110.21(B)(3)*

Sample available fault-current label

Available fault current and the date the calculation was performed to be field marked on the enclosure at the point of supply *(other than one- and two-family dwelling units)*

408.8 Reconditioning of Equipment (Switchboards, Switchgear, and Panelboards)

- New section added to address **reconditioning** of panelboards **(No)** and switchboards and switchgear **(Yes)**
- Marking requirement for reconditioned equipment at **110.21(A)(2)**
- Panelboards are defined as encompassing the bus structure but not the enclosure, typically a cabinet *(fundamentally different from switchboards and switchgear)*
- Panelboard listings are available for bus structures that can be field mounted in enclosures, as is appropriate
- Buswork itself is unlikely to be fit for reconditioning, but replacement is generally an option with field inspection and without additional listing
- When the available fault current exceeds 10,000 amperes, the enclosure must be evaluated in conjunction with the panel bus

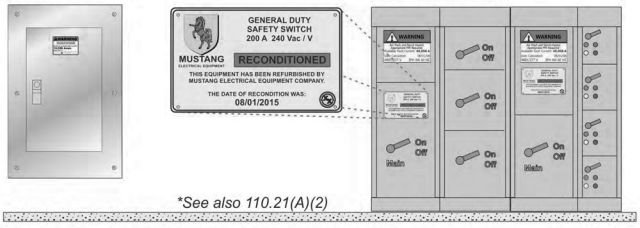
408.8 Reconditioning of Equipment (Switchboards, Switchgear, and Panelboards)

- New section added to address **reconditioning** of panelboards **(No)** and switchboards and switchgear **(Yes)** *(cont.)*
- Switchboards and switchgear can be reconditioned, and typically that work is **done in place** due to the inherent construction difficulties and expense in removing and reinstalling it *(involves a field evaluation)*
- In some cases an accident may damage a section but not warrant condemning an entire switchboard or switchgear line-up

408.8 Reconditioning of Equipment for Switchboards, Switchgear, and Panelboards

Panelboards NOT Permitted to be Reconditioned

Switchboards and Switchgear Permitted to be Reconditioned



*See also 110.21(A)(2)

Panelboards shall not be permitted to be reconditioned

Switchboards and switchgear, or sections of switchboards or switchgear, shall be permitted to be reconditioned

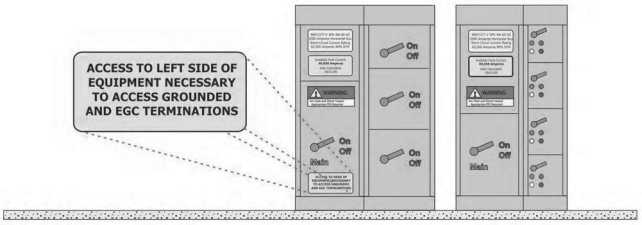
408.18(C) Switchboards and Switchgear Requiring Rear or Side Access

- New provision will require switchboards and switchgear requiring **rear or side access** to be marked (by manufacturer) on the front of said equipment indicating rear or side access is needed
- Existing 408.3(D) was moved to new 408.18(C) to emphasis the requirement that **grounded and grounding terminals** be installed such that it is not necessary to reach across ungrounded bus or terminal(s) to make connections
- Where a section of a switchboard or switchgear has an opening requiring rear or side access, that opening must provide proper working space as called for by 110.26
- This type of gear is often installed against a wall, precluding rear or side access, especially if it is not known that rear or side access is needed

408.18(C) Switchboards and Switchgear Requiring Rear or Side Access *(cont.)*

- New provision will require switchboards and switchgear requiring **rear or side access** to be marked (by manufacturer) on the front of said equipment indicating rear or side access is needed *(cont.)*
- Without this new rule for manufactures to provide a **label on the front of the equipment**, this is a problem that will only intensify as market pressures on scarce electrical room areas steadily limit the placement of switchgear in the middle of a floor

408.18(C) Switchboards and Switchgear - Rear or Side Access



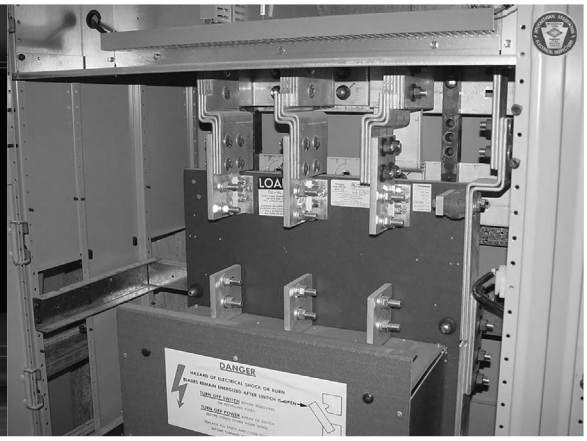
For switchboards and switchgear, each section of equipment that requires rear or side access to make field connections shall be so marked by the manufacturer on the front of said equipment

Section openings requiring rear or side access shall comply with 110.26 *(working space)*

Load terminals for field wiring shall comply with 408.18(C)(1), (C)(2), or (C)(3) *(prohibits reaching across ungrounded uninsulated bus to make connections)*

408.18(C) Switchboards and Switchgear – Rear and Side Access

408.18(C) Switchboards and Switchgear – Rear and Side Access

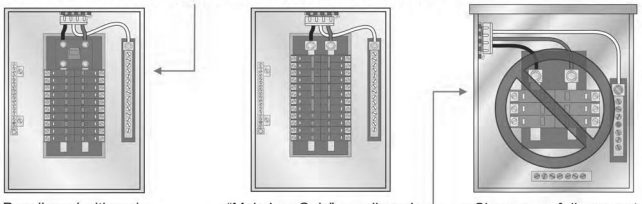


408.36 Overcurrent Protection for Panelboards

- Existing Ex. No. 1 was **deleted** due to revisions to **230.71(B)**, which eliminates more than one service disconnecting means in the **same panelboard or enclosure**
- 230.71(B) allows up to six means of disconnect for a service, but the multiple disconnecting means must now be located in **separate enclosures** *(no longer permitted to be located in the same enclosure)*
- Panelboards are generally required to be provided with individual overcurrent protected having a rating not greater than that of the panelboard with OCPD iocated within the panelboard itself or at any point on the supply side of the panelboard
- Previous Ex. No. 1 rule gave permission to exclude this individual overcurrent protection if the panelboard was being used as service equipment with up to six means of disconnect as previously permitted by 230.71

408.36 Overcurrent Protection for Panelboards

Panelboards generally required to be provided with individual overcurrent protected having a rating not greater than that of the panelboard with this overcurrent protection located within the panelboard itself or at any point on the supply side of the panelboard



Panelboard with main in same cabinet

"Main Lug Only" panelboard *(with main at supply side of feeder)* [408.36, Ex. No. 1]

Six means of disconnect in one enclosure [previous 408.36, Ex. No. 1]

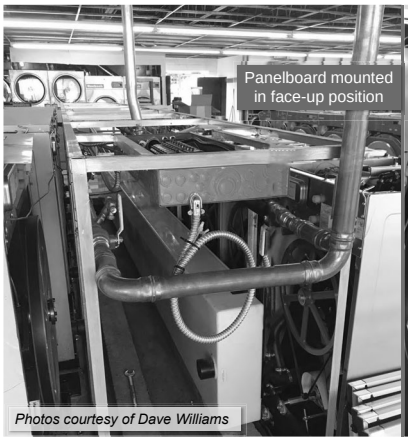
408.36 Ex. No. 1 was deleted with revision of 230.71(B) which allows up to six means of disconnect for a service, but the multiple disconnecting means must now be located in separate enclosures *(no longer permitted to be located in the same enclosure)*

408.43 Panelboard Orientation

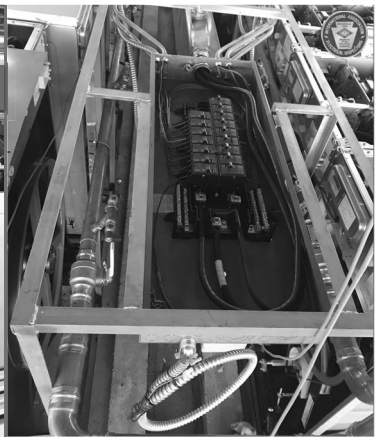
- Panelboards shall not be installed in the **face-up position**
- Installing panelboards in a face-up position increases the likelihood that **contaminants** accumulate on the circuit breakers and panelboard bussing, creating a hazard
- Additionally creates a challenge with applying **work space requirements**
- New text prevents the installation of panelboards in the face-up position and no overcurrent devices would be allowed on such a panelboard
- It should be noted that this new limitation does not prohibit the mounting of a panelboard in a horizontal face-down position

408.43 Panelboard Orientation

408.43 Panelboard Orientation: Panelboards shall not be installed in the face-up position.



Photos courtesy of Dave Williams



410.2 Definitions: Clothes Closet Storage Space and 410.16 Luminaires in Clothes Closets

- The word **"Clothes"** was added at the definition," Figure 410.2 and the requirements of 410.16 to limit these requirements to "**Clothes Closet Storage Spaces**"
- Previously throughout Article 410 storage spaces were often referred to as "closet storage space"
- 1990 *NEC* substantiation that brought about limitations for luminaires in storage closets was indeed based on **clothes closets**
- This revision could necessitate research into **other types of closet storage** *(bath towels, blankets, bed sheets, etc.)*
- Other types of storage closets perhaps need this same protection as a clothes closet

410.2 Definitions: Clothes Closet Storage Space and 410.16 Luminaires in Clothes Closets

Clothes Closet Storage Space. The volume bounded by the sides and back closet walls and planes extending from the closet floor vertically to a height of 1.8 m (6 ft) or to the highest clothes-hanging rod and parallel to the walls at a horizontal distance of 600 mm (24 in.) from the sides and back of the closet walls, respectively, and continuing vertically to the closet ceiling parallel to the walls at a horizontal distance of 300 mm (12 in.) or the width of the shelf, whichever is greater; for a closet that permits access to both sides of a hanging rod, this space includes the volume below the highest rod extending 300 mm (12 in.) on either side of the rod on a plane horizontal to the floor extending the entire length of the rod.

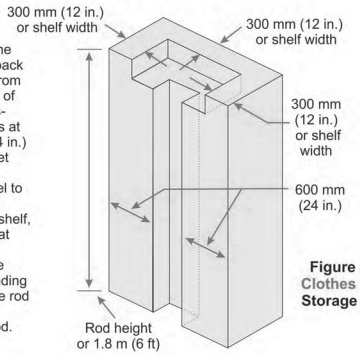
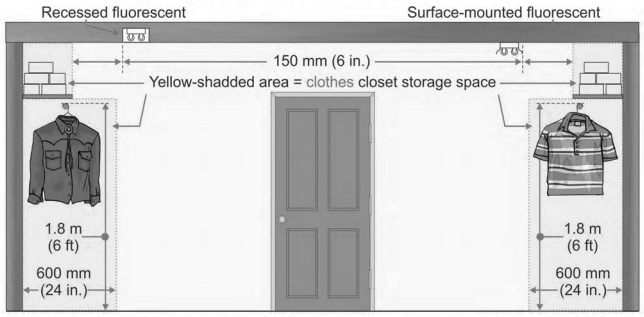


Figure 410.2 Clothes Closet Storage Space

410.2 Definitions: Clothes Closet Storage Space and 410.16 Luminaires in Clothes Closets



Surface-mounted fluorescent or LED luminaires permitted to be installed within the clothes closet storage space where identified for such use

410.36(A) Luminaires Supported By Outlet Boxes

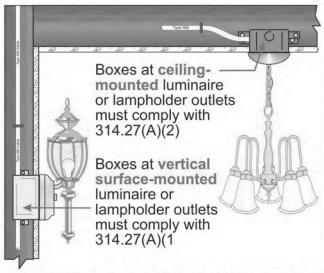
- Revision illustrates that luminaires can be supported in accordance with **separable attachment fittings** and these outlet boxes are considered lighting outlets
- Outlet boxes or fittings installed as required by the support methods of 314.23 and complying with the provisions of **314.27(A)(1)** (vertical surface outlets) and **314.27(A)(2)** (ceiling outlets) permitted to support luminaires
- Luminaires are now also permitted to be supported in accordance with **314.27(E)** *(Separable Attachment Fittings)* and outlet boxes complying with 314.27(E) are considered lighting outlets
- Revised text clarifies that there is no requirement to add yet another lighting outlet with these 314.27(E) compatible devices

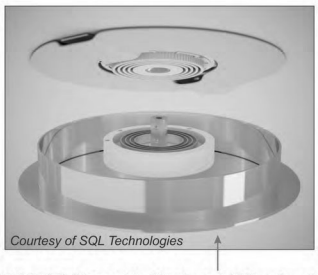
410.36(A) Luminaires Supported By Outlet Boxes *(cont.)*

- Revision illustrates that luminaires can be supported in accordance with **separable attachment fittings** and these outlet boxes are considered lighting outlets *(cont.)*
- **Separable attachment fittings** incorporate listed power supply devices and listed locking support and mounting receptacles and supporting means as an option for mounting and supporting luminaires, lampholders, and ceiling suspended (paddle) fans
- Same basic change at **new 422.22** for appliances and installing a ceiling suspended (paddle) fan

410.36(A) Luminaires Supported By Outlet Boxes

Outlet boxes or fittings installed as required by the support methods of 314.23 and complying with provisions of 314.27(A)(1) (vertical surface outlets) and 314.27(A)(2) (ceiling outlets) permitted to support luminaires




Courtesy of SQL Technologies

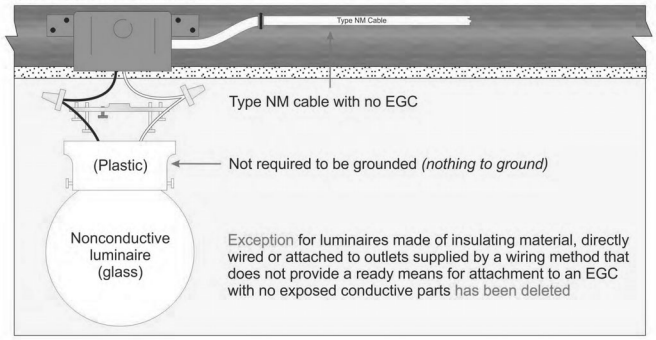
Luminaires also permitted to be supported per 314.27(E) (Separable Attachment Fittings) and outlet boxes complying with 314.27(E) are considered lighting outlets

410.44 Methods of Grounding Luminaires

- **Previous Ex. No. 1 to 410.44 was deleted** since there is no requirement for a luminaire with no accessible conductive parts, or a luminaire made of insulating material to be grounded
- Luminaires and equipment are generally required to be mechanically connected (grounded) to an equipment grounding conductor
- There are no *NEC* requirements for a luminaire with "no exposed conductive parts," or a luminaire "made of insulating material'" to be grounded *(connected to an equipment grounding conductor) (**no need to "exempt" such a luminaire** from the grounding requirements for a luminaire)*
- The term "**made of insulating material**" in the deleted exception was felt to be too broad of a term

410.44 Methods of Grounding Luminaires

Luminaires are generally required to be mechanically connected (grounded) to an equipment grounding conductor (EGC)



410.69 Identification of Control Conductors

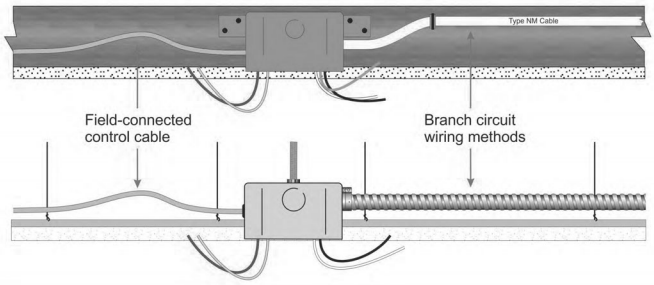
- New section added to prevent **lighting control conductors** from being installed using the **same color schemes** as the branch circuit grounded conductors and the equipment grounding conductor
- Future effective date of **January 1, 2022**
- Becoming more and more commonplace to control lighting with **low voltage** lighting control conductors and devices
- **Lighting control conductors** are used to communicate commands and other information between control devices in lighting system and the luminaire, etc.
- In today's modern social media society, for a more advanced functionality and flexible lighting system, **dedicated control wiring** may be needed

410.69 Identification of Control Conductors *(cont.)*

- New section added to prevent **lighting control conductors** from being installed using the **same color schemes** as the branch circuit grounded conductors and the equipment grounding conductor *(cont.)*
- This wiring is typically low voltage *(Class 2, 12–24-volt dc)*, providing a pathway for communication of analog or digital signals, such as incoming sensor input data *(lighting levels, occupancy sensing conditions, etc.)*
- Multiple **shock incidents** that have occurred and been reported involving the low voltage lighting control conductors being inadvertently spliced or connected to the grounded (neutral) conductor for the nominal voltage wiring system
- One very common lighting control conductor scheme is to use "**purple and gray**" colored lighting control conductors *("continuous white or gray outer finish" reserved for identification of grounded conductor systems)*

410.69 Identification of Control Conductor

Field-connected control conductor not permitted to utilize the same color identification scheme as reserved for the grounded branch-circuit conductor (white or gray) or the EGC (green) where control conductors are spliced, terminated, or connected in the same luminaire or enclosure as the branch-circuit conductors *(Future effective date of January 1, 2022)*



410.116(C) Recessed Luminaires Installed in Fire-Resistant Construction

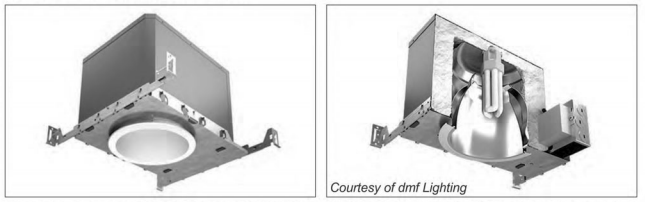
- The requirements for **recessed luminaires** installed in **fire-resistance construction** revised to be consistent with current listing options and relocated to 410.116(C)
- Recessed luminaires installed in fire-resistant construction must be **listed for use in a fire resistance-rated construction** and the recessed luminaire is required to be installed in or used with a **luminaire enclosure that is listed for use in a fire resistance-rated construction**
- Must also be installed in accordance with a tested **fire resistance-rated assembly**
- New text at 410.116(C) also recognizes the use of recessed **LED luminaires** of comparable construction for recessed installations in a building of fire-resistant construction

410.116(C) Recessed Luminaires Installed in Fire-Resistant Construction

Recessed luminaires installed in fire-resistant construction must be listed for use in a fire-rated construction and required to be installed in or used with a luminaire enclosure that is listed for use in a fire-rated construction

Must also be installed in accordance with a tested fire resistance-rated assembly

Recessed LED luminaires of comparable construction permitted for recessed installations in a building of fire-resistant construction



Courtesy of dmf Lighting

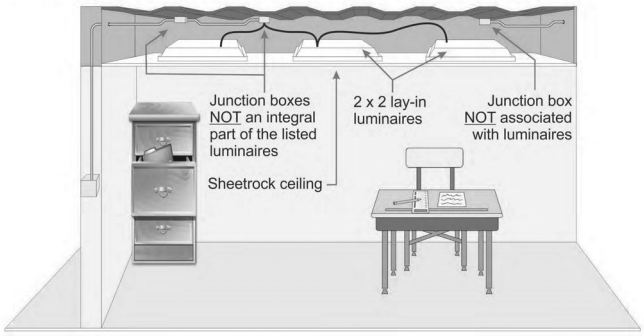
Luminaires marked "FOR USE IN NON-FIRE-RATED INSTALLATIONS" prohibited in fire-rated installations

410.118 Access to Other Boxes

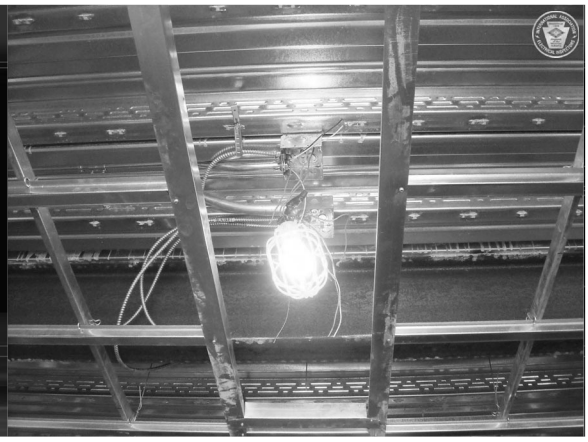
- New section added to clarify that a luminaire cannot be used to access outlet, pull, or junction boxes or conduit bodies that are **not associated with** wiring for that luminaire
- Luminaires recessed in ceilings, floors, or walls are now prohibited from being used to access outlet, pull, or junction boxes or conduit bodies unless the box or conduit body is an **integral part of the listed luminaire**
- Previously selected installations involved recessed luminaires that were fastened to structural components of a dropped ceiling and designed and intended to be used to access junction boxes for wiring that was not associated with these recessed luminaires
- These installations involved fixed ceilings *(no removable ceiling tiles)*, with junction boxes **not visible or accessible** without the removal of the luminaire

410.118 Access to Other Boxes

Luminaires recessed in ceilings, floors, or walls shall not be used to access outlet, pull, or junction boxes or conduit bodies, unless the box or conduit body is an integral part of the listed luminaire.



410.118 Access to Other Boxes *(thru Luminaires)*



Article 410, Part XVI Special Provisions for Horticultural Lighting Equipment

- A new **Part XVI** was added to **Article 410** with special provisions for **Horticultural Lighting Equipment**
- These new requirements respond to rapidly increasing industry of indoor plant growing facilities
- Luminaires used for growing plants are very specialized
- Equipment installed in a horticultural environment is commonly exposed to dust, water spray, high humidity levels, and high ambient temperatures
- To maximize plant growth, horticultural lighting equipment can be designed with **flexible cord and plug supply connections** in lieu of a permanent connection to make the equipment adjustable
- Horticultural lighting equipment also produces **light wavelengths and intensities** different than that needed for general illumination and requires additional protection for users against light exposure

Article 410, Part XVI Special Provisions for Horticultural Lighting Equipment *(cont.)*

- A new **Part XVI** was added to **Article 410** with special provisions for **Horticultural Lighting Equipment** *(cont.)*
- New Part XVI will cover such things as listing requirements, installation and use, locations not permitted, general lighting requirements, flexible cord provisions, fittings and connectors, grounding requirements, GFCI protection provisions, supporting requirements and requirements for installations in hazardous (classified) locations
- While **Article 547** has requirements for **agricultural buildings**, horticultural lighting installations have **special considerations** not previously addressed by the *Code*
- These new *Code* requirements were needed to ensure safe installations and to facilitate inspection procedures

Article 410, Part XVI
Special Provisions for Horticultural Lighting Equipment

New Part XVI of Article 410 will cover such things as listing requirements, installation and use, locations not permitted, general lighting requirements, flexible cord provisions, fittings and connectors, grounding requirements, GFCI protection provisions, supporting requirements and requirements for installations in hazardous (classified) locations

422.5(A) GFCI Protection for Appliances

- The "**provided for public use**" condition has been removed from GFCI requirements for both **automotive vacuum machines** and **tire inflation machines**
  - With this phrase in place, GFCI protection for automotive vacuum machines and tire inflation machines that were NOT "provided for public use" was eliminated
- **Sump pumps** has been added to the list of appliances requiring GFCI protection
  - Previously, a sump pump might have been required to be GFCI protected, but only because of its location *(in an unfinished basement, etc.)*, not because it was a "sump pump"

422.5(A) GFCI Protection for Appliances *(cont.)*

- **Bottle fill stations** was added to GFCI requirements for drinking water coolers
  - Bottle fill stations are often integral with or installed adjacent to a drinking water cooler and present similar risk of electric shock hazard
- GFCI requirements for **dishwashers** moved from 210.8(D) to 422.5(A)(7)
  - Article 210 is dedicated to the requirements for branch circuits *(better served by having the all the GFCI requirements for appliances located in Article 422)*
  - This GFCI rule would now encompass **dishwashers** rated at 150 volts or less to ground and 60 amperes or less, single- or 3-phase located at a **non-dwelling unit location**, such as a restaurant, school cafeteria, etc. ***(previously limited to dwelling unit dishwashers)***

422.5(A) GFCI Protection for Appliances

GFCI requirements for Appliances *(150 volts or less to ground and 60 amperes or less, single- or 3-phase)* shall be provided with Class A GFCI protection for personnel *(Multiple GFCI devices permitted but not be required)*

(1) Automotive vacuum machines ~~provided for the public~~; (2) Drinking water coolers and bottle fill stations; (3) Cord-and-plug-connected high-pressure spray washing machines; (4) Tire inflation machines ~~provided for the public~~; (5) Vending machines; (6) Sump pumps; (7) Dishwashers

422.5(A) GFCI Protection for Appliances

GFCI requirements for Appliances *(150 volts or less to ground and 60 amperes or less, single- or 3-phase)* shall be provided with Class A GFCI protection for personnel *(Multiple GFCI devices permitted but not be required)*

Automotive vacuum machines

Tire inflation machines

(1) Automotive vacuum machines ~~provided for the public~~; (2) Drinking water coolers and bottle fill stations; (3) Cord-and-plug-connected high-pressure spray washing machines; (4) Tire inflation machines ~~provided for the public~~; (5) Vending machines; (6) Sump pumps; (7) Dishwashers

422.5(A) GFCI Protection for Appliances

GFCI requirements for Appliances *(150 volts or less to ground and 60 amperes or less, single- or 3-phase)* shall be provided with Class A GFCI protection for personnel *(Multiple GFCI devices permitted but not be required)*

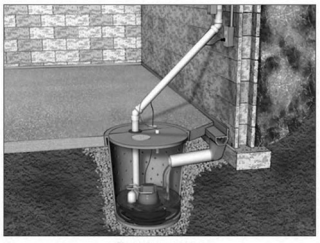
Drinking water coolers

Bottle fill stations

(1) Automotive vacuum machines ~~provided for the public~~; (2) Drinking water coolers and bottle fill stations; (3) Cord-and-plug-connected high-pressure spray washing machines; (4) Tire inflation machines ~~provided for the public~~; (5) Vending machines; (6) Sump pumps; (7) Dishwashers

422.5(A) GFCI Protection for Appliances

GFCI requirements for Appliances *(150 volts or less to ground and 60 amperes or less, single- or 3-phase)* shall be provided with Class A GFCI protection for personnel *(Multiple GFCI devices permitted but not be required)*



Sump pumps

Sump pumps

(1) Automotive vacuum machines ~~provided for the public~~; (2) Drinking water coolers and bottle fill stations; (3) Cord-and-plug-connected high-pressure spray washing machines; (4) Tire inflation machines ~~provided for the public~~; (5) Vending machines; (6) Sump pumps; (7) Dishwashers

422.5(A) GFCI Protection for Appliances

GFCI requirements for Appliances *(150 volts or less to ground and 60 amperes or less, single- or 3-phase)* shall be provided with Class A GFCI protection for personnel *(Multiple GFCI devices permitted but not be required)*

Dishwashers (Dwelling units)

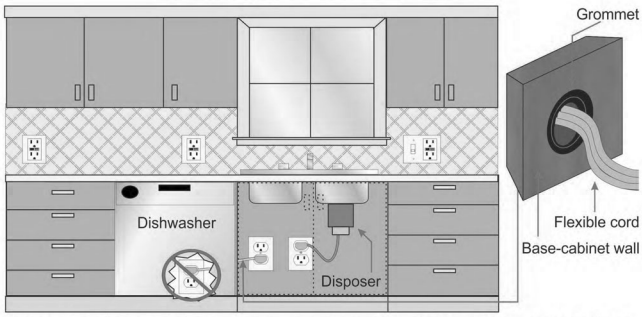
Dishwashers (Non-dwelling unit)

(1) Automotive vacuum machines ~~provided for the public~~; (2) Drinking water coolers and bottle fill stations; (3) Cord-and-plug-connected high-pressure spray washing machines; (4) Tire inflation machines ~~provided for the public~~; (5) Vending machines; (6) Sump pumps; (7) Dishwashers

422.16(B)(2) Flexible Cords for Built-in Dishwashers

- A flexible cord to an **adjacent space for a dishwasher** passing through an opening is now required to be protected in the form of a **bushing, grommet or other approved means**
- Dishwashers permitted to be cord-and-plug connected *(not required)*
- If cord-and-plug connected, receptacle outlet is required to be located in the **space adjacent to** the space occupied by the dishwasher with a maximum length of a cord for a built-in dishwasher of 2.0 m (6.5 ft)
- When the flexible cord passes through a **drilled or rough opening**, such as in a base-cabinet, these openings can sometimes cause **damage to the flexible cord** during installation or servicing potentially requiring additional protection

422.16(B)(2) Built-In Dishwashers



Receptacle outlet for cord-and-plug connected built-in dishwasher required to be located in the space adjacent to the dishwasher with the max. length of the cord 2.0 m (6½ ft)

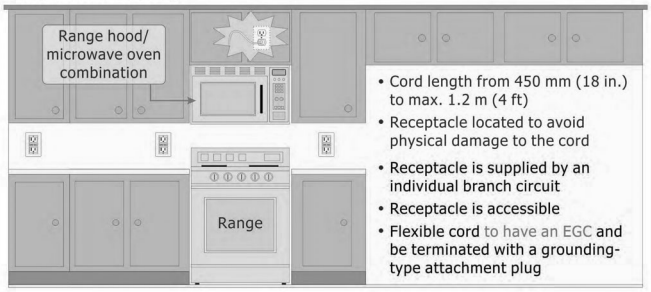
Flexible cord passing through an opening shall be protected against damage by a bushing, grommet, or other approved means

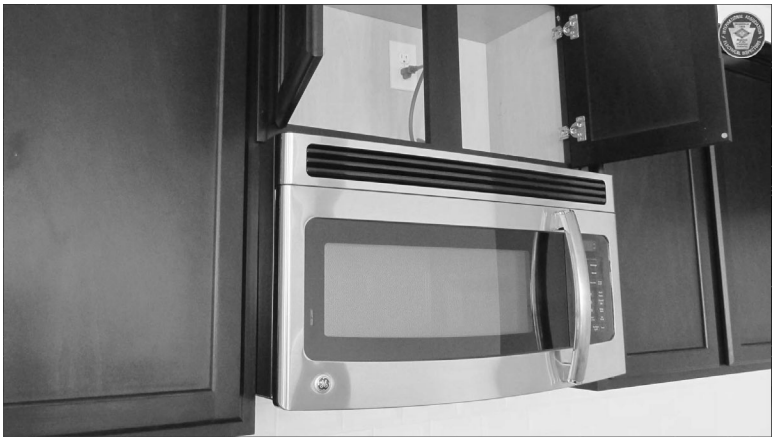
422.16(B)(4) Range Hoods and Microwave Oven/Range Hood Combinations

- Revision clarifies that the same conditions of **422.16(B)(4)** are applicable to cord-and-plug-connected, **over-the-range microwave ovens** incorporating range-hood as a range hood
- Previously, some would argue that 422.16(B)(4) did *NOT* apply because there was no mention of "**microwave ovens**" in the list item of 422.16(B)
- To remedy that incorrect interpretation of the *Code*, the title of 422.16(B)(4) was changed from simply "Range Hoods" to "**Range Hoods and Microwave Oven/Range Hood Combinations**" *(Code text changed as well)*
- The requirement for and **individual branch circuit** was originally incorporated to account for an ordinary range hood being replaced with a range hood/microwave oven combination *[see 422.16(B)(4)(3)]*

422.16(B)(4) Range Hoods and Microwave Oven/Range Hood Combinations

Range hoods and over-the-range microwave ovens with integral range hoods permitted to be cord-and-plug connected where identified on installation instructions by manufacturer and meets the following:

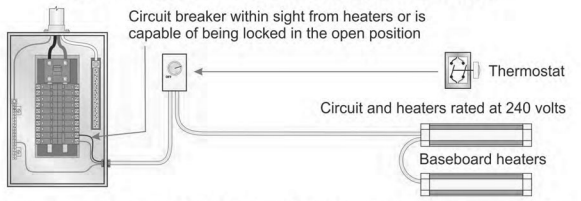




424.20(A) Thermostatically Controlled Switching Devices Permitted as Disconnecting Means

- Revision requires thermostatically controlled switching devices and combination thermostats and manually controlled switches for fixed electric space-heating equipment (FESHE) to be located in an **accessible location**
- Thermostatically controlled switching devices and combination thermostats and manually controlled switches are **permitted to serve as both controllers and disconnecting means**, provided they meet five specific conditions of 424.20(A) *(including located in an accessible location)*
- Conditions include; provided with a marked "off" (open) position, they directly open all ungrounded (hot) conductors when manually placed in the "off" (open) position, designed so the circuit cannot be energized automatically after the device has been manually placed in the "off" (open) position, and located within sight of the heater(s) they control (see 424.19)

424.20(A) Thermostatically Controlled Switching Devices Permitted as Disconnect



Thermostat permitted to serve as both the controller and the disconnecting means as follows:

(1) It has a marked "OFF" position

(2) Directly opens all ungrounded (hot) conductors when placed in the "OFF" position

(3) Is designed so that the circuit cannot be energized automatically after the device is placed in the "OFF" position

(4) Thermostat located within sight from heater(s) *(see 424.19 and definition "of within sight from")*

(5) Located in an accessible location

425.22(B) Resistance Elements *(Fixed Resistance and Electrode Industrial Process Heating Equipment)*

- **Resistance-type heating elements** in fixed industrial process heating equipment are now permitted to be **subdivided** into circuits **not exceeding 120 amperes** and protected at **not more than 150 amperes** under certain conditions
- One of the following conditions for the elements must be met:
  - (1) integral with and enclosed within a process heating surface
  - (2) completely contained within enclosure, identified as suitable for this use
  - (3) contained within an ASME-rated and stamped vessel
- Previously were required to be protected at not more than **60 amperes**
- Equipment rated **more than 48 amperes** and employing such elements were previously required to have the heating elements **subdivided** with each subdivided load **not exceed 48 amperes**

425.22(B) Resistance Elements *(Fixed Resistance and Electrode Industrial Process Heating Equipment) (cont.)*

- **Resistance-type heating elements** in fixed industrial process heating equipment are now permitted to be **subdivided** into circuits **not exceeding 120 amperes** and protected at **not more than 150 amperes** under certain conditions *(cont.)*
- Revisions are consistent with **422.11(F)(2)**, which deals with **electric heating appliances** employing resistance-type heating elements rated **more than 48 amperes**
- Large industrial facilities frequently have heating applications for hundreds of kilowatts or even megawatts of heat power into their process at low voltages
- Previous restriction of **48 amperes maximum** for subdivided loads in the industrial applications simply was **not practical**
- Adding significantly to the end user's capital equipment, operating, and maintenance costs during project execution and the lifetime of the equipment

425.22(B) Resistance Elements for Fixed Industrial Process Heating Equipment

430.2 Electronically Protected Motor

- A new definition for **"Electronically Protected (as applied to motors)"** was added to 430.2
- Electronically protected motors are becoming more and more common in use as stand-alone motors
- Several *Code* references to "EP" or "electronically protected motors" was added throughout Article 430
- New 430.7(A)(16) allows electronic protection of motors marked **"Electronically Protected"** or **"E.P."** to be suitable for overload protection
- These motors can be found in applications such as heating, ventilation and air-conditioning (HVAC), pool pumps, and refrigeration
- These EP motors have typically been evaluated by third party testing agencies and should post little impact to installers

430.122(B) Output Conductors for Adjustable-Speed Drive Systems

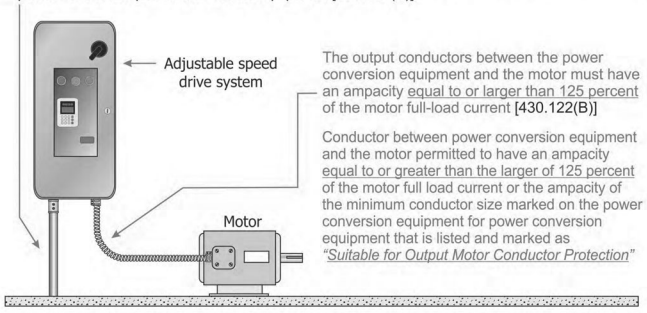
- New provisions added requiring **output conductors** between power conversion equipment and a motor to generally have an ampacity **equal to or larger than 125 percent** of the motor full-load current *(with one exception)*
- **Supply conductors** supplying power conversion equipment included as part of an adjustable-speed drive system are required to have an ampacity **not less than 125 percent** of the rated input current to the power conversion equipment
- New exception to 430.122(B) allows the conductor between the power conversion equipment and the motor to have an ampacity **equal to or greater than the larger of 125 percent** of the motor full load current as determined by 430.6(A) or (B) ***or*** the ampacity of the minimum conductor size marked on the power conversion equipment for power conversion equipment that is listed and marked as "**Suitable for Output Motor Conductor Protection**"

430.122(B) Output Conductors for Adjustable-Speed Drive Systems *(cont.)*

- Modern motor drive technology is capable of providing output conductor short-circuit and ground-fault protection
- New 430.122(B) permits the use of such a drive and separates the output conductor sizing **[430.122(B)]** from the branch-circuit short-circuit ground-fault protective device sizing **[430.122(A)]**
- Same basic change occurred at **430.130(A)(1)** where a new exception was added at this provision pertaining to branch-circuit short-circuit and ground-fault protection for single motor circuits containing power conversion equipment

430.122(B) Output Conductors-Adjustable-Speed Drive Systems

Branch circuit or feeder conductors supplying power conversion equipment included as part of an adjustable-speed drive system shall have an ampacity not less than 125 percent of the rated input current to the power conversion equipment [430.122(A)]



The output conductors between the power conversion equipment and the motor must have an ampacity equal to or larger than 125 percent of the motor full-load current [430.122(B)]

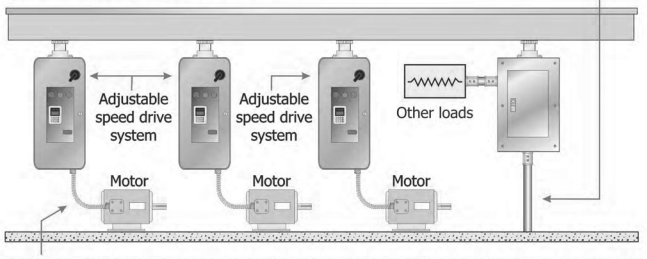
Conductor between power conversion equipment and the motor permitted to have an ampacity equal to or greater than the larger of 125 percent of the motor full load current or the ampacity of the minimum conductor size marked on the power conversion equipment for power conversion equipment that is listed and marked as *"Suitable for Output Motor Conductor Protection"*

430.122(D) Several Motors or a Motor and Other Loads

- New requirement clarifies sizing of conductors for **several motors or motor(s) and other load(s)** that include **adjustable-speed drive systems** and **power conversion equipment** needs to be based on the **rated input current** to the power conversion equipment in the calculations *(not HP rating of the motor on the output of the power conversion equipment)*
- Requirements for sizing motor circuit conductors for several motors or motor(s) and other load(s) are still found at 430.24
- Sizing of motor circuit conductors for several motors or motor(s) and other load(s) involving **adjustable-speed drive systems** and **power conversion equipment** is now addressed at new **430.122(D)**
- This material is appropriately located at **430.122**, which covers conductor sizing for adjustable-speed drive systems and power conversion equipment

430.122(D) Several Motors or Motor(s) and Other Load(s)-Adjustable-Speed Drive Systems With Power Conversion Equipment

Conductors supplying several motors or motor(s) and other load(s), including power conversion equipment, required to have calculated ampacity in accordance with 430.24, using the rated input current of the power conversion equipment



Output conductors between power conversion equipment and the motor must have an ampacity equal to or larger than 125 percent of the motor full-load current (w/ exception) [430.122(B)]

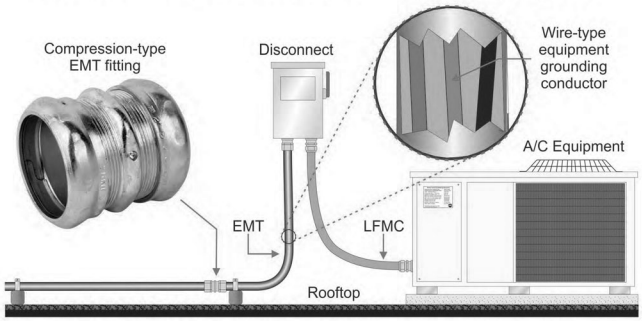
440.9 Grounding and Bonding – Rooftop HACR Equipment

- Outdoor metallic raceway systems that use "**compression-type fittings**" required to contain a **wire-type equipment grounding conductor (EGC)** when installed outdoors on a roof to supply heating, air-conditioning, and refrigeration (HACR) equipment
- Previously, outdoor portions of metallic raceway systems that use **non-threaded fittings** were required to contain a wire-type EGC when installed outdoors on a roof to supply multimotor and combination-load equipment
- 2017 *NEC* rule was intended to **not apply** to metallic raceway systems that utilize **threaded connections** at couplings and conduits, such as **RMC** and **IMC** as these fittings are unlikely to separate even under slight abuse or movement
- Intended for metallic wiring systems such as **electrical metallic tubing (EMT)** that utilize "**non-threaded fittings**"

440.9 Grounding and Bonding – Rooftop HACR Equipment *(cont.)*

- Outdoor metallic raceway systems that use "**compression-type fittings**" required to contain a **wire-type equipment grounding conductor (EGC)** when installed outdoors on a roof to supply heating, air-conditioning, and refrigeration (HACR) equipment *(cont.)*
- Problems arose as EMT compression-type fitting has threads *(not the type of threads that CMP-11 was referring to at 440.9)*, but threads none the less
- More appropriate term was needed here
- For the 2020 *NEC*, the term "**non-threaded fittings**" was replaced with "**compression-type fittings**" to give a **more appropriate description** of the type of fitting that is being targeted at 440.9 for a companion wire-type EGC to be installed in outdoor portions of metallic raceway systems

440.9 Grounding and Bonding-Rooftop HACR Equipment

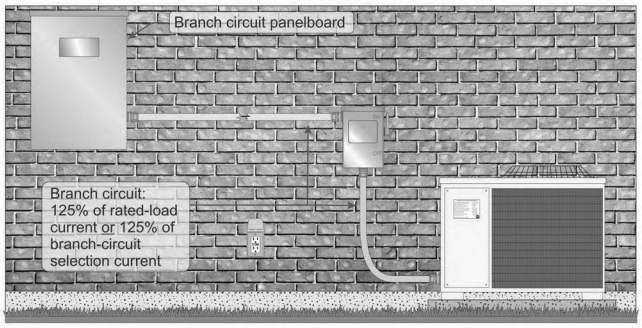


Where ~~multimotor and combination-load~~ equipment is installed outdoors on a roof, a wire type equipment grounding conductor is required to be installed in outdoor portions of metallic raceway systems that utilize ~~non-threaded~~ compression-type fittings

440.32 Single Motor-Compressor – Minimum Circuit Ampacity

- Revision clarifies that **125 percent** is to be applied to ***either*** the branch-circuit selection current ***or*** the rated load current, **whichever is greater** for the branch-circuit conductors supplying a single motor-compressor
- Incorrect assumption to assume that the 125 percent for sizing of the branch-circuit conductors supplying a single motor-compressor was only to apply to the full load compressor rated current and not the branch-circuit selection current
- Section was reformatted into a **list format** to help with the clarity
- This is a **clarification more than a revision** as this has been true since the **1971 *NEC*** when Article 440 *(Air-Conditioning and Refrigerating Equipment)* became part of the *NEC*

440.32 Single Motor-Compressor - Minimum Circuit Ampacity



Branch-circuit conductors supplying a single motor-compressor to have an ampacity not less than the greater of 125 percent of the motor-compressor rated-load current ***or*** 125 percent of the branch-circuit selection current

440.32 Single Motor-Compressor - Minimum Circuit Ampacity

Breezy Cool Air-Conditioning Equipment

Model Number RAKA-36JAZ	MFD 03/99
Serial Number 5340 F0994 8995	Outdoor Use
Volts - 208/230 Phase 1	Hertz 60
Compressor RLA - 18.0/18.0	LRA 96
Outdoor Fan Motor FLA - 1.3	HP 1/5
Minimum supply circuit ampacity	24/24 amp
Max. fuse or circuit breaker size*	40/40 amp
Min. fuse or circuit breaker size*	30/30 amp
Design pressure high	300 PSIG
Design pressure low	150 PSIG
Outdoor units factor charge	77 OZ. R22
Total system charge	OZ. R22

*HACR type breaker for USA
See instructions inside access panel

Listed by ABC Labs

Minimum Supply Circuit Ampacity - 18 A X 1.25 = 22.5 A + 1.3 A = 23.8 Amperes

445.6 Listing (Generators)

- New provisions added to require **stationary generators** of 600 volts and less to be **listed**
- Exception for **one-of-a-kind** or **custom manufactured generators** permitted to be field labeled by a field evaluation body
- Intentional efforts have been instituted for the last few *Code* cycles to put into place **listing requirements** for specific equipment, wiring methods, etc. throughout the *NEC*
- Addition of listing requirements for stationary generators will address **safety concerns** for both the electric and fuel control for stationary generators that are rated 600 volts and below
- The *International Building Code* requires all emergency and legally required standby generators to be listed

445.6 Listing Requirements for Stationary Generators

445.18(D) Emergency Shutdown at One- and Two-Family Dwelling Units

- New requirements added to require a readily accessible **outdoor emergency generator shutdown device** for generators *(other than cord-and-plug-connected generators)* installed at one- and two-family dwelling units
- This new requirement primarily based upon providing **first responders** an outdoor emergency generator shutdown device in an **emergency situation** such as a fire, gas leak, structural damage, or flooding
- Very challenging when the emergency generator shutdown device was installed in an **indoor location** of a dwelling unit area such as a basement
- New requirement will further enhance the safety of emergency responders
- New requirement for an outdoor emergency generator shutdown device is a **companion requirement** for an **emergency disconnecting means** for a one- or two-family dwelling be installed and located on the outside of the structure (see 230.85)

445.18(D) Emergency Shutdown Device at Dwelling Units

An outdoor emergency generator shutdown device is required for generators installed at one- and two-family dwelling units *(other than cord-and-plug-connected generators)*

450.9 Horizontal Transformer Top Prohibited as Storage

- New sentence added to **prohibit** horizontal top surfaces of transformers from being used as a **storage area**
- A **marking requirement** was added prohibiting such actions
- The top of a floor-mounted transformer seems to be a **"catch-all" storage shelf** and a convenient spot to store janitor supplies, rags, replacement parts, tools, etc. commonly found to electrical equipment rooms or closets
- Transformers are not designed, intended, identified, or listed for that type of an application
- Common problem encountered by both fire and electrical inspectors
- This new *Code* language will assist the enforcement community in requiring the tops of these transformers be kept clear of stored items and debris

450.9 Horizontal Transformer Tops Prohibited as Storage

Horizontal top surfaces of transformers are prohibited from being used as a storage area and a marking requirement was added prohibiting such actions

480.7(G) Identification of Power Sources (Storage Batteries)

- New requirements were added for **directory** and **identification of power sources** for storage batteries
- A disconnecting means is required to be provided for all ungrounded conductors derived from a stationary battery system with a **voltage over 60 volts dc**, installed readily accessible and located within sight of the battery system
- Similar to directories and identification of power sources required for such systems as **interconnected electric power production sources** *[see 705.10]*, **stand-alone systems** *[see 710.10]*, and **direct current microgrids** *[see 712.10]*
- These new directory provisions will address ongoing concerns expressed by fire service personnel and other **first responders**

480.7(G) Identification of Power Sources

CAUTION: MULTIPLE SOURCES OF POWER

BATTERY STORAGE DISCONNECT LOCATED AT NE CORNER OF BUILDING

Facilities with utility services and battery systems required to display plaques or directories in accordance with 705.10 *(Interconnected Electric Power Production Sources)* and 712.10 *(Direct Current Microgrids)*

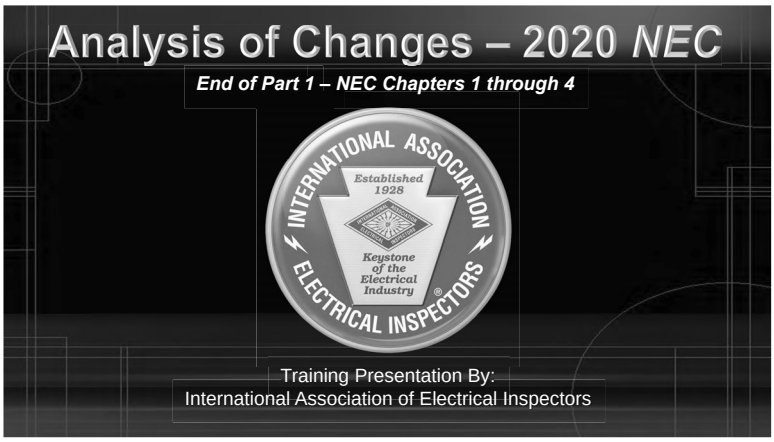
Facilities with stand-alone systems require a permanent plaque or directory to be installed in accordance with 710.10 *(Stand-Alone Systems)*

490.21(A)(5) Retrofit Trip Units - Interrupting Devices for *Equipment Over 1000 Volts, Nominal*

- **Retrofit trip units** are now required to be **listed for use** with the specific circuit breaker with which it is installed
- For circuit breakers and equipment rated over 1000 volts, nominal, retrofit trip units have become more commonplace over the past decade
- Retrofit trip units are designed to replace conventional electromechanical series overload trip devices, thermal magnetic overcurrent releases, and older style electronic trip devices to provide **greater accuracy, reliability, and functionality**
- Provides **life extension** of older circuit breakers at a fraction of the cost of a new circuit breaker without modifying the switchboard, switchgear, etc.
- Retrofit trip units are typically listed and evaluated for one manufacturer's particular circuit breaker

490.21(A)(5) Retrofit Trip Units
Circuit Breakers for Equipment Over 1000 Volts, Nominal

Retrofit trip units required to be listed for use with the specific circuit breaker with which they are installed


Analysis of Changes – 2020 NEC
End of Part 1 – NEC Chapters 1 through 4
INTERNATIONAL ASSOCIATION
ELECTRICAL INSPECTORS
Established 1928
Keystone of the Electrical Industry
Training Presentation By:
International Association of Electrical Inspectors

File Attachments for Item:

ER-2 DIC - Analysis of 2020 NEC Changes Training Course 2

5 hours, BO, BI, MPE, BPE, ESI

Staff Notes: Standard IAEI course. Suggest addition of EPE.

ESIAC Recommendations:

Committee Recommendation:

APPLICATION

FOR

Continuing Education Course Approval

Continuing education programs approved for education credit by the Ohio Board of Building Standards may be used for compliance with certification requirements related to code enforcement, plan review, and inspection responsibilities. The credit is to be used to renew the certifications issued by the Ohio Board of Building Standards pursuant to section 3781.10(E) ORC.

Board of Building Standards
6606 Tussing Road, P.O. Box 4009
Reynoldsburg, Ohio 43068-9009
(614) 644-2613 Fax: (614) 644-3147
dic.bbs@com.state.oh.us
www.com.state.oh.us/dic/dicbbs.htm

COURSE SUBMITTER: # 5068

Course Submitter: Michael Thompson
(Contact Name)

Organization: State Of Ohio Department of Industrial Compliance
(Organization/Company)

Address: 6606 Tussing Road
(Include Room Number, Suite, etc.)

City: Reynoldsburg State: _____ Zip: _____

E-Mail: michael.thompson@com.state.oh.us

Telephone: 614-728-5293 Fax: _____

Course Sponsor: # 5068

COURSE INFORMATION:

Course Title: IAEI Analysis of Changes – 2020 NEC part 2 Chapters 5-9

New Course Submittal: ■ Update Course: ☐ Prior Approval Number: _____

Purpose and Objective: Training the staff on the changes to the 2020 code for references and knowledge of the changes to this code. to hold group training and discusion for plans examiners , building official and the Electrical field inspectors.

Number of Instructional Contact Hours that can be obtained upon completion: 5 hrs

If Multi-Session, Number of Instructional Contact Hours Per Session: _____

Program Applicable for the Following Participants:

Building Official ■	Master Plans Examiner ■	Building Inspector ■	Fire Protection Inspector ☐	Mechanical Inspector ☐	
	Building Plans Exam. ✔			Plumbing Inspector ☐	
	Plumbing Plans Exam. ☐			Non-Res IU Inspector ☐	
	Electrical Plans Exam. ☐				
	Mechanical Plans Exam. ☐				
	Fire Protect. Plans Exam. ☐				
Res Building Official ☐	Res Plans Examiner ☐	Res Building Inspector ☐	Res Mechanical Inspector ☐	Res IU Inspector ☐	

Electrical Safety Inspectors [X]

Location of ESI Course: Department of Commerce Date(s) of ESI Course(s): TBD

SUBMITTAL CHECKLIST: **Make Sure** all of the Following Information is **Submitted**:		Check Off
Course Submitter:	Name of contact person and their certification numbers, organization, address, fax, phone	
	Organization sponsoring or requesting the program (if any)	
Course Title:	Name of course (related to content)	
Purpose/Objective:	Describe purpose and how course will improve competency of certification(s) listed	
Contact Hours:	Indicate instructional time and credit requested in hours (e.g.: 0.5 hr, 1 hr, 3.5 hrs)	
Participants:	Check off each certification for which credit is requested (for which course relates to certification)	
Content of Program:	Include collated agenda, time schedule, course outline; list specific sections of code, references, and topics covered	
Course Materials:	Collated workbooks, handouts, hard copy or electronic versions of program is available	
Instructor(s) Info.:	Resume of professional/educational qualifications & teaching/training experience/BBS certifications	
Test Materials:		
Completed Application:		

NOTE: The Board does NOT grant retroactive approval for courses presented prior to approval date.

Analysis of Changes- 2020 NEC Part 2 AGENDA

1. 8:00 am – 8:30: Introduction of class concepts and distributing the PDF handout.
2. 8:30 – 10:00 - Part 2 NEC Article 500 through Article 551
3. Break 10:00 10:10
4. 10:10 – 12:00 Part 1 NEC Article 552 through Article 682
5. 12:00 12:30 lunch
6. 12:30pm -2:20 NEC Article 690 through Chapter 9
7. Discussion 2:20 – 2:45
8. Dismissal.

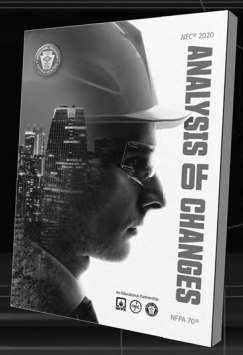
Analysis of Changes – 2020 *NEC*

Part 2 – NEC Chapters 5 through 9

Training Presentation By:
International Association of Electrical Inspectors

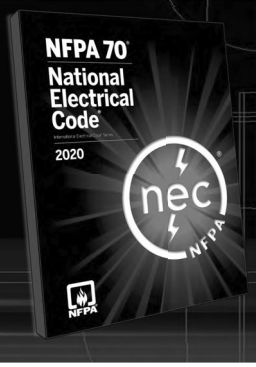
Licensing Agreement

- This program is licensed solely for the purpose of in-person electrical education and training by the licensee.
- *Analysis of Changes-NEC-2020* training presentation is prohibited from being further copied, broadcast, posted online, sublicensed, used for on-line training or in any way further distributed or displayed for any other purpose by the licensee.

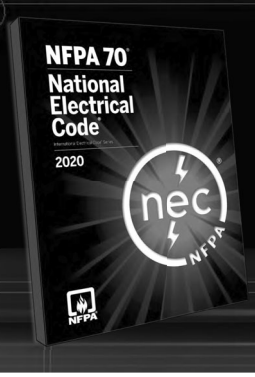


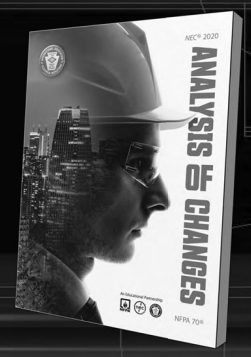
National Electrical Code® *(NEC)*

- Portions of this material are reprinted with permission from the 2020 edition of the National Electrical Code® Copyright © 2019 National Fire Protection Association. This material is not the complete and official position of the National Fire Protection Association on the reference subject which is represented solely by the standard in its entirety which can be obtained from the NFPA at www.nfpa.org and can be viewed at www.nfpa.org/70. Also available from IAEI at www.iaei.org/NEC20.
- National Electrical Code®, NFPA 70®, NEC®, and the NEC Logo™ are trademarks of the National Fire Protection Association, Quincy, MA 02169



Analysis of Change-2020 *NEC*





Chapter Five Special Occupancies

500.7(K) Combustible Gas Detection System

- The requirements for a **combustible gas detection system** as a **protection technique** was **sufficiently revised and expanded** to provide more specific detail for the installation and operation of a gas detection system
- Previous text at 500.7(K) did not provide specific requirements and the enforcement community would often encounter enforcement concerns
- At **500.7(K)(1)** for "**General**" requirements, information was relocated to this list item calling for the gas detection equipment used to be listed for Class I, Division 1 and listed for the detection of the specific gas or vapor to be encountered
- Under the heading of "**Inadequate Ventilation**," **500.7(K)(2)** was revised to permit a location, enclosed space, or building that is classified as a Class I, Division 1 location due to inadequate ventilation to utilize electrical equipment, installation methods, and wiring practices suitable for Class I, Division 2 installations as long as the space is provided with a combustible gas detection system

500.7(K) Combustible Gas Detection System *(cont.)*

- Revisions also occurred at **500.7(K)(3)** titled "**Interior of a Building or Enclosed Space**," which addresses any building or enclosed space that does not contain a source of flammable gas or vapors that is located in, or with an opening into, a Class I, Division 2 hazardous (classified) location that is provided with a combustible gas detection system
- **500.7(K)(4)** titled "**Interior of a Control Panel**" now states that inside the interior of a control panel containing instrumentation or other equipment utilizing or measuring flammable liquids, gases, or vapors, electrical equipment, installation methods, and wiring practices suitable for Class I, Division 2 installations are permitted when protected by combustible gas detection equipment
- Same change occurred at **505.8(I)** for **Zone 0, 1, and 2 locations**

500.7(K) Combustible Gas Detection System

These requirements surrounding a combustible gas detection system as a protection technique were appropriately revised and expanded to provide more sufficient detail to install and operate a gas detection system

500.7 Protections Techniques for Hazardous (Classified) Locations

- Four new **protection techniques** were added for protection of electrical and electronic equipment in hazardous (classified) locations
- The requirements of 500.7 now contained **(16) protection techniques** for electrical and electronic equipment in hazardous (classified) locations
- New protection techniques include:
  - 500.7(L) Inherently Safe Optical Radiation “op is”
  - 500.7(M) Protected Optical Radiation “op pr”
  - 500.7(N) Optical System With Interlock “op sh”
  - 500.7(O) Protection by Skin Effect Trace Heating “IEEE 844.1”

500.7 Protections Techniques for Hazardous (Classified) Locations *(cont.)*

- Four new **protection techniques** were added for protection of electrical and electronic equipment in hazardous (classified) locations *(cont.)*
- Three of these new protection techniques involves **optical radiation**
- **Optical radiation** is absorbed by surfaces or particles, causing them to heat up, and under certain circumstances this may allow them to attain a temperature which will ignite a surrounding explosive atmosphere
- These types of protection for **optical radiation** have been added based on UL Product Standard **UL 60079-28** *(Standard for Explosive Atmospheres - Part 28: Protection of Equipment and Transmission Systems Using Optical Radiation)*

500.7 Protections Techniques for Hazardous (Classified) Locations *(cont.)*

- Four new **protection techniques** were added for protection of electrical and electronic equipment in hazardous (classified) locations *(cont.)*
- The fourth new protection technique added at 500.7(O) pertains to protection by **skin effect trace heating**
- Skin effect heating is used specifically for providing indirect heat to longer runs of piping from a single electrical supply source
- Same **optical radiation protection techniques** were added at 505.9(G) for Zone 0, 1, and 2 locations and 506.9(G) for Zone 20, 21, and 22 locations
- Same **skin effect trace heating protection techniques** were added at 505.8(N) for Zone 1 or Zone 2 Locations and at 506.8(N) for Zone 21 or Zone 22 Locations

500.7 Protections Techniques for Hazardous (Classified) Locations

Technique	Location
(A) Explosionproof Apparatus	Class I, Division 1 or 2 locations
(B) Dust Ignitionprooff	Class II, Division 1 or 2 locations
(C) Dusttight	Class II, Div 2 or Class III Div 1 or 2 locations
(D) Purged and Pressurized	Any classified location for which it is identified
(E) Intrinsic Safety	Class I, II, or III, Division 1 or 2 locations
(F) Nonincendive Circuit	Class I or II, Div 2 or Class III, Div 1 or 2 locations
(G) Nonincendive Equipment	Class I or II, Div 2 or Class III, Div 1 or 2 locations
(H) Nonincendive Component	Class I or II, Div 2 or Class III, Div 1 or 2 locations
(I) Oil Immersion	Class I, Division 2
(J) Hermetically Sealed	Class I or II, Div 2 or Class III, Div 1 or 2 locations
(K) Combustible Gas Detection System	Class I, Division 1 or 2 *(industrial restricted)*
(L) Inherently Safe Optical Radiation	Class I or II, Division 1 or 2 locations
(M) Protected Optical Radiation	Class I or II, Division 2 locations
(N) Optical System With Interlock	Class I or II, Division 1 or 2 locations
(O) Protection by Skin Effect Trace Heating	Class I, II, or III, Division 2 *(for which it is listed)*
(P) Other Protection Techniques	Other protection techniques *(identified for use)*

501.10(A)(1) Wiring Methods – Class I, Division 1 Locations

- **Type TC-ER-HL cable** and **Type P cable** were added as two new wiring methods for Class I, Division 1 locations
- Wiring methods in a Class I, Division 1 location are now open to **(7) types** of wiring methods
- **Type TC-ER-HL cable** permitted where not subject to physical damage and terminated with fittings listed for the location
- **Type P cable** permitted with metal braid armor, with an overall jacket, terminated with fittings listed for the location
- Both Type TC-ER-HL cable and Type P cable are limited to **industrial establishments with restricted public access**, where the conditions of maintenance and supervision ensure that only qualified persons service the installation

501.10(A)(1) Wiring Methods – Class I, Division 1 Locations *(cont.)*

- **Type TC-ER-HL cable** and **Type P cable** were added as two new wiring methods for Class I, Division 1 locations *(cont.)*
- These wiring methods will allow new and innovative designs and materials technologies to be employed in these hazardous (classified) location applications, providing new solutions to existing, long standing, hazardous conditions
- Same wiring methods were accepted as identified wiring methods for a Class I, Division 2 location at 502.10(A)(1)(6) and (7); for a Class II, Division 1 location at 502.10(A)(2)(7) and (8); and for a Class II, Division 2 location at 502.10(B)(1)(1)
- Type TC-ER-HL cable and Type P cable were also recognized as identified wiring methods for Zone 1 and 2 locations at 505.15(B)(1), 505.15(C)(2), and 505.15(B)(2)

501.10(A)(1) Wiring Methods - Class I, Division 1 Locations

Two additional wiring methods have been incorporated into 501.10(A)(1) as acceptable wiring methods in Class I, Division 1 locations

Type TC-ER-HL cable where not subject to physical damage and terminated with fittings listed for the location

Type P cable with metal braid armor, with an overall jacket, terminated with fittings listed for the location

Both limited to industrial establishments with restricted public access, where the conditions of maintenance and supervision ensure that only qualified persons service the installation

Table 505.9(C)(2)(4) Equipment Suitability

- Table 505.9(C)(2)(4) Types of Protection Designation was replaced with an updated applicability table and is now **Table 505.9(C)(2)(4) Equipment Suitability**
- The headings are now (L to R), “Type of Protection,” “Marking,” and “Permitted Location”
- Equipment Protection Levels (EPL) were added to align with the introduction of this concept in the UL 60079 product standards
- EPL is rigidly aligned with the Zone and the varying of this relationship based on a risk assessment per the International Electrotechnical Commission (IEC) reference standard IEC 60079-14 is NOT included
- Same change occurred at **Table 506.9(C)(2)(3)** for Zone 20, 21, and 22 Locations

Table 505.9(C)(2)(4) Equipment Suitability *(in Part)*

Type of Protection	Marking	Permitted Location
Associated Apparatus for Zone 0	[ia]	Unclassified[1]
Associated Apparatus for Zone 1	[ib]	Unclassified[1]
Associated Apparatus for Zone 2	[ic]	Unclassified[1]
Associated Pressurization Equipment	[p]	Unclassified[1]
Equipment Suitable for Use in Zone 0		
Equipment Suitable for Use in Class I, Division 1		
Flameproof Enclosure	d; db	
Intrinsic Safety	ib	
Increased Safety	e; eb	
Pressurized Enclosure	p; px, pxb, py, pyb	
Encapsulation	m; mb	
Powder Filling	q; qb	Zone 1
Liquid Immersion	o, ob	
Electrical Resistance Trace Heating	60079-30-1, *with EPL Gb*[2]	
Skin Effect Trace Heating	IEEE 844.1, *with EPL Gb*[2]	
Optical Radiation, Inherently Safe	op is, *with EPL Gb*[2]	
Optical Radiation, with Interlock	op sh, *with EPL Gb*[2]	
Optical Radiation, Protected	op pr, *with EPL Gb*[2]	
EPL Gb, *with Suitable Type of Protection*[3]		

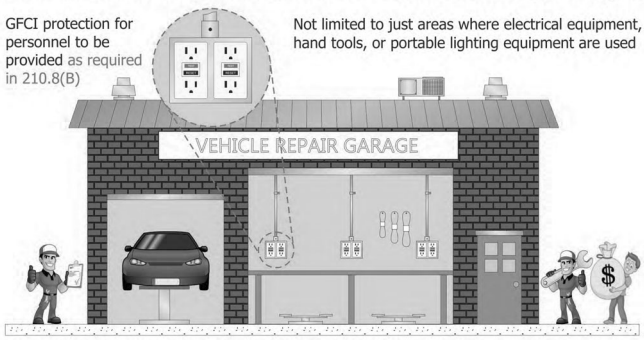
511.12 GFCI Protection at Commercial Garages, Repair and Storage

- Revision to 511.12 now points and aligns GFCI requirements for commercial garages to GFCI requirements of **210.8(B)**
- 210.8(B)(8) calls for ***all*** 125-volt, single-phase, 15- and 20-ampere receptacles installed in garages, service bays, and similar areas (*other than vehicle exhibition halls and showrooms)* to have GFCI protection for personnel *(not just those receptacles where electrical diagnostic equipment, electrical hand tools, or portable lighting equipment are to be used)*
- Previous 511.12 required all 125-volt, single-phase, 15- and 20-ampere receptacles installed in **areas where electrical diagnostic equipment, electrical hand tools, or portable lighting equipment** are to be used to shall have GFCI protection for personnel

511.12 GFCI Protection at Commercial Garages, Repair and Storage *(cont.)*

- Revision to 511.12 now points and aligns GFCI requirements for commercial garages to GFCI requirements of **210.8(B)** *(cont.)*
- By simply pointing 511.12 back to 210.8(B), these two sections will be in alignment
- Same alignment of GFCI protection for ***all*** 125-volt, single-phase, 15- and 20-ampere receptacles for aircraft hangers occurred at **513.12** with a reference to 210.8(B)(8)

511.12 GFCI Protection at Commercial Repair and Storage Garages



GFCI protection for personnel required for ALL 125-volt, single-phase, 15- and 20-ampere receptacles installed in non-dwelling unit garages, service bays, and similar areas *(other than vehicle exhibition halls and showrooms)*

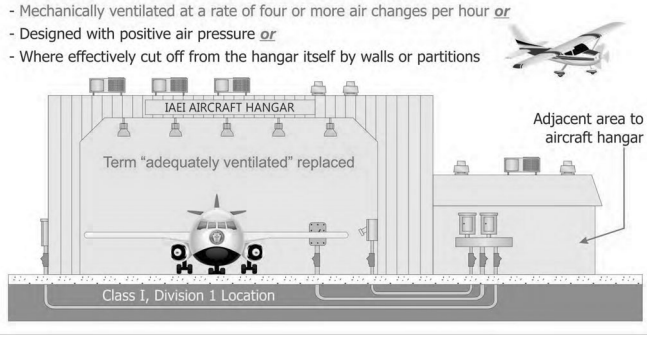
513.3(D) Areas Suitably Cut Off and Ventilated

- Revision clarifies what "**adequately ventilated**" means for an adjacent area of an aircraft hangar by replacing "adequately ventilated" with "**mechanically ventilated at a rate of four or more air changes per hour**"
- Previous language stated that "adjacent areas" in which flammable liquids or vapors are not likely to be released were permitted to be considered unclassified where the space was "adequately ventilated" ***and*** where effectively cut off from the hangar itself by walls or partitions
- Adjacent areas could include areas such as stock rooms, electrical control rooms, and other similar locations
- New *Code* language for **513.3(D)** was crafted and inspired by the existing *Code* language at **511.3(E)(1)** for adjacent areas at a commercial repair garage

513.3(D) Areas Suitably Cut Off and Ventilated

Adjacent areas of an aircraft hangar in which flammable liquids or vapors were not likely to be released *(such as stock rooms, electrical control rooms, and other similar locations)* permitted to be considered unclassified where any of the following occur:

- Mechanically ventilated at a rate of four or more air changes per hour ***or***
- Designed with positive air pressure ***or***
- Where effectively cut off from the hangar itself by walls or partitions

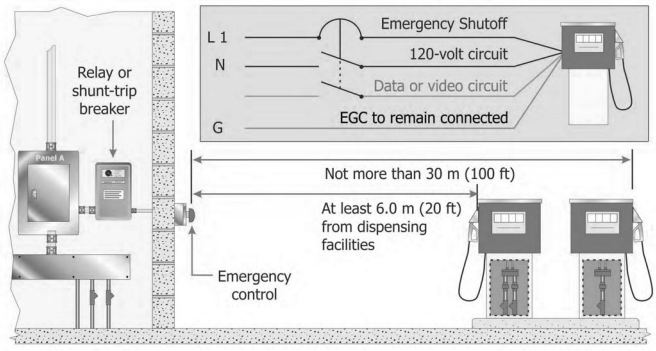


514.11(A) Emergency Electrical Disconnects for Motor Fuel Dispensing Facilities

- Revisions also make it clear that the **equipment grounding conductors (EGC)** should not be disconnected by the emergency disconnect
- **Grounded conductor** should be disconnected simultaneously with the all the other conductors when the emergency disconnect is activated
- Previously, some jurisdictions were requiring the EGC to be included as one of the required conductors that needed to be disconnected in order to fulfil the requirement of 514.11(A)
- New *Code* language added after NFPA 30A extracted text to say that the "**equipment grounding conductors shall remain connected**"
- Additional *Code* language will provide AHJ the clear *Code* language needed to enforce this emergency disconnect rule and allow installers to comply with this requirement

514.11(A) Emergency Controls for Fuel Dispensers

Emergency shutoff device shall disconnect simultaneously from the source of supply, all conductors of the circuits, including the grounded conductor *(EGCs to remain connected)*



517.10(B) Applicability (Health Care Facilities)

- New areas **not covered** by the wiring and protection methods of **Part II of Article 517** *[Intramuscular injections (immunizations), etc.]* have been added to 517.10(B)
- Areas used exclusively for intramuscular injections (immunizations), psychiatry and psychotherapy, alternative medicine, and optometry are areas **not applicable** to Part II of Article 517
- Part II of Article 517 means that the wiring methods in a **patient care space** must consist of a **metal raceway system** or a cable having a metallic armor or sheath assembly that qualifies as an as an EGC in accordance with 250.118 [517.13(A)] ***and*** an have **insulated copper EGC** installed with the metallic raceway [517.13(B)] *(sometimes referred to as a "redundant" grounding)*
- Shock hazards are greatly reduced with **no invasive procedures** performed and **no electro-medical equipment** connected to the body or patient

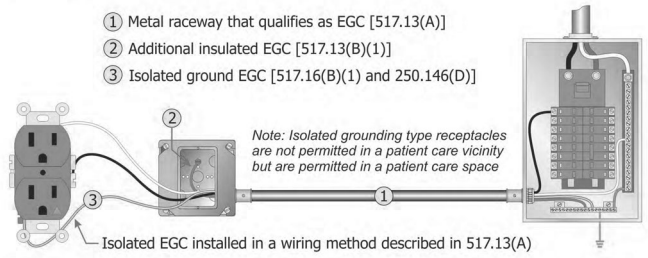
517.10(B) Not Covered - Wiring and Protection - Health Care Facilities

517.16 Use of Isolated Ground Receptacles for Health Care Facilities

- Further revision to 517.16 provides better explanation of use of **isolated receptacles outside the patent care vicinity**
- Where installed, an isolated ground receptacle **cannot eliminate** the **two equipment grounding paths** required by 517.13
- **517.16(B)(1)** revised for clarity to state that the equipment grounding terminals of isolated ground receptacles installed in a patient care space shall be connected to an isolated EGC ***AND*** this isolated EGC must be "**installed in a wiring method described in 517.13(A)**"
- Both grounding methods required in **517.13(A)** *(metal wiring method)* and **517.13(B)** *(wire-type insulated EGC)* must be present in wiring methods used for isolated grounding receptacles in addition to a separate EGC using a **green insulation with a yellow stripe** connected to the equipment grounding terminal of the isolated grounding receptacle terminal

517.16 Use of Isolated Ground Receptacles

An isolated ground receptacle *(if installed)* shall not defeat the purposes of the equipment grounding systems detailed in 517.13 *(two paths for equipment grounding in a patient care space)*



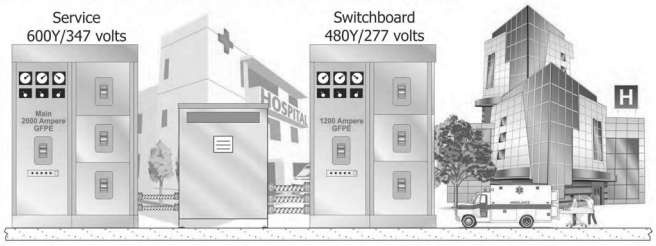
Equipment grounding terminals of isolated ground receptacles installed in a patient care space shall be connected to an isolated equipment grounding conductor AND this isolated equipment grounding conductor must be "installed in a wiring method described in 517.13(A)"

517.17(D) Performance Testing of GFP Equipment at Health Care Facilities

- Revision were made to provide clarity by requiring a **qualified person** *(written record)* to perform a **test process of GFP** primary current injection
- Previously, GFP systems were required to be performance tested when the equipment ground-fault protection was first installed with little detail
- This performance testing is now required to be conducted by a **qualified person(s)** using a test process in accordance with the **instruction** provided with the equipment and a **written record** of this testing must be kept and made available to the authority having jurisdiction
- Same *Code* language found at **230.95(C)** was inserted at 517.17(D) for performance testing of ground-fault protection systems of health care facilities

517.17(D) Performance Testing of GFP Systems at Health Care Facilities

When ground-fault protection of equipment is first installed, each level required to be performance tested to ensure compliance with 517.17(C) *(selectively coordinated)*



Testing to be conducted by a qualified person(s) using a test process in accordance with the instruction provided with the equipment

Written record of this testing to be kept and made available to the authority having jurisdiction

517.26 Application of Other Articles (Health Care Facilities)

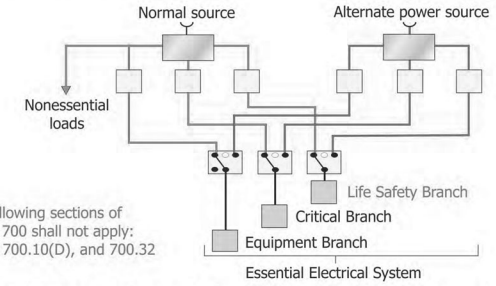
- New text was added to give needed guidance to what parts of Article 700 that Article 517 amends
- Revision added **four specific amendments** to Article 517 from requirements of Article 700 that does not apply to the **life safety branch** of the **essential electrical system** of a health care facility
  - **700.4** *(emergency system equipment required to be suitable for the available fault current)* does not apply
  - **700.10(D)** *(fire protection)* does not apply
  - **700.17** *(Branch Circuits for Emergency Lighting)* has been **replaced** with a provision that states that branch circuits that supply emergency lighting is required to be installed to provide service from a source complying with 700.12 *(Sources of Power)* when normal supply for lighting is interrupted or where single circuits supply luminaires containing secondary batteries
  - **700.32** *(selective coordination)* is also "amended" from Article 517

517.26 Application of Other Articles (Health Care Facilities) *(cont.)*

- New text was added to give needed guidance to want parts of Article 700 that Article 517 amends *(cont.)*
- Revisions brought about as a result of the work of the **NFPA 99 Electrical Systems Technical Committee**
- Changes meant to improve the **correlation** between NFPA 99 *(Health Care Facilities Code)* and the *NEC*
- NFPA 99 has jurisdiction over **performance requirements** for electrical systems in health care facilities while the *NEC* has jurisdiction over the **installation requirements**
- Life safety branch of the essential electrical system of a health care facility is required to conform to Article 700 with the exception of the performance requirements as described earlier

517.26 Application of Other Articles (Health Care Facilities)

Life safety branch of the essential electrical system shall meet the requirements of Article 700, except as amended by Article 517



The following sections of Article 700 shall not apply: 700.4, 700.10(D), and 700.32

Branch circuits that supply emergency lighting shall be installed to provide service from a source complying with 700.12 when normal supply for lighting is interrupted or where single circuits supply luminaires containing secondary batteries (amended from 700.17)

517.30(B)(3) Sources of Power – Battery Systems

- **Battery systems** are now permitted to serve as the **alternate source** for all or part of an **essential electrical system** of a health care facility
- **Two independent sources of power** required with one being the normal power source *(typically a utility supplied source of power)* and one or more alternate power sources for use when the normal power source is interrupted
- Battery systems are a recognized essential electrical system source by **NFPA 99** *(Health Care Facilities Code)*
- 2014 *NEC* recognized a battery system located on the premises as an acceptable alternate source of power for an essential electrical system
- Battery systems can supply power to critical life-support equipment until the main power can be restored

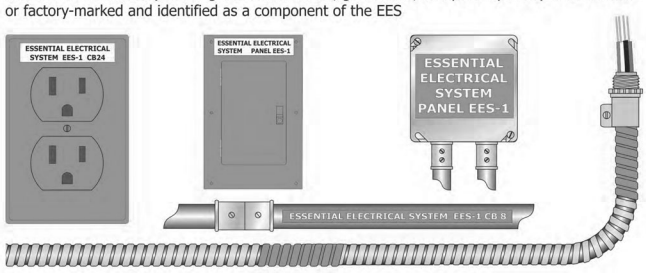
517.31(C)(1)(a) Identification of Essential Electrical Systems

- **Identification and marking requirements** for the life safety branch and critical branch of **essential electrical systems** was added to 517.31(C)(1)(a)
- Raceways and cables required to be **field- or factory-marked** as components of the essential electrical system at intervals **not to exceed 7.6 m (25 ft)**
- Raceways, cables, or enclosures of the life safety and critical branch of the essential electrical systems of a health care facility required be "**readily identified**" as a component of the essential electrical system (EES)
- **No specific color-coding, etc.** specified for "readily identifying" the EES
- This added identification marking requirement correlates 517.31 with the identification requirements for emergency systems in **700.10**

517.31(C)(1)(a) Identification of Essential Electrical Systems

Raceways, cables, or enclosures of the life safety and critical branch shall be readily identified as a component of the essential electrical system (EES)

Boxes and enclosures (including transfer switches, generators, and power panels) shall be field- or factory-marked and identified as a component of the EES



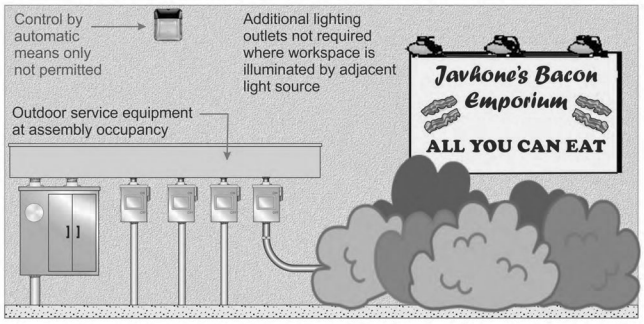
Raceways and cables shall be field- or factory-marked as a component of the EES at intervals not to exceed 7.6 m (25 ft)

518.6 Outdoor Illumination (Assembly Occupancies)

- New section added to require the working space pertaining to **outdoor fixed service equipment** at **assembly occupancies** to be provided with **proper illumination**
- Includes all working spaces about fixed service equipment, switchboards, switchgear, panelboards, or motor control centers installed outdoors that serve assembly occupancies
- Similar to the requirements of 110.26(D) and 110.34(D), this illumination **cannot be controlled by an automatic means** only *(must have manual override)*
- Lighting specifically for the illumination of this outdoor equipment is not required where the outdoor workspace is illuminated by an **adjacent light source** such as outdoor parking lot lighting
- Assembly occupancies can include, but not be is not limited to places like auditoriums, conference centers, exhibition halls, gymnasiums, churches, restaurants, etc. *(see 518.2)*

518.6 Outdoor Illumination - Assembly Occupancies

Illumination required for working spaces about fixed service equipment, switchboards, switchgear, panelboards, or motor control centers installed outdoors that serve assembly occupancies



520.25 Dimmers - Theaters, Television Studios, Etc.

- **Resistance- and reactor-type dimmers** for theatrical use have been deleted as a recognized dimmer option
- Two types of dimmers for theatrical use; **autotransformer-type dimmers** and **solid-state dimmers**
- According to industry experts, resistance- and reactor-type dimmers for theatrical use have not been manufactured or produced, much less installed for at least 50 years
- A dimmer switch for theatrical use allows technicians and stagehands to have more control over the lighting on stage than just a simple on/off

520.25 Dimmers - Theaters, Television Studios, Etc.

Resistance- and reactor-type dimmers for theatrical use have been deleted from 520.25

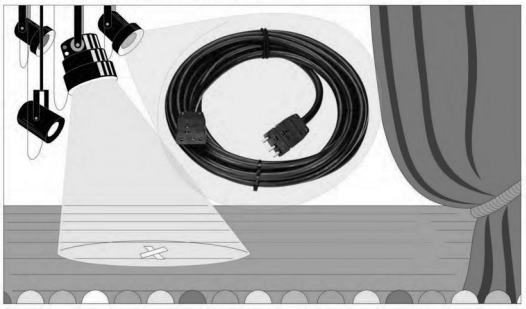
Resistance- and reactor-type dimmers for theatrical use have not been manufactured or installed for at least 50 years

520.68(A)(2) Listed Hard Usage Cords in Protected Applications

- **Listed hard usage cords or cables** *(rather than extra-hard usage cords or cables)* permitted for use with portable stage equipment in **protected applications**
- Listed, hard usage (junior hard service) cord or cable is permitted where (1) **protected from physical damage**, (2) protected by an overcurrent protective device rated at **not over 20 amperes**, and (3) does not exceed **30 m (100 ft) in length**
- As far back as the **1996 *NEC***, listed hard usage cord has been allowed in limited applications in Article 520 theatrical type occupancies
- Listed hard usage cord has a **proven track record** and performs safely in limited applications where not subject to physical damage
- No longer a reason to require extra-hard usage cord only in these protected applications

520.68(A)(2) Listed Hard Usage Cord in Protected Applications

Listed hard usage (junior hard service) cords or cables *(rather than extra-hard usage cords or cables)* permitted for use with portable stage equipment in protected applications



The cord or cable must be protected from physical damage, protected by an overcurrent protective device rated at not over 20 amperes, and the cord or cable does not exceed 30 m (100 ft) in length

525.20(G) Protection of Flexible Cords or Cables at Carnivals, Circuses, Fairs, and Similar Events

- **Non-conductive matting** for flexible cords or cables accessible at carnivals, etc. must be **secured to in place to the walkway surface** to minimize tripping hazard
- This section now allows either **secured matting** or an **approved alternate protection method**
- Previously, the nonconductive matting could create a **greater tripping hazard** than the uncovered cables
- Burying a cable to prevent a tripping hazard is also an option *(cable does not have to comply with the burial depth requirements of 300.5)*
- Wiring methods at carnivals, circuses, and county fairs should not be given the same latitude given temporary construction sites because they are **open to the public** unlike a construction jobsite

525.20(G) Protection of Flexible Cords or Cables

Flexible cords or cables accessible to the public shall be arranged to minimize tripping hazards

Flexible cords or cables permitted to be covered with nonconductive matting secured to the walkway surface *or* protected with another approved cable protection method

The matting or other protection method cannot constitute a greater tripping hazard than the uncovered cables

Article 545 Manufactured Buildings and Relocatable Structures

- A new Part II was added to Article 545 for "**Relocatable Structures**" with a definition of same added at 545.2
- **Relocatable Structures:** A factory-assembled structure or structures transportable in one or more sections that are built on a permanent chassis and designed to be used as other than a dwelling unit without a permanent foundation.
- Mobile office units, mobile classrooms, etc. are typically a factory-assembled structure and are not constructed and assembled on site, they are mobile and towed to the site much like a mobile home *(but they are not a "home")*
- There was a need for a **new approach** to properly install and maintain electrical supply and equipment to these mobile structures that **did not properly fit into any of the existing articles** in Chapter 5 of the *NEC*

Article 545 Manufactured Buildings and Relocatable Structures *(cont.)*

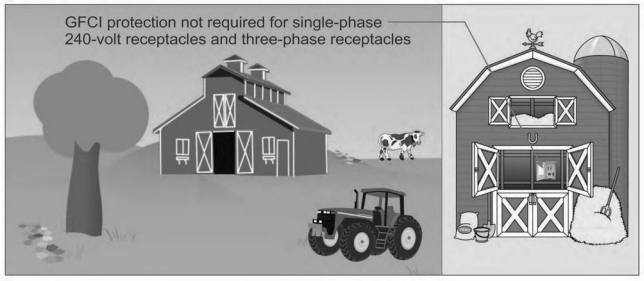
- A new Part II was added to Article 545 for "**Relocatable Structures**" with a definition of same added at 545.2 *(cont.)*
- In previous editions of the *Code*, any attempt to fit these relocatable structures under Article 550 was **difficult and ill-fitting at best**
- Quite often there were Article 550 requirements that were **impracticable or unnecessary** but not excluded while trying to apply Article 550 to these mobile units
- The previous requirements for "mobile homes used as other than dwelling units," formally covered at 550.4 in Article 550, have been incorporated into **new Part II of Article 545**
- The term "**relocatable structures**" was chosen as it is already a **commonly used industry term** that still identifies the portable nature of these units

547.5(G) GFCI Protection at Agricultural Buildings

- Revision eliminates GFCI protection for receptacles rated **above 125-volt, single-phase, 20-ampere** *(240-volt and 3-phase receptacles)* at agricultural buildings
- GFCI protection is now required to be provided as required in 210.8(B), which would cover areas like bathrooms, rooftops, sink areas, etc.
- GFCI protection is only required for **125-volt, 15- and 20-ampere receptacles** installed in areas having an equipotential plane, outdoors, damp or wet locations, and dirt confinement areas for livestock
- Equipment such as portable air compressors, welders, milk pumps, feed augers and conveyors often cause **unintended or unwanted tripping of GFCI protective devices**, which can create a hazard or cause property damage

547.5(G) GFCI Protection at Agricultural Buildings

Ground-fault circuit-interrupter (GFCI) protection at agricultural buildings shall be provided as required in 210.8(B)



GFCI protection shall not be required for other than 125-volt, 15- and 20-ampere receptacles

547.9 Electrical Supply from a Distribution Point (Agricultural Buildings)

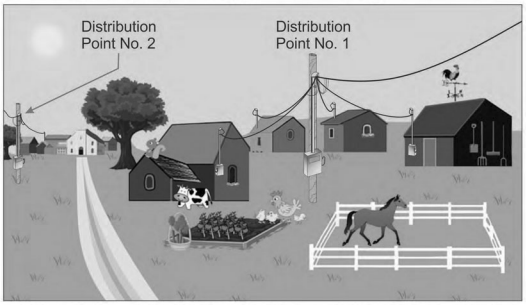
- Revision provides clarity that a **distribution point** is required for livestock agricultural buildings and structures
- A "**Distribution Point**" by Article 547 standards is defined as "an electrical supply point from which service drops, service conductors, feeders, or branch circuits to buildings or structures utilized under single management are supplied"
- Branch circuits and feeders to agricultural buildings required to be supplied through a **distribution point** and **overcurrent protection required** for all underground feeder and branch circuit installations
- More than one distribution point on the same premises permitted

547.9 Electrical Supply from a Distribution Point (Agricultural Buildings) *(cont.)*

- Revision provides clarity that a **distribution point** is required for livestock agricultural buildings and structures *(cont.)*
- Service disconnecting means and overcurrent protection for each set of feeders or branch circuits required to be located at the distribution point
- Service disconnecting means required to be installed in accordance with **Part VI of Article 230**
- Feeders or branch circuits supplied to buildings or structures to comply with the provisions of **250.32** and **Article 225, Parts I and II**
- In previous editions of the *Code*, any building or structure located on the same premises was "**permitted**" to be supplied by a distribution point *(not required)*

547.9 Electrical Supply from a Distribution Point

Any agricultural building or structure for livestock located on the same premises is *required* to be supplied from a distribution point *(previously "permitted" to be supplied from a distribution point)*



Existing agricultural building or structure (for other than livestock) and any existing non-Article 547 buildings or structures is permitted to be supplied in accordance with 250.32(B)(1) Ex. No. 1

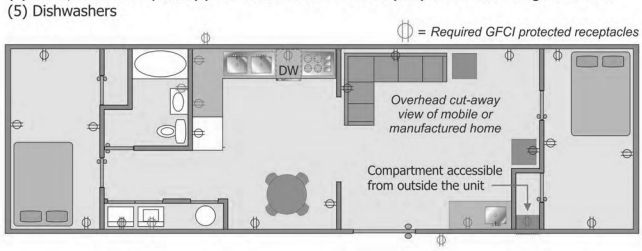
550.13(B) GFCI Protection for Mobile and Manufactured Homes

- Language was revised to include **210.8(A)**, which will provide GFCI protection to those additional locations at a dwelling covered in 210.8(A) for a mobile or manufactured home such as a **detached garage**
- **210.8(A)** revelation will allow CMP-7 *(purview over Article 550)* to stop "**chasing the tail**" of CMP-2 *(purview over Article 210)* every time CMP-2 makes a change to the GFCI protection requirements for conventional dwelling units at 210.8(A)
- Revision also **eliminates GFCI protection** for receptacles rated above 125-volt, single-phase, 20-ampere ***(240-volt and 3-phase receptacles)***
- These revisions are a step in the right direction in equaling GFCI protection for mobile or manufactured homes with GFCI protection at a conventional dwelling unit

550.13(B) GFCI Required for Mobile and Manufactured Homes

Ground-fault circuit-interrupter (GFCI) protection shall be provided as required in 210.8(A)

GFCI protection not required for other than 125-volt, 15- and 20-ampere receptacles installed within a mobile or manufactured home in the following areas:
(1) Compartments accessible from outside the unit
(2) Bathrooms (including receptacles in luminaires)
(3) Kitchens, where receptacles are installed to serve countertop surfaces
(4) Sinks, where receptacle(s) are installed within 1.8 m (6 ft) of the outer edge of a sink
(5) Dishwashers



550.32(E) Supply Receptacles for Mobile or Manufactured Homes

- Revisions clarify that a **supply receptacle providing power** to a mobile or manufactured home in accordance with 550.10 **need not be provided with** ground-fault circuit-interrupter protection **(GFCI) protection**
- Receptacles located **outside** a mobile or manufactured home are required to be provided with **GFCI protection as specified by 210.8(A)**
- Revision in the 2017 *NEC* at **210.8(B)** resulted in the expansion of GFCI protection for non-dwelling unit receptacles to include all **single-phase receptacles** rated **150 volts to ground or less**, **50 amperes or less**; and **three-phase receptacles** rated **150 volts to ground or less**, **100 amperes or less**
- 210.8(A) for the 2020 *NEC* will now encompass GFCI protection requirements for receptacle outlets rated at **125-volt through 250-volt** supplied by **single-phase** branch circuits rated **150 volts or less to ground**

550.32(E) Supply Receptacles for Mobile or Manufactured Homes *(cont.)*

- Part of the argument against GFCI protection for supply outlets and supply cords to a mobile or manufactured home pertains to a **branch circuit** verses a feeder
- The definition of a **feeder assembly** at 550.2 and 550.10 clarifies that the power supply cord to a mobile home is **considered a feeder**
- GFCI protection typically associated with a branch circuit rather than a feeder
- The supply cord to a mobile home is the **main power to the unit**
- The argument is rarely if ever made for the need for GFCI protection on the **main power feeder** to a **conventional dwelling unit**

550.32(E) Supply Receptacles for Mobile or Manufactured Homes

Receptacles located outside mobile or manufactured homes required to be provided with GFCI protection as specified by 210.8(A)

Receptacles providing power to mobile or manufactured homes in accordance with 550.10, are not required to be provided with GFCI protection

551.40(D) Reverse Polarity Devices for RVs

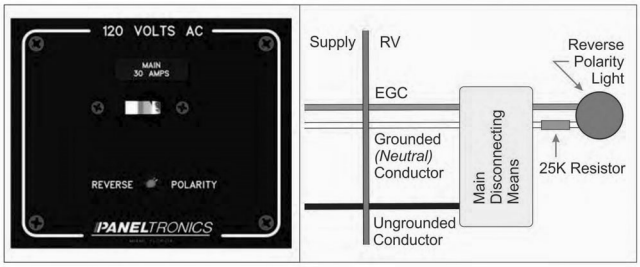
- New requirements added for a **reverse polarity indicating device** ***(providing a continuous visible or audible signal)*** to be installed in newly manufactured recreational vehicles (RV)
- Required to respond to the **reversal of the ungrounded and the grounded conductors** in a 120-volt ac system
- **Reverse polarity** at a recreational vehicle (RV) is a **known cause** of many incidents of people receiving an **electrical shock** from the RV itself
- Chance of having reverse polarity to an RV is increased as RVs are often plugged in at locations other than an RV campground
- Reverse polarity incidents are also more prevalent due to customers using adaptors to turn a 30-ampere receptacle into a 15-ampere receptacle that can be inserted backwards at the pedestal receptacle

551.40(D) Reverse Polarity Devices for RVs *(cont.)*

- New requirements added for a **reverse polarity indicating device** ***(providing a continuous visible or audible signal)*** to be installed in newly manufactured recreational vehicles (RV) ***(cont.)***
- Reverse polarity indicating devices are **readily available** as they are currently required for 30-ampere power supplies on **marine vessels**
- Requiring these devices could significantly **reduce shock incidents**, all of which are technically a potential electrocution in the RV world

551.40(D) Reverse Polarity Device for RVs

A reverse polarity indicating device providing a continuous visible or audible signal is now required to be installed in recreational vehicles in accordance with the installation instructions



The reverse polarity indicating device shall respond to the reversal of the ungrounded and the grounded conductors in a 120-volt ac system

555.2 Definitions: (Marinas. Boatyards, Floating Buildings, and Commercial and Noncommercial Docking Facilities)

- **New definitions** were added to Article 555 for clarity as these terms were **previously not defined**
- Several new definitions were extracted from **NFPA 303**-2016 (Fire Protection Standard for Marinas and Boatyards)
- Section 555.2 of Article 555 now contains **fourteen definitions**
- One of the new definitions (**Floating Building**) was relocated from previous Article 553 for floating buildings
- This previous article was deleted from the 2020 *NEC* and information relocated to Article 555, Part III

555.2 Definitions: (Marinas. Boatyards, Floating Buildings, and Commercial and Noncommercial Docking Facilities)

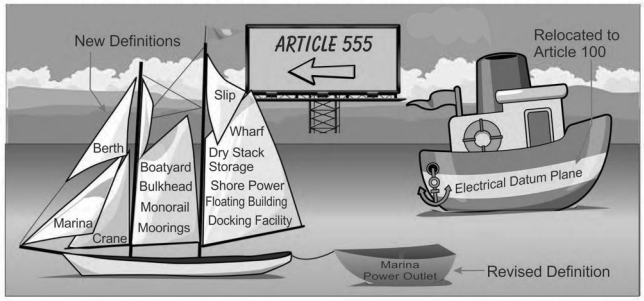
- Section 555.2 of Article 555 now contains **fourteen definitions**

Berth
Boatyard
Bulkhead
Crane
Docking Facility
Floating Building
Marina
~~**Marine**~~ **Marina Power Outlet**
Monorail
Mooring(s)
Shore Power
Slip
Storage, Dry Stack
Wharf

~~**Electrical Datum Plane**~~ *(Previous definition at 555.2 moved to 682.2) (New definition for Electrical Datum Plane added to Article 100 and assigned to CMP-7)*

555.2 Definitions - Marinas, Boatyards, Etc.

New definitions were added to Article 555 for clarity as these terms were previously not defined



Several new definitions were extracted from NFPA 303-2016 *(Fire Protection Standard for Marinas and Boatyards)*

555.13 Bonding of Non-Current-Carrying Metal Parts (Marinas, Boatyards, Etc.)

- All metal parts in contact with the water, all metal piping, and all non-current-carrying metal parts that are **likely to become energized** shall be connected to the grounding bus in the panelboard using solid copper conductors; insulated, covered, or bare; not smaller than 8 AWG
- Connections to bonded parts shall be made in accordance with **250.8**
- Comparable with equipotential bonding grid of **680.26**
- Same issues with **voltage gradients** (differences) is present at marinas, boatyards, floating buildings, and commercial and noncommercial docking facilities
- The marine environment associated with marinas, floating buildings, docking facilities, etc. is **harsh and less compatible** with electrical equipment than most conditions presented to electrical installations

555.13 Bonding of Non-Current-Carrying Metal Parts (Marinas, Boatyards, Etc.) *(cont.)*

- All metal parts in contact with the water, all metal piping, and all non-current-carrying metal parts that are **likely to become energized** shall be connected to the grounding bus in the panelboard using solid copper conductors; insulated, covered, or bare; not smaller than 8 AWG *(cont.)*
- Electrical equipment and metal parts in these marine environments are exposed to wet conditions, lightning, unusual movement, rough use by the public, extreme temperature changes, and significant UV exposure
- Combination of this environment and the normal use of these marine facilities result in conditions where equipment **failure is significant** and bonding for equipment and metal parts is critically important
- This bonding provision was located at **553.11** *(Floating Building)* in the 2017 *NEC*

555.13 Bonding of Non-Current-Carrying Metal Parts at Marinas, Etc.

All metal parts in contact with the water, all metal piping, and all non-current-carrying metal parts that are likely to become energized shall be connected to the grounding bus in the panelboard

Solid copper conductors; insulated, covered, or bare; not smaller than 8 AWG required to be used with connections to bonded parts made in accordance with 250.8

555.35 GFP of Equipment and GFCI Protection (Marinas, Boatyards, Etc.)

- Ground-Fault Protection of Equipment (GFPE) and Ground-Fault Circuit-Interrupter (GFCI) Protection divided into three parts:
  - **555.35(A)** addresses **shore power receptacles** *(not to exceed 30 mA)*
  - **555.35(B)** addresses **15- and 20-ampere receptacles** for other than shore power *[GFCI protection (4 to 6 mA)]*
  - **555.35(C)** addresses **feeder and branch-circuit conductors** that are installed on docking facilities *(not to exceed 100 mA)*
- Previous *Code* language required the overcurrent protective devices that supplied marinas, boatyards, and commercial and noncommercial docking facilities to have GFP **not exceeding 30 mA** *(see 555.3 for the 2017 NEC)*
- This **30 mA** maximum GFP requirement proved to be **unreliable** and **impracticable**

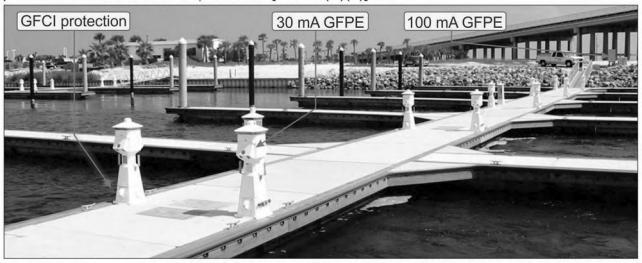
555.35 GFP of Equipment and GFCI Protection (Marinas, Boatyards, Etc.) *(cont.)*

- Through a culminative effect, it did not take but a few boats leaking current into the water around a marina before the 30 mA level was exceeded
- **Exception** added which would exempt **transformer secondary conductors** of a separately derived system *[not exceed 3 m (10 ft)]* installed in a raceway from this GFPE protection
- *Code* language added to require **leakage current measurement devices**
- Where **more than three receptacles** supply shore power to boats, a **leakage current measurement device** required to be available and be used to determine leakage current **from each boat** that will utilize shore power
- Test data has shown that a great deal of the **stray current in the water** around marinas comes from the boats (vessels) themselves

555.35 GFPE and GFCI Protection at Marinas, Boatyards, Etc.

Shore power receptacles shall have individual GFPE not exceeding 30 milliamperes [555.35(A)(1)]

All 125-volt, single-phase, 15- and 20-ampere receptacles *(other than shore power)* shall be provided with Class A GFCI protection [555.35(A)(2)]



Feeder and branch-circuit conductors installed on docking facilities shall be provided with GFPE set to open at currents not exceeding 100 milliamperes with downstream GFPE coordination permitted at the feeder overcurrent protective device [555.35(A)(3)]

555.35(B) Leakage Current Measurement Device at Marinas, Etc.

Where more than three receptacles supply shore power to boats, a leakage current measurement device shall be available and be used to determine leakage current from each boat that will utilize shore power

Photo courtesy of Marina Electrical Equipment (MEE)

Leakage current measurement will provide the capability to determine when an individual boat has defective wiring or other problems contributing to hazardous voltage and current

The use of a test device will allow the facility operator to identify a boat that is creating problems

The use of a test device will also help the facility operator prevent a particular boat from contributing to hazardous voltage and current in the marina area

Article 555 Part III – Floating Buildings

- Previous **Article 553 (Floating Buildings)** was deleted and requirements incorporated into **new Part III of Article 555**
- Incorporating the requirements for floating buildings into Article 555 is a **natural fit** as the two articles *(previous Article 553 and Article 555)* were **similar in nature**
- Previously, Article 555 had no parts *(it now has 3 parts)*
- Title and scope of Article 555 updated to reference **floating buildings**
- Addition of floating buildings to Article 555 will **enhance electrical safety** and usability of the *NEC*
- Significant change occurred at **555.4** (Location of Service Equipment) *(formerly 555.7)* requiring the service equipment for a floating building, dock, or marina to be located **on land adjacent to the structure served** *(not on or in the structure itself or any other floating structure)*

590.4(G), Ex. No. 2 – Splices at Temporary Installations

- On construction sites, a **new exception** to 590.4(G) permits branch-circuits that are **permanently installed** in framed walls and ceilings to be used for **temporary power or lighting** *(with GFCI protection)*
- Previously, no provisions existed in Article 590 to allow a permanent wiring method *(branch circuits)* to be used as temporary construction lighting circuits without covers on boxes, etc.
- On a typical construction jobsite, temporary lighting becomes an issue in individual rooms leaving these rooms in the dark after drywall finishes applied
- Very common method employed to get temporary lighting in those individual rooms and areas is to string **Type NM cable** through doorways and through each room in each unit *(unsafe and unreliable)*
- These permanent wiring methods (branch circuits) used as temporary construction lighting circuits to be **GFCI protected** through the duration of the temporary installation

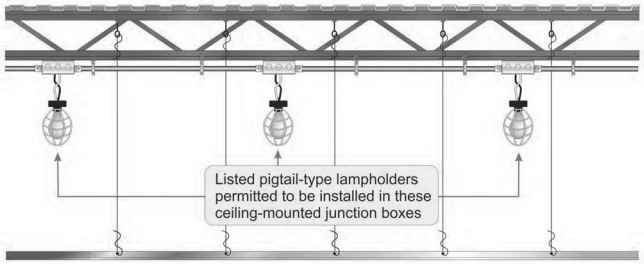
590.4(G), Ex. No. 2 – Splices at Temporary Installations *(cont.)*

- On construction sites, a **new exception** to 590.4(G) permits branch-circuits that are **permanently installed** in framed walls and ceilings to be used for **temporary power or lighting** *(with GFCI protection) (cont.)*
- Viable solution is to **temporarily energize** one or more of the **permanently installed branch circuit(s)** to provide temporary lighting in each room, bathroom, etc.
- This method requires splices in junction boxes typically located above the suspended drop-in ceiling tile *(installed at a later date)* without covers to energize temporary listed lighting pig tails
- **New exception** stipulates that a **cover is not required** for splices installed completely inside of junction boxes with plaster rings and that **listed pigtail-type lampholders are permitted** to be installed in these ceiling-mounted junction boxes with plaster rings

590.4(G), Ex. No. 2 Splices at Temporary Installations

A box, conduit body, or other enclosure *(with a cover installed)* generally required at all splice points

By exception, permanent wiring in framed walls and ceilings permitted to be used to supply temporary power or lighting with no cover for splices installed completely inside of junction boxes with plaster rings



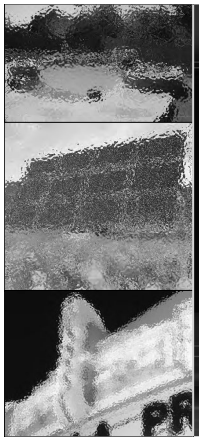
Permanent wiring methods *(branch circuits)* used as temporary construction lighting circuits to be GFCI protected through the duration of the temporary installation

590.8 Overcurrent Protective Devices (Temporary Installations)

- New section added to provide guidance in the **reuse of overcurrent protective devices** in temporary installations and the use of **current limiting overcurrent protective devices** required for solidly grounded wye electrical services of more than 150 volts to ground but not exceeding 1000 volts phase-to-phase in temporary installations
- When equipment is re-used, and that equipment has previously been subjected to environments, uses, and conditions that may not be visibly obvious, approval of that equipment is difficult in many cases
- The re-used equipment, such as overcurrent protective devices is more than likely listed equipment but could very well have been **previously used or exposed to conditions outside the scope of its listing certification**

590.8 Overcurrent Protective Devices (Temporary Installations) *(cont.)*

- New **590.8(A)** mandates that overcurrent protective devices be examined to ensure that these devices have been "**properly installed**," "**properly maintained**," and there is "**no evidence of impending failure**" whenever these overcurrent protective devices have been previously used are installed in a temporary installation
- New **590.8(B)** addresses overcurrent protective devices used as part of the service equipment in temporary installations, calling for overcurrent protective devices for **solidly grounded wye electrical services** of **more than 150 volts to ground** but **not exceeding 1000 volts phase-to-phase** to be of the "**current limiting**" type
- **Current-Limiting Overcurrent Protective Device**: "A device that, when interrupting currents in its current-limiting range, reduces the current flowing in the faulted circuit to a magnitude substantially less than that obtainable in the same circuit if the device were replaced with a solid conductor having comparable impedance."



Chapter Six Special Equipment

600.2 Definitions – Electric Signs and Outline Lighting

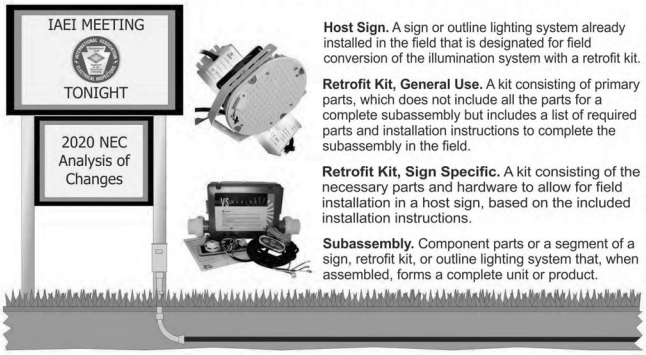
- **Four new definitions** were added to 600.2 pertaining to **retrofit kits for signs** (1) Host Sign, (2) Retrofit Kit, General Use, (3) Retrofit Kit, Sign Specific, (4) Subassembly
- Luminaires are typically standardized and are typically mass produced, whereas **signs** are typically **custom made** and have **distinctly different structural and illumination characteristics**, including multi-location corporate signage programs which are dissimilar in size
- A retrofit kit for a sign typically has **more "moving parts"** to deal with than a retrofit kit for a luminaire
- Concentrated efforts has been pursued in the sign industry to upgrade signs to achieve **greater energy efficiency** by replacing in-place illumination systems such as florescent with light emitting diodes (LED) technology

600.2 Definitions – Electric Signs and Outline Lighting *(cont.)*

- **Four new definitions** were added to 600.2 pertaining to **retrofit kits for signs** (1) Host Sign, (2) Retrofit Kit, General Use, (3) Retrofit Kit, Sign Specific, (4) Subassembly *(cont.)*
- An upgrade of the sign typically involves **field modifications** of the sign
- Proper adherence to **developed protocols** for these field conversions, such that when done within the testing laboratory parameters, ensures these field conversion "retrofit kits" do not compromise the safety profile of the listed sign
- These **added definitions** will aid the installer and the inspector in assuring the right retrofit kit is used with the correct host sign

600.2 Definitions. (Electric Signs and Outline Lighting)

Four new definitions were added to 600.2 pertaining to retrofit kits for signs



Host Sign. A sign or outline lighting system already installed in the field that is designated for field conversion of the illumination system with a retrofit kit.

Retrofit Kit, General Use. A kit consisting of primary parts, which does not include all the parts for a complete subassembly but includes a list of required parts and installation instructions to complete the subassembly in the field.

Retrofit Kit, Sign Specific. A kit consisting of the necessary parts and hardware to allow for field installation in a host sign, based on the included installation instructions.

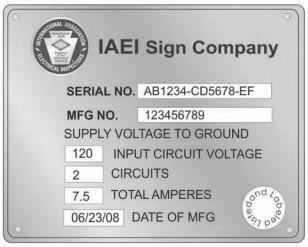
Subassembly. Component parts or a segment of a sign, retrofit kit, or outline lighting system that, when assembled, forms a complete unit or product.

600.4(D) Visibility of Markings for Electric Signs and Outline Lighting

- Revisions now require **visibility of markings** at the time of installation, inspection, and prior to servicing, but can be installed in a location **not viewed by the public**
- Previously, 600.4(A) markings and listing labels were not required to be visible after installation, but were required to be permanently applied in a location **visible during servicing** ***(rather than prior to servicing)***
- This marking would include such things as manufacturer's name, trademark, maximum allowable lamp wattage, input voltage, and current rating
- New *Code* text was added to clarify that "***visible after installation***" does not necessarily mean visible in a location viewed by the public
- When an installer or inspector first approaches a sign, they should be able to identify **input voltage** and **current rating** prior to opening the sign

600.4(D) Visibility of Markings - Electric Signs and Outline Lighting

Signs and outline lighting systems required to be marked with such things as manufacturer's name, trademark, input voltage and current rating, maximum allowable lamp wattage per lampholder, and other means of identification [600.4(A) and (C)]



Markings and listing labels are required to be visible after installation and must be permanently applied in a location visible prior to servicing

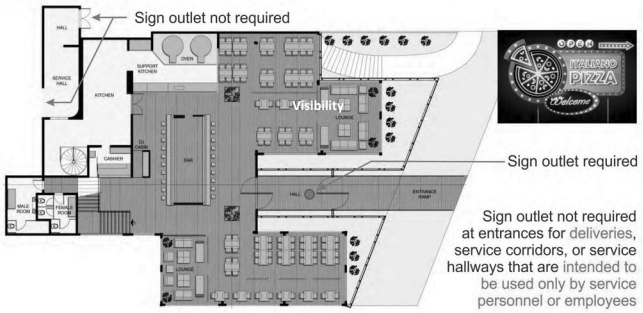
Marking permitted to be installed in a location not viewed by the public

600.5(A) Required Branch Circuit for Electric Signs and Outline Lighting

- Revision clarifies that **entrances not accessible to customers**, such as delivery doors, **do not require a sign outlet**
- At each commercial building and each commercial occupancy accessible to pedestrians, at least one outlet ***(located in an accessible location)*** is required to be installed at each entrance to each tenant space for a sign or outline lighting system
- A sign or outline lighting outlet **not required** at entrances for deliveries, service corridors, or service hallways that are intended to be used only by service personnel or employees
- Clarification was needed to distinguish what entry doors did and did not require this required sign outlet

600.5(A) Required Branch Circuit for Electric Signs/Outline Lighting

At each commercial building and each commercial occupancy accessible to pedestrians, at least one outlet is required to be provided at an accessible location for each entrance to each tenant space for a sign or outline lighting system *(required to be supplied by a 20-ampere branch circuit with no other loads)*



600.5(B) Marking Requirements at Sign Disconnects

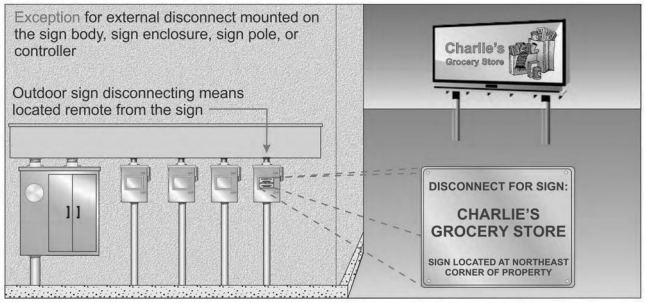
- Disconnecting means for a sign, outline lighting system, or controller now required to be **marked to identify** sign, outline lighting system, or controller it controls
- **Exception** for external disconnect mounted on the sign, etc.
- If **located remote**, disconnect required to be mounted at an **accessible location** available to first responders and service personnel
- Previous provisions required a permanent field-applied marking identifying the location of the disconnecting means applied to a sign in a location visible during servicing identifying the location of the disconnecting *means [see 600.6(A)(2)]*
- No provisions existed *(until now)* in Article 600 requiring a marking or label at the disconnection means for a sign, outline lighting system, or controller identify the sign, outline lighting system, or controller it controls

600.5(B) Marking Requirements at Sign Disconnects *(cont.)*

- Disconnecting means for a sign, outline lighting system, or controller now required to be **marked to identify** sign, outline lighting system, or controller it controls *(cont.)*
- Without a marking or label identifying the sign it controls, a remote disconnecting means might not be recognized or identified as controlling the sign, outline lighting system or controller by anyone other than the service technician
- Sign service employees and maintenance personnel, and in particular **emergency responders** have a **need to know** what utilization equipment the disconnect(s) is designated for where it is not mounted on the sign, outline lighting system or controller
- This new marking requirement at **600.5(B)** can be tied to **new remote location provision at 600.6(A)(4)**, which calls for the sign disconnecting means *(if located remote from the sign, sign body, or pole)* to be mounted at an **accessible location available to first responders and service personnel**

600.5(B) Marking Requirements at Disconnect

Disconnecting means for a sign, outline lighting system, or controller is now required to be marked to identify the sign, outline lighting system, or controller it controls



The disconnecting means *(if located remote from the sign, sign body, or pole)* shall be mounted at an accessible location available to first responders and service personnel *[See 600.6(A)(4)]*

600.35 Retrofit Kits for Electric Signs and Outline Lighting

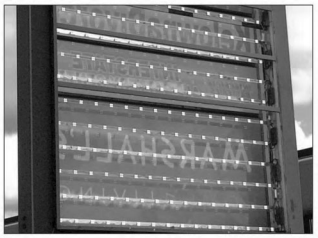
- New section added pertaining to "**Retrofit Kits**" for signs and outline lighting systems
- New **600.35** gives **specific and needed installation instructions** for **retrofit kits** for signs and outline lighting systems
- **Retrofit Kit**: "A general term for a complete subassembly of parts and devices for field conversion of utilization equipment."
- To some in the electrical industry *(particularly the sign industry)* the term "**complete**" in the definition of "**Retrofit Kit**" was deemed **subjective** and felt more information was needed to install and enforce requirements for a **sign retrofit kit**

600.35 Retrofit Kits for Electric Signs and Outline Lighting *(cont.)*

- New *Code* rules will provide the impetus for implementation of retrofit kits and its "**complete subassembly**" intended to applied to signs and outline lighting retrofit kits, with each listed retrofit kit mandated to include "**all the necessary parts**" for field conversion of a "**host sign***" (see new definitions at 600.2)*
- Retrofit kits are now required to be "**listed and labeled**," which will bring some consistency to these retrofit kits
- Installation instructions for **field conversions** are **distinguishable** for use in the host sign
- New *Code* requirements for sign retrofit kits harmonize with **UL 879A** *(Standard for LED Sign and Sign Retrofit Kits)*, enabling the installer to identify the correct replacement parts and devices needed for a **safe conversion** and facilitates the AHJ's approval process

600.35 Retrofit Kits

New 600.35 gives specific installation instructions for retrofit kits for signs and outline lighting systems



General-use or sign-specific retrofit kits for sign or outline lighting systems to include installation instructions and requirements for field conversion of a host sign

Retrofit kits shall be listed and labeled

All parts that are not replaced by a retrofit kit shall be inspected for damage

605.1(A) and (B) Covered and Not Covered (Office Furnishings)

- The scope of Article 605 was clarified to specify items that are **not covered** by Article 605
- Previously, the scope of Article 605 only told the user of the *Code* what was **covered** by the article
- New *Code* text at **605.1(B)** states that Article 605 **does not apply to** "individual office furnishings not connected to a system, such as chairs, freestanding desks, tables, storage units, and shelving units"
- Some jurisdictions have improperly applied Article 605 to **individual free-standing furnishings**, such as **motorized adjustable workstations**, which are not intended to be covered by this article
- New provisions should clarify the products intended to be **covered** and **not covered** by Article 605

605.1(A) and (B) Covered and Not Covered (Office Furnishings)

605.1(A) Covered. This article covers electrical equipment, lighting accessories, and wiring systems used to connect, contained within, or installed on office furnishings.

COVERED

NOT COVERED

605.1(B) Not Covered. This article does not apply to individual office furnishings not connected to a system, such as chairs, freestanding desks, tables, storage units, and shelving units.

620.6 GFCI Protection in Elevator Pits, Etc.

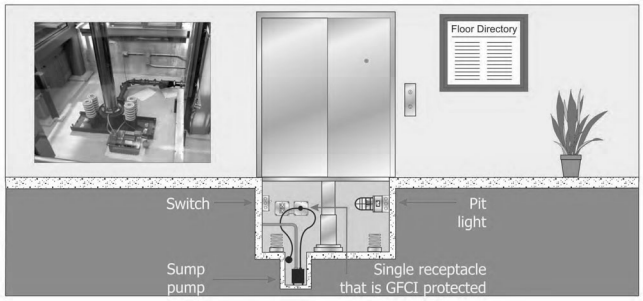
- Revision clarifies that any receptacle in a pit must be **GFCI protected**
- GFCI protection **not required** for a **hard-wired** sump pump
- Permanently installed sump pump is now required to be ***either*** permanently wired ***or*** must be supplied by a **single receptacle** that is **GFCI protected** *(no GFCI protection required in previous Code)*
- **Complete reversal** for the GFCI provisions for a single receptacle supplying a permanently installed sump pump in something like an elevator pit since the 1996 *NEC*
- These GFCI rules were moved to **Part I** of Article 620 as these GFCI rules were more appropriately located in Part I (General Requirements) *(was 620.85)*

620.6 GFCI Protection in Elevator Pits, Etc. *(cont.)*

- This is one of the few places in the entire *Code* where the **GFCI protection** is required to be delivered in the form of a **receptacle outlet-type GFCI protection** (at the outlet) rather than GFCI overcurrent protection in the form of a circuit breaker or a GFCI receptacle located remote
- In an elevator pit or similar pit, **GFCI protection** is called upon to be **located at the receptacle outlet** in the pit so that GFCI device can be reset if tripped without service personnel having to climb out of the pit to reset the GFCI device *(see first sentence at 620.6)*
- This revision is similar to revision that occurred at **422.5(A)(6)** *(GFCI protection now required on **all** 150 volts or less to ground and 60 amperes or less, single- or 3-phase sump pumps (hard wired or cord-and-plug connected)*
- For the sump pump in an elevator pit, one would have to rely on **90.3** to take precedence and indicate that rules in Chapter 6 [620.6] would "**supplement or modify**" the rules in Chapter 4 [422.5(A)(6)]

620.6 GFCI Protection in Elevator Pits, Etc.

All 125-volt, single-phase, 15- and 20-ampere receptacle installed in pits, for hoistways, elevators, dumbwaiters, escalators, etc. are required to be of the GFCI receptacle type



Permanently installed sump pumps required to be either permanently wired or must be supplied by a single receptacle that is GFCI protected

620.65 Signage for Selective Coordination

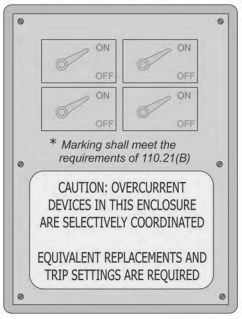
(Elevators, Dumbwaiters, Escalators, Moving Walks, Platform Lifts, and Stairway Chairlifts)

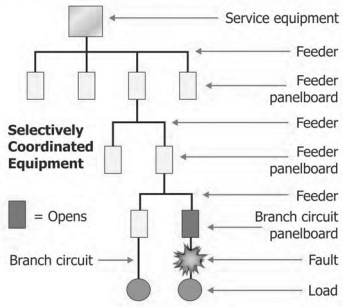
- New section added to require **equipment enclosures** for elevators, etc. containing **selectively coordinated** overcurrent devices to **be legibly marked in the field**
- More than one driving machine disconnecting means for elevators, escalators, etc. were **required to be selectively coordinated** with any other supply side overcurrent protective devices when supplied by a single ***feeder (but no marking was required)***
- Field marking will alert those who are authorized to maintain, inspect or work on the system that the overcurrent devices are selectively coordinated and provide a **higher level of safety**
- Change will also aid in enforcement by making information readily available to the AHJ

620.65 Signage for Selective Coordination

(Elevators, Dumbwaiters, Escalators, Moving Walks, Platform Lifts, and Stairway Chairlifts)

Equipment enclosures containing selectively coordinated overcurrent devices required to be legibly marked in the field to indicate that the overcurrent devices are selectively coordinated





Article 625 and 625.1 Electric Vehicle Charging Power Transfer Systems

- With the addition of **power export equipment** and **bidirectional current flow equipment**, a change to the title and scope of Article 625 was needed for clarify
- Previous scope of Article 625 covered "the electrical conductors and equipment external to an electric vehicle that connect an electric vehicle to a supply of electricity by conductive, inductive, or wireless power transfer *(contactless inductive charging)* means, and the installation of equipment and devices related to electric vehicle charging"
- Scope now covers "the electrical conductors and equipment connecting an electric vehicle **to premises wiring** for the purposes of **charging**, **power export**, or **bidirectional current flow**"
- Significant changes to Article 625 occurred last *Code* cycle when the **wireless power transfer technology** was introduced to the article

Article 625 and 625.1 Electric Vehicle Charging Power Transfer Systems *(cont.)*

- Another significant change is being incorporated into Article 625 this *Code* cycle with the introduction of rules pertaining to **power export equipment** and **bidirectional current flow equipment**
- **Power export equipment** and **bidirectional current flow equipment** provisions are being added to a couple of definitions ***[Electric Vehicle Power Export Equipment (EVPE) and Electric Vehicle Supply Equipment (EVSE)]***
- These terms are also being added at **625.41** (Overcurrent Protection), **625.43** (Disconnection Means), and **625.48** (Interactive Systems)
- **Power export equipment** and **bidirectional current flow equipment** can cover a wide range of devices, **including but not limited to**: an inverter regardless of off-board or on-board, an EVSE that works for reverse power flow from a vehicle, an AC outlet regardless of off-board or on-board, a dc 12 volt outlet, and a USB socket as a 5 volt power outlet

Article 625 and 625.1 Electric Vehicle ~~Charging~~ Power Transfer Systems

This article covers the electrical conductors and equipment connecting an electric vehicle to premises wiring for the purposes of charging, power export, or bidirectional current flow.

Article 625, Part II – EV Equipment Construction

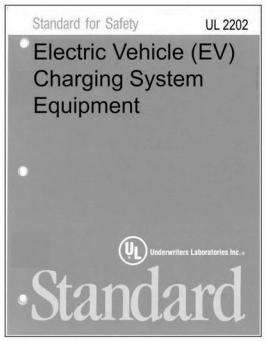
- **Product construction requirements** in Part II of Article 625 were deleted from Article 625
- Previously, Part II of Article 625 contained **several product construction requirements** that are **better suited in one of the product standards** for EV equipment
- ***All*** **product construction requirements** in Part II of Article 625 addressing product features that are an **integral part of the listing requirements** *(required by 625.5)* for the product were **removed from Article 625**
- Equipment construction requirements were **developed and added to the 1999** ***NEC*** at a time when there were **no existing published product safety standards** specifically covering electric vehicle charging or supply equipment

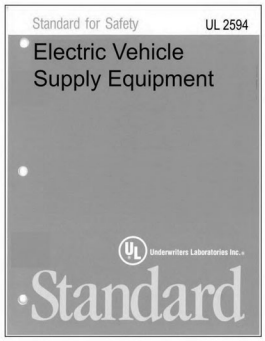
Article 625, Part II – EV Equipment Construction *(cont.)*

- **Product construction requirements** in Part II of Article 625 were deleted from Article 625 *(cont.)*
- Since that time, **several product safety standards** covering electric vehicles and electric vehicle supply equipment with associated product listing programs **available** from several of the nationally recognized testing laboratories (NRTL) have been **developed and implemented** in the electric vehicle world
- All of these product standards are included in **Informative Annex A** *(see 90.7, Informational Note No. 3)*
- With the elimination of these sections, **two definitions** that are not used elsewhere in the Article are also **removed** ***(Electric Vehicle Coupler and Electric Vehicle Inlet)***

Article 625 - Part II EV Equipment Construction

All product construction requirements in Part II of Article 625 addressing product features that are an integral part of the listing requirements for EV product were removed from Article 625





625.17(B) Output Cable to Electric Vehicles

- Revision allows the **output cable** to an electric vehicle to be an **integral part of listed electric vehicle supply equipment**
- Previously, Type EV, EVJ, EVE, EVJE, EVT, or EVJT flexible cable were the **only permitted output cables** to an electric vehicle
- Output cable to an electric vehicle now permitted to be **listed** Type EV, EVJ, EVE, EVJE, EVT, or EVJT flexible cable as specified in Table 400.4 ***or*** an output cable that is an **integral part of listed electric vehicle supply equipment**
- Introduction of **multiple long range, mass-market priced electric vehicles** requires **exponential growth** in the number of fast charge stations accessible to the public
- Due to the larger batteries, fast charges must increase the power delivery rates in order to keep the charging times reasonable

625.17(B) Output Cable to Electric Vehicles *(cont.)*

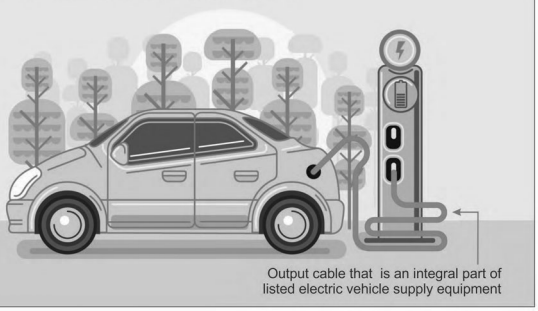
- Some in the EV industry felt like the previous *Code* language was **overly restrictive** and precluded any innovation or progress to deliver smaller, lighter, and safer cables for charging an EV
  - Such as the **engineered cabling solutions** being incorporated into the electric vehicles themselves that are **an integral *(nondetachable)* part of the listed electric vehicle supply equipment** (EVSE)
- Using the allowable cable types and construction types previously permitted at 625.17(B) for fast charging, long range EVs would result in **cables so large and heavy** that they would be practically rendered **unusable**

625.17(B) Output Cable to an Electric Vehicle

The output cable to the electric vehicle shall be one of the following:

(1) Listed Type EV, EVJ, EVE, EVJE, EVT, or EVJT flexible cable as specified in Table 400.4 or...

(2) An integral part of listed electric vehicle supply equipment



625.44 EV Portable Equipment Connection

- The connection methods for connection of **portable EV charging equipment** to the premises wiring system has been **expanded** to include certain **250-volt rated receptacle outlets**
- Previously, **portable EV charging equipment** for connection to the premises wiring system was limited to **(1)** a nonlocking, 2-pole, 3-wire grounding-type receptacle outlet rated at 125 volt, single phase, 15 or 20 amperes or **(2)** a nonlocking, 2-pole, 3-wire grounding-type receptacle outlet rated 60 volt dc maximum, 15 or 20 amperes
- Expanded to the use of a nonlocking, 2-pole, 3-wire, **250-volt, single phase, 15 or 20 amperes** grounding-type receptacle outlet or a nonlocking, 2-pole, 3-wire or 3-pole, 4-wire grounding-type receptacle outlet rated at **250 volts, single phase, 30 or 50 amperes**

625.44 EV Portable Equipment Connection *(cont.)*

- The connection methods for connection of **portable EV charging equipment** to the premises wiring system has been **expanded** to include certain **250-volt rated receptacle outlets** *(cont.)*
- Electric vehicle (EV) manufacturers continue to **extend the range** or distance an EV can travel **between charges**
- Demand exist for having the ability to charge upon reaching that extended range destination in order to make **longer range EV travel plausible**
- Multiple EV manufacturers insist that **250-volt portable charging** is a must in order to support the sale and deployment of longer range EVs
- Title of **625.44(B)** changed from "Stationary Equipment" to "Fastened-in-Place Equipment" *(wiring method suitable for portable equipment is suitable for fastened in place equipment as well)*

625.54 GFCI Protection for EV Charging Equipment

- Revision clarifies that all receptacle outlets used for electric vehicle (EV) charging be provided with **GFCI protection** for personnel for all **cord and plug connected** electric vehicle power transfer equipment
- In the past, receptacle outlet(s) used for EV charging equipment may or may not have been required to be GFCI protected, depending on the location of the receptacle outlet and the rating of said outlet
- All receptacle outlets installed for the connection of EV charging will be required to be provide with **GFCI protection** for personnel *(regardless of the receptacle outlet's location)*
- Electrical safety concerns were expressed concerning personnel plugging and unplugging something like a 250-volt cord cap into a receptacle outlet in a wet or damp environment
- GFCI protection for receptacle outlets used for EV charging is "**in addition to the requirements in 210.8**"

625.54 GFCI Protection for EV Charging Equipment

In addition to the requirements in 210.8, ***ALL*** receptacles installed for the connection of electric vehicle charging equipment is required to provide GFCI protection for personnel

625.56 Weatherproof Enclosure for EV Charging Receptacle Outlets

- New requirement added requiring ***all*** receptacles installed in **wet locations** for **electric vehicle (EV) charging** to be installed in an enclosure that provides **weatherproof protection** with or without an attachment plug cap inserted
- Similar to weatherproof enclosure requirements of **406.9(B)**, but this Chapter 4 requirement only applies to 15 and 20 amperes rated receptacles
- No voltage or amperage rating limitation to this new Article 625 rule
- Outlet box hood installed for this purpose required to be **listed** and be identified as "**extra duty**," while allowing other listed products, enclosures, or assemblies providing weatherproof protection that do not utilize an outlet box hood to not be required to be marked "extra duty"
- New receptacle enclosure requirement at 625.56 will bring some consistency between Article 406 and Article 625

625.56 WP Enclosure for EV Charging Receptacle Outlets

All receptacles installed in a wet location for electric vehicle charging require an enclosure that is weatherproof with the attachment plug cap inserted or removed

An outlet box hood installed for this purpose required to be listed and identified as "extra duty"

Other listed products, enclosures, or assemblies providing weatherproof protection *(not utilizing an outlet box hood)* shall not be required to be marked "extra duty"

625.60 AC Receptacle Outlets Used for EVPE

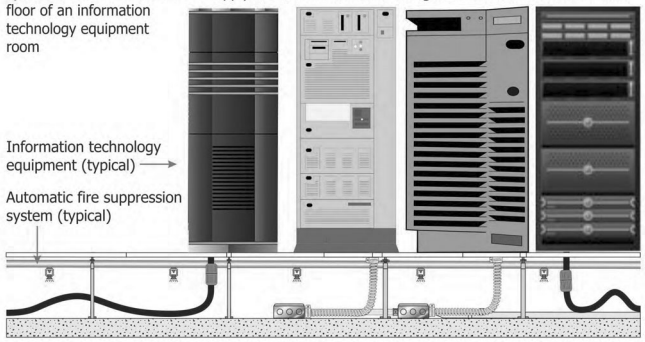
- New section added to require **all on-board receptacle outlets** on or in an electric vehicle to be **GFCI protected**
- The ground-fault circuit-interrupter indication and reset to be installed in a **readily accessible location**
- Common occurrence to see **120-volt alternating current (ac) receptacle outlets** installed on-board in vehicles *(not just electric vehicles)*
- These on-board ac receptacle outlets will be required to be **listed** and rated at **250 volts maximum**, single phase **50 amperes maximum** with overcurrent protection integral to the power export system
- Should a person be less protected in their electric vehicle at the beach that they would be at home in their garage?

645.5(E) Wiring Under Raised Floors (IT Equipment Rooms)

- Revisions distinguish between air space under a raised floor in an information technology (IT) equipment room when protected by an **automatic fire suppression system** and those that are not
- This information is a condition that is needed to help determine the **appropriate wiring method** under a raised floor
- Protection by an automatic fire suppression system *(or lack thereof)* is a condition spelled out in detail in **NFPA 75** *(Standard for the Fire Protection of Information Technology Equipment)*
- This revision removes any conflict between *NEC* and NFPA 75, which permits non-plenum wiring under a raised floor when an automatic fire suppression system is present, otherwise plenum wiring is required

645.5(E) Wiring Under Raised Floors (ITE Rooms)

Requirements revised to incorporate protected techniques offered by an automatic fire suppression system under a raised floor for supply circuits and interconnecting cables installed under a raised floor of an information technology equipment room



645.5(E) Supply Circuits and Interconnecting Cables Under Raised Floors

680.2 and 680.14 Corrosive Environment

- The definition of "**Corrosive Environment**" was revised and moved from 680.14 to 680.2
- Title of **680.14** was revised to **"Wiring Methods in Corrosive Environment"** and now only address the **wiring methods identified for use in a corrosive environment** in and around swimming pools, fountains, and similar installations
- 2017 *NEC* added section at 680.14 with a "**description**" of what a corrosive environment could be
- This "description" was very close to a "definition" of a corrosive environment and needed to be relocated to 680.2

680.2 and 680.14 Corrosive Environments

Corrosive Environment. Areas where pool sanitation chemicals are stored, handled, or dispensed, and confined areas under decks adjacent to such areas, as well as areas with circulation pumps, automatic chlorinators, filters, open areas under decks adjacent to or abutting the pool structure, and similar locations.

680.2, 680.35, and 680.45 Immersion Pools

- Two new sections covering **immersion pools** were added to Article 680 providing installation requirements for a newly added definition at 680.2 for "**Immersion Pools**"
- "Immersion pools" were previously covered by Article 680 with these terms included in the **three definitions** but their unique characteristics were not specifically addressed in previous *Code* language
- New requirements at 680.35 and 680.45 and definition at 680.2 will provide needed clarity to applications where listed pre-packaged units are not used
- New definition added to 680.2 indicates that an immersion pool is "a pool for ceremonial or ritual immersion of users, which is designed and intended to have its contents drained or discharged"

680.2, 680.35, and 680.45 Immersion Pools *(cont.)*

- Two new sections covering **immersion pools** were added to Article 680 providing installation requirements for a newly added definition at 680.2 for "**Immersion Pools**" *(cont.)*
- Immersion pools are typically installed in a building such as a church and are generally installed indoors but may be installed outdoors, on the ground or supporting structure, or in the ground or supporting structure
- Typically contain integral interior steps and may be equipped with a heater and/or pump and can employ an underwater luminaire
- New **680.35** will deal with requirements for "**Storable and Portable Immersion Pools**" and new **680.45** was added for "**Permanently Installed Immersion Pools**"

680.2 and 680.50 Splash Pads

- A **new definition** for **"Splash Pads"** was added and provisions added at **680.50** to allow for future revisions to more accurately target installation requirements for these units
- **Splash Pad.** A fountain with a pool depth **25 mm (1 in.) or less**, intended for recreational use by pedestrians. This definition does not include showers intended for hygienic rinsing prior to use of a pool, spa, or other water feature.
- Splash pads now required to comply with **Part II** *(permanently installed pools)* and equipotential bonding requirements
- Splash pads and similar installations present the **same potential risk of electric shock** as do the areas around swimming pools
- Similar **equipotential bonding** should therefore be required

680.4 Inspections After Installation (Swimming Pools, Fountains, and Similar Installations)

- New section ***(Inspections After Installation)*** added to provide the AHJ with the opportunity to address hazards associated with **aging pool installations**
- Grants AHJ permission to require **periodic inspection and testing** of pool related equipment
- After final inspection of a new installation, AHJ rarely sees that installation again during the lifespan of that particular installation *(unless a remodel or renovation occurs)*
- Due to corrosive conditions beyond what normal electrical equipment has to endure, pool-related electrical equipment is **subject to failure** and typically has a **shorter lifespan** than most electrical equipment
- Leaving the nature and frequency of inspection or maintenance to the AHJ allows jurisdictions to decide whether to apply this to all pools, commercial pools, etc.

680.4 Inspections After Installation

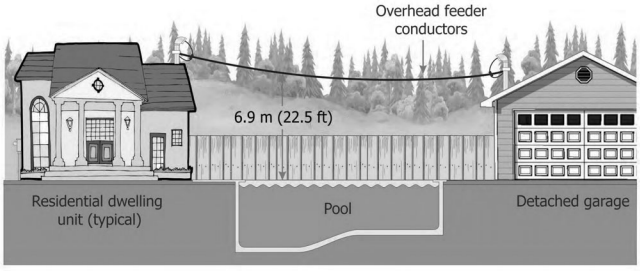
The AHJ shall be permitted to require periodic inspection and testing of Article 680 equipment

680.9(A) Overhead Power Conductor Clearances

- Revision clarifies that **all overhead conductor** *(not just service conductors)* need proper clearances when installed over swimming pools and similar installations
- Previous requirements only addressed overhead service-drop conductors, overhead service conductors, and open overhead wiring
- 680.9(A) revised to make these overhead clearances applicable to any and *ALL* overhead power conductors *(**overhead feeders, branch circuits, etc.**)*
- Overhead clearances for communications cables [680.9(B)] and overhead network-powered broadband communications systems (NPBCS) conductors [690.9(C)] remain the same as previous *Code* cycle

680.9(A) Overhead Power Conductor Clearances

The minimum clearances for overhead power conductors *(not just service conductors)* from pools, fountains, etc. shall comply with the provisions in Table 680.9(A) for conductors operating at 0 to 750 volts to ground [6.9 m (22.5 ft)] *(typical)*

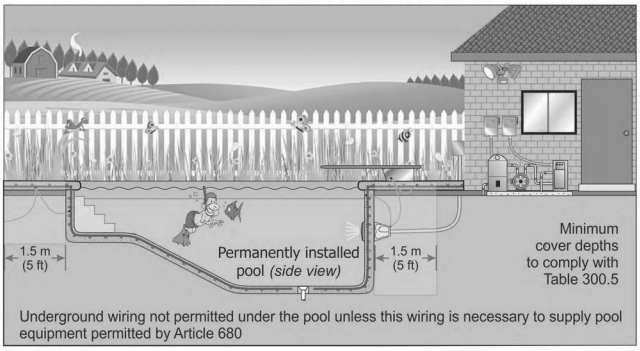


680.11 Underground Wiring Around Swimming Pools

- Underground wiring methods around a swimming pool revised into a **list format**
- Long-standing distance of **1.5 m (5 ft)** *(removed for the 2017 NEC)* around pool that **underground wiring restrictions were subject to** was revived for this *Code* cycle and apply to acceptable wiring methods that are listed for direct burial in these areas where exposure to a corrosive environment is a concern
- Two new wiring methods added to the list of **acceptable wiring methods** within this 1.5 m (5 ft) underground zone ***(liquidtight flexible nonmetallic conduit** listed for direct burial use and **liquidtight flexible metal conduit** listed for direct burial use)*

680.11 Underground Wiring Around Swimming Pools

Underground wiring within 1.5 m (5 ft) horizontally from the inside wall of the pool shall be permitted



Underground wiring not permitted under the pool unless this wiring is necessary to supply pool equipment permitted by Article 680

680.21(C) GFCI Protection for Motors

- **GFCI protection** generally applicable to all **motors** used in pool applications
- **Exception** added for **listed low-voltage motors** not requiring grounding *(with ratings not exceeding the low-voltage contact limit)*
  - A GFCI device cannot detect a loss of current on the low-voltage side of a listed transformers or power supply, so it offers no protection on the low-voltage side
- **Outlets** supplying **all pool motors** *(not just pool pump motors)* on branch circuits rated 150 volts or less to ground and 60 amperes or less, single- or 3-phase, shall be provided with Class A GFCI protection
- Prior to this revision, GFCI protection was only called upon for "single-phase, 120-volt through 240-volt" rated pool pump motors
- Revision incorporates **single-phase** and **3-phase motors**, which would include **single-phase 120/240 volt**, **single-phase 208Y/120 volt**, and **3-phase 208Y/120 volt** motors

680.21(C) GFCI Protection for Motors

Outlets supplying ***all*** pool motors on branch circuits rated 150 volts or less to ground and 60 amperes or less, single- or 3-phase, shall be provided with Class A GFCI protection

Exception permits listed low-voltage motors not requiring grounding (with ratings not exceeding the low-voltage contact limit) supplied by listed transformers or power supplies to be installed without GFCI protection

680.21(D) Pool Pump Motor Replacement

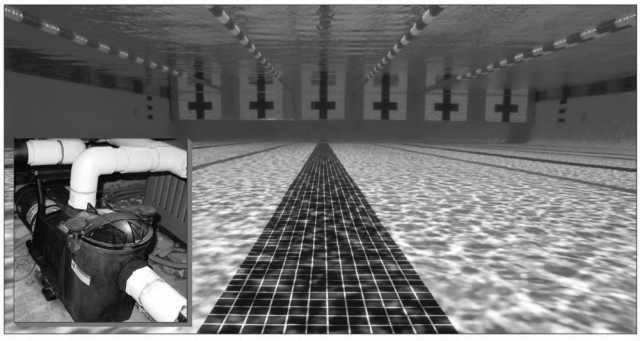
- A new requirement was added to facilitate **GFCI protection** implantation on older pools for **replacement motors**
- New rule will demand **GFCI protection** for a new pool pump motor replacing an existing pool pump motor being **replaced** for maintenance or repair
- Substantiated **injuries** and **fatalities** have occurred in the past by a non-GFCI protected pool pump motor being replaced with a non-GFCI protected motor
- This new GFCI requirement is intended to facilitate **GFCI protection** at **older existing swimming pools** that might not have been required to provide GFCI protection at pool pump motors installed under previous *Code* cycles

680.21(D) Pool Pump Motor Replacement

Where an existing pool pump motor described at 680.21(C) is replaced for maintenance or repair, the replacement pump motor shall be provided with ground-fault circuit-interrupter protection

680.21(D) Pool Pump Motor Replacement

Where an existing pool pump motor described at 680.21(C) is replaced for maintenance or repair, the replacement pump motor shall be provided with ground-fault circuit-interrupter protection



680.22(A)(5) Pool Equipment Room Receptacle

- New provisions were added to require **at least one GFCI-protected receptacle** within a **pool equipment room**
- At least one **GFCI-protected 125-volt**, **15- or 20- ampere** receptacle on a **general-purpose circuit** to be located within a pool equipment room
- All other receptacles *(supplied by branch circuits rated 150 volts or less to ground)* in a pool equipment room now require **GFCI protection** as well
- Requiring at least one GFCI protected receptacle within a pool equipment room will lessen the **potential hazard of employing an extension cord** run from a receptacle outlet elsewhere that is not GFCI protected
- Water is typically present on the floor during normal operation or maintenance of pool equipment rooms

680.22(A)(5) Pool Equipment Room Receptacle

At least one GFCI-protected 125-volt, 15- or 20- ampere receptacle on a general-purpose circuit required to be located within a pool equipment room

All other receptacles supplied by branch circuits rated 150 volts or less to ground within a pool equipment room required to be GFCI protected

680.22(E) Other Equipment in Close Proximity to a Pool

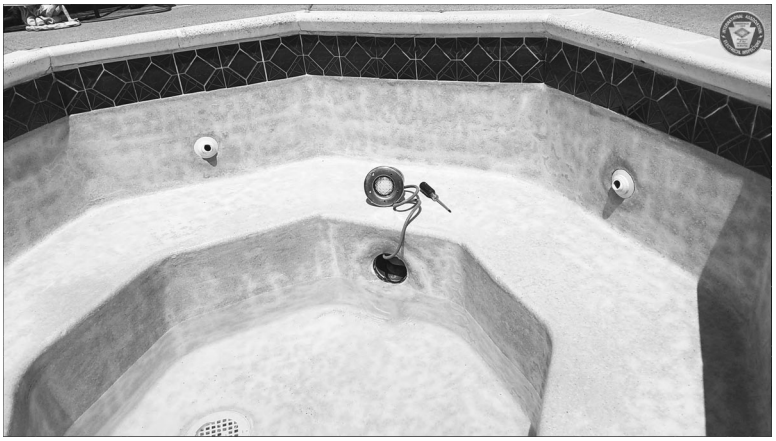
- **Other equipment** *(other than traditional pool pump motors and controllers)* are now required to generally be located **at least 1.5 m (5 ft) horizontally** from the inside walls of a pool
- **Other equipment** *(with ratings exceeding the low-voltage contact limit)* required to be located at least **1.5 m (5 ft)** horizontally from the inside walls of a pool **unless separated** from the pool by a **solid fence, wall, or other permanent barrier**
- Of particular concern is **electric power production equipment** such as generators, solar photovoltaic (PV) systems, fuel cell systems, wind systems, and energy storage systems being **installed in close proximity to a pool**
  - With this type of equipment, concern about **metal parts being at different voltage potentials**, and a real concern is a **shock hazard** associated with this type of equipment located too close to a pool

680.22(E) Other Equipment in Close Proximity to a Pool

Electrical equipment with ratings exceeding the low-voltage contact limit must be located at least 1.5 m (5 ft) horizontally from the inside walls of a pool unless separated from the pool by a solid fence, wall, or other permanent barrier

680.23(B)(6) Servicing Wet-Niche Luminaires

- "**Servicing**" requirement for a wet-niche luminaire was revised for clarity
- Provisions added for **spas** that can be drained so luminaire can be placed on the **spa bench** for servicing
- For servicing wet-niche luminaires in **spa locations** with luminaire installed low in the foot well of the spa, the luminaire is only required to reach the **bench location**, where the spa can be drained to make the bench location dry
- Wet-niche luminaires installed in permanently installed swimming pools are typically required to be installed in such a manner where they were **removable from the water** for inspection, relamping, or other maintenance
- Bench of a spa that can be drained below the bench area **serves the same function as the deck of a pool** with no need to take the spa luminaire all the way to the deck in order to change a light bulb when a dry bench can serve the same purpose



680.26(B)(2)(c) Copper Grid for Perimeter Surfaces Equipotential Bonding

- A **new option** was added to allow a **copper grid system** as **alternative method** for **equipotential bonding** at the **perimeter surface** when structural steel is not available
- Copper grid system would consist of **8 AWG solid bare copper** arranged in a **300-mm (12-in.) by 300-mm (12-in.) network** of conductors in a **uniformly spaced perpendicular grid pattern** with a tolerance of **100 mm (4 in.)**
- Copper grid must follow the **contour of the perimeter surface** extending **1 m (3 ft) horizontally** beyond the inside walls of the pool
- Splices are permitted, but only with **listed splicing devices** or the **exothermic welding process**
- Copper grid is required to be secured within or under the deck or unpaved surfaces between **100 mm to 150 mm (4 in. to 6 in.)** below the subgrade

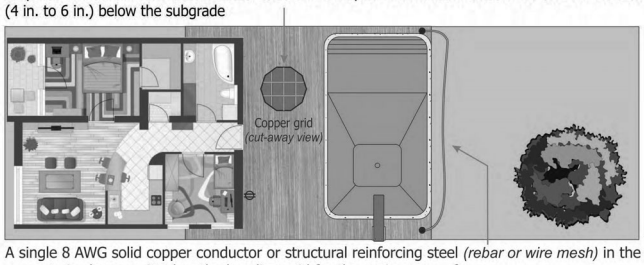
680.26(B)(2)(c) Copper Grid for Perimeter Surfaces Equipotential Bonding *(cont.)*

- Copper grid system is an **extremely effective means of bonding** when the structural reinforcing steel is encapsulated in a nonconductive compound or where unencapsulated structural reinforcing steel is not available or utilized
- Previous **copper ring system** of at least one minimum **8 AWG bare solid copper conductor** described at **680.26(B)(2)(b)** is still a **viable option** for bonding around a pool when the structural reinforcing steel is encapsulated in a nonconductive compound or where unencapsulated structural reinforcing steel is not available or utilized
- Bonding requirements are an **important and unique protective method** employed to increase the safety of the users of bodies of water such as pools, spas and hot tubs
- Bonding is required to **eliminate voltage gradients** (rises) in the pool area

680.26(B)(2)(c) Copper Grid for Perimeter Surfaces

Where structural reinforcing steel is not available or encapsulated, an 8 AWG copper grid system is permitted to be utilized arranged in a 300-mm (12-in.) by 300-mm (12-in.) network of conductors in a uniformly spaced perpendicular grid pattern with a tolerance of 100 mm (4 in.)

Required to be secured within or under the deck or unpaved surfaces between 100 mm to 150 mm (4 in. to 6 in.) below the subgrade



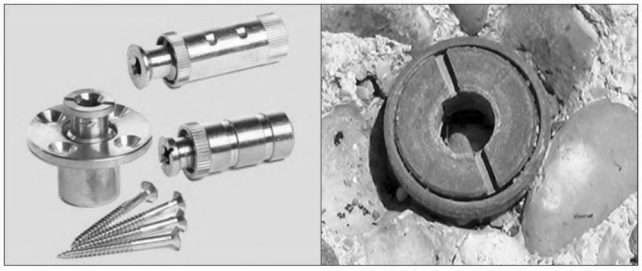
A single 8 AWG solid copper conductor or structural reinforcing steel *(rebar or wire mesh)* in the concrete is also permitted as the bonding grid for the perimeter surface

680.26(B)(5) Metallic Pool Cover Anchors

- Bonding of **metal anchors** used for pool safety covers were added to items that are **not required to be bonded** to the equipotential bonding grid
- This would include metallic pool cover anchors that are intended for insertion in a concrete or masonry deck surface **25 mm (1 in.) or less** in any dimension and **51 mm (2 in.) or less** in length
- If they are intended for insertion in a **wood or composite deck surface**, they would have to be **51 mm (2 in.) or less** in any flange dimension and **51 mm (2 in.) or less** in length
- Impractical to bond **small metal parts** commonly used in pools as these small conductive parts are **not likely to become energized** and are not considered to create a hazard for users of the pool
- Small isolated parts ***[not over 100 mm (4 in.) in any dimension]*** that do not penetrate into the pool structure more than **25 mm (1 in.)** are not required to be bonded *[see 680.26(B)(5)]*

680.26(B)(5) Metallic Pool Cover Anchors

Generally, all metal fittings within or attached to a pool structure are required to be bonded to the equipotential bonding grid of a pool *(small Isolated parts shall not require bonding)*



Metallic pool cover anchors intended for insertion in a concrete or masonry deck surface or wood or composite deck surface shall not require bonding

680.59 GFCI Protection for Permanently Installed Nonsubmersible Pumps

- New section added to specifically address **GFCI protection** for **nonsubmersible fountain pumps**
- Previous requirements called for GFCI protection for submersible fountain pumps only *(but not nonsubmersible fountain pumps) [see 680.51(A)]*
- This new section states that **outlets** supplying all permanently installed nonsubmersible pump motors rated **250 volts or less** and **60 amperes or less**, **single- or 3-phase**, shall be provided with GFCI protection
- Even though they are not submerged in the water, nonsubmersible pumps still move every drop of water contained in a fountain and **deserve GFCI protection** as much as their submergible counterparts
- Nonsubmersible pumps, sometimes referred to as "**centrifugal pumps**"

680.59 GFCI Protection for Nonsubmersible Fountain Pumps

Outlets supplying all permanently installed nonsubmersible pump motors rated 250 volts or less and 60 amperes or less, single- or 3-phase, required to be provided with GFCI protection

680.80 Electrically Powered Pool Lifts

- Revision removes text indicating that **electrically powered pool lifts** do not have to comply with **other parts of Article 680**
- Previously, electrically powered pool lifts were to comply with **Part VIII of Article 680** but did not have to comply with other parts of Article 680
- Electrically powered pool lifts now must comply with **Part VIII** of Article 680, with Part VIII is not subject to the requirements of other parts of Article 680 "**except where the requirements are specifically referenced**"
- References to other parts of Article 680 were added throughout Part VIII

680.84 Receptacles for Electrically Powered Pool Lifts

- Provisions for **receptacles** for electrically powered pool lifts were added to 680.84 stating that these receptacle operating above the low-voltage contact limit must comply with **680.22(A)(3) and (A)(4)**
- The above *Code* references call for receptacles to be located not less than **1.83 m (6 ft)** from the inside walls of a pool and requires GFCI protection for all 15- and 20-ampere, single-phase,125-volt receptacles located **within 6.0 m (20 ft)** of the inside walls of a pool
- 680.84 also calls for switches and switching devices that are operated above the low-voltage contact limit to comply with 680.22(C)
- 680.22(C) generally requires switches to be located at least **1.5 m (5 ft) horizontally** from the inside walls of a pool

682.15 GFP for Natural and Artificially Made Bodies of Water

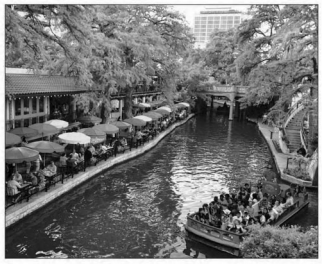
- Revision incorporates **ground-fault protection (GFP)** of equipment and **ground-fault circuit-interrupter (GFCI)** protection for personnel to **one location** in Article 682
- Previously, there were no ground-fault protection (GFP) of equipment requirements in Article 682
- New provisions added for GFP ***(not exceeding 30 mA)*** for feeder and branch circuit conductors installed on piers
- Similar to the revised provisions at **555.35(A)(3)** for marinas, boatyards, floating buildings, and commercial and noncommercial docking facilities
- The revised provisions of **555.35(A)(3)** calls for GFP of equipment set to open at currents **not exceeding 100 mA** for feeder and branch-circuit conductors that are installed on docking facilities

682.15 GFP for Natural and Artificially Made Bodies of Water *(cont.)*

- Revision incorporates **ground-fault protection (GFP)** of equipment and **ground-fault circuit-interrupter (GFCI)** protection for personnel to **one location** in Article 682 *(cont.)*
- Previous **GFCI protection requirements** at 682.15 pertained to 15- and 20-ampere single-phase, 125-volt through 250-volt **receptacle outlets only**
- Revised GFCI provisions at **682.15(A)** pertain to direct connected or "**hard-wired**" equipment **as well as receptacle outlets** for cord-and-plug connected equipment

682.15 GFP for Natural and Artificially Made Bodies of Water

Outlets supplied by branch circuits not exceeding 150 volts to ground and 60 amperes, single-phase, shall be provided with ground-fault circuit-interrupter (GFCI) protection for personnel



Feeder and branch-circuit conductors installed on piers shall be provided with ground-fault protection (GFP) not exceeding 30 mA *(Coordination with downstream GFP permitted)*

682.33(C) Bonding of Equipotential Planes

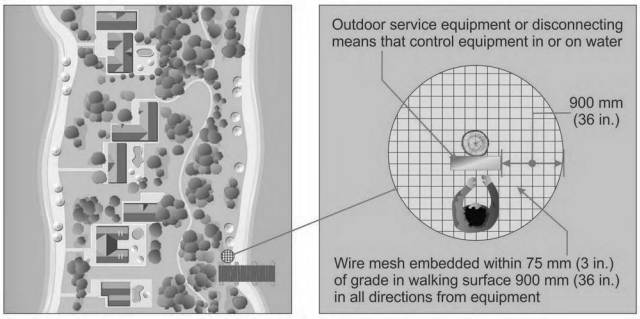
- Revision were made to more clearly define what needs to be **bonded together** and **how to bond each part** in order to properly construct an **equipotential plane** at natural and artificially made bodies of water
- The parts specified in **682.33(C)(1)** *(Bonded Parts)*, **682.33(C)(2)** *(Outdoor Service Equipment and Disconnects)*, and **682.33(C)(3)** *(Walking Surfaces)* are now required to be bonded together and to the electrical grounding system *(grounding electrode system)*
- Bonding conductors *(there can be more than one)* are required to be solid copper, insulated, covered or bare, and not smaller than 8 AWG
- Connections from the equipotential plane to the grounding electrode system are required to be made by exothermic welding or by listed pressure connectors or clamps that are labeled as being suitable for the purpose and are of stainless steel, brass, copper, or copper alloy
- **Equipotential Plane.** Accessible conductive parts bonded together to reduce voltage gradients in a designated area. *(see Article 100)*

682.33(C) Bonding of Equipotential Planes *(cont.)*

- **682.33(C)** detailing bonding provisions was **extensively revised** this *Code* cycle and was broken into **three list items**
- **682.33(C)(2)** is new text and calls for **metallic enclosures** of **outdoor service equipment or disconnecting means** that control equipment in or on water to be bonded to the equipotential plane
- **680.33(C)(3)** will now require surfaces directly below the service equipment to be bonded to the equipotential plane as well
- This surface requiring bonding is considered to be the surface area **not less than 900 mm (36 in.) in all directions** from the equipment from which a person would be able to stand and come in contact with the equipment
- Surface in question can be bonding by employing **wire mesh** or **other conductive elements** on, embedded in, or placed under the walk surface **within 75 mm (3 in.) from grade**

682.33(C) Bonding of Equipotential Planes

Revision made to 682.33(C) more clearly explains in more details as to what needs to be bonded together and how to bond each part in order to properly construct an equipotential plane



690.2 Definitions: ~~Functional~~ Grounded, Functionally ~~PV System~~

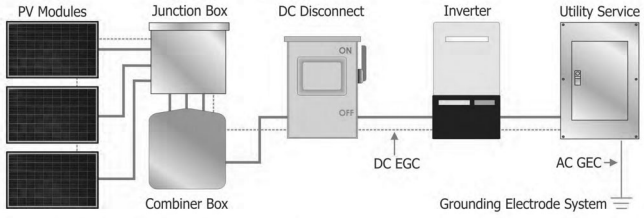
- The previous definition for "**Functional Grounded PV System**" was revised to "**Grounded, Functionally**"
- **Informational Note** also revised to clarify the operational purposes for a functionally grounded system and to indicate that ground faults are only one reason to employ a functionally grounded system
- Changed to "**Grounded, Functionally**" to follow the format in Article 100 as this definition is used in multiple articles such as Article 705, 706, and 712
- Text in the previous definition was **vague and misleading** since functionally grounded PV systems *(without a point of direct connection to a grounding electrode system)* is only permitted through the use of a **listed ground-fault protection system** that will open all of the ungrounded conductors of a system when a fault is detected in accordance with **690.41(A) or (B)**
- To accomplish this detection, an **equipment grounding connection** is necessary as a reference to a grounding system since the functionally grounded system is effectively isolated from a ground reference until a ground fault is sensed

690.2 Definitions: ~~Functional~~ Grounded, Functionally ~~PV System~~ *(cont.)*

- The previous definition for "**Functional Grounded PV System**" was revised to "**Grounded, Functionally**" *(cont.)*
- Most PV systems installed in the past decade or so are actually functionally grounded systems rather than solidly grounded systems as defined in Article 100
- For functionally grounded PV systems with an interactive inverter output, the ac equipment grounding conductor is connected to associated grounded ac distribution equipment
- This connection is often the connection to ground for ground-fault protection and equipment grounding of the PV array

690.2 Definition: Grounded, Functionally

~~Functional~~ Grounded, Functionally ~~PV System~~. A system that has an electrical ground reference for operational purposes that is not solidly grounded.



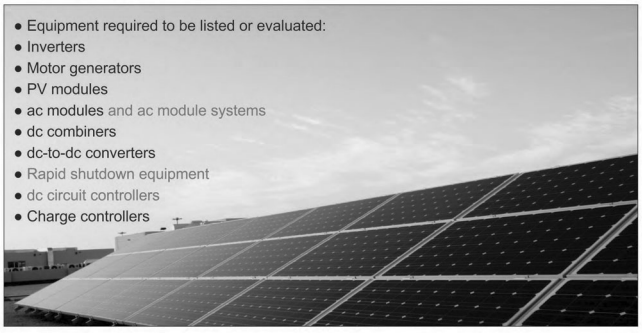
Informational Note: A functionally grounded system is often connected to ground through an electronic means internal to an inverter or charge controller that provides ground-fault protection. Examples of operational purposes for functionally grounded systems include ground-fault detection and performance-related issues for some power sources.

690.4(B) PV Equipment Listing and Evaluation

- Revision clarifies that if the **listed PV equipment** is not **listed for the application** then it must be **field evaluated** by a NRTL or Field Evaluation Body (FEB) and have a field label applied if it passes the evaluation
- Inverters, motor generators, PV modules, ac modules and ac module systems, dc combiners, dc-to-dc converters, rapid shutdown equipment, dc circuit controllers, and charge controllers **intended for use in PV systems** are now required to be listed or be **evaluated for the application** and have a **field label applied** *(function of the "field evaluation" process)*
- New *Code* language added to not just require this equipment to be "**field labeled**" but be "**evaluated**" for the intended application
- Equipment that is listed for the application means that it is intended for use in that application

690.4(B) PV Equipment Listing and Evaluation

Equipment intended for use in PV systems required to be listed or be evaluated for the application and have a field label applied



690.8(A) PV Circuit Sizing and Calculation of Maximum Circuit Current

- 690.8(A) was reorganized to provide improvement to the understanding of the requirements for PV circuit sizing and current
- Maximum current for specific PV circuits are now calculated in accordance with **690.8(A)(1) through (A)(2)**, with previous 690.8(A)(2), (A)(3), (A)(5), and (A)(6) incorporated into **revised 690.8(A)(1)**
- Language was added to clarify that calculations for these circuits have **options**, however, the **secondary options** in 690.8(A)(1)(b) and 690.8(A)(1)(a)(2) contain **restrictions**
- New **690.8(A)(2)** titled, "**Circuits Connected to the Input of Electronic Power Converters**" added to provide provision pertaining to the case in stand-alone inverter input circuit currents *[previous 680.8(A)(4)]*
  - This section includes clarifying language to require an overcurrent device in accordance with **240.4(B)** to address the allowance to **round up to the next standard size**

690.9(A) Overcurrent Protection for PV Circuits and Equipment

- Revision reorganizes **690.9(A)** for **overcurrent protection** to eliminate previous exception with three List Items created for unique and different protection scenarios
- The previous exception was written in positive *Code* language and transformed into **new 690.9(A)(1)** *(Circuits Where Overcurrent Protection Not Required)* with two conditions that must be meet in order to not have to provide overcurrent protection
- New **690.9(A)(2)** addresses circuits connected to current limited sources
- New **690.9(A)(3)** titled "**Other Circuits**" captures all remaining options covered under this section with four protection options

690.9(A) Overcurrent Protection for PV Systems

690.12 Rapid Shutdown of PV Systems on Buildings

- The requirements for a **Rapid Shutdown** of PV systems received extensive revision again this *Code* cycle
- The **2014** ***NEC*** genesis of the rapid shutdown requirements of 690.12 were launched with the United States Department of Homeland Security (DHS) Assistance to Firefighter grant program
- For the **2017** ***NEC***, the rapid shutdown requirements of 690.12 was revised to emphases the primary existence of the rapid shutdown requirements is to **reduced shock hazard for emergency responders** and to answer questions regarding the functionality of the PV rapid shutdown device itself
- This pattern of revision continued for the **2020** ***NEC***

690.12 Rapid Shutdown of PV Systems on Buildings *(cont.)*

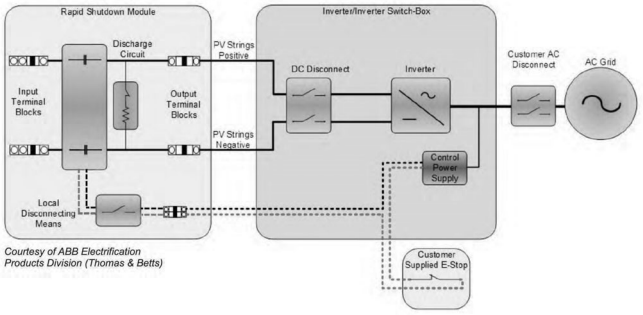
- The requirements for a **Rapid Shutdown** of PV systems received extensive revision again this *Code* cycle *(cont.)*
- A **new product standard** has been developed by UL so that hazardous energy levels within a PV array can be reduced when firefighters or other emergency response personnel are required to enter the array area to mitigate emergency conditions
- See **UL 3741** *(Standard for Safety Photovoltaic Hazard Control)*
- Parent text of 690.12 "**emergency responders**" replaced with "**fire fighter**" to narrow down exactly who the rapid shutdown function is intended for which harmonizes this *Code* text with **UL 3741**

690.12 Rapid Shutdown of PV Systems on Buildings *(cont.)*

- The requirements for a **Rapid Shutdown** of PV systems received extensive revision again this *Code* cycle *(cont.)*
- Revision to **690.12(A)** *(Controlled Conductors)* define what conductors are to be controlled; **(1)** PV system dc circuits and **(2)** Inverter output circuits
- **690.12(B)** *(Controlled Limits)* revised to indicate that controlled conductors **outside** the array boundary comply with **690.12(B)(1)** and **inside** the array boundary comply with **690.12(B)(2)**
- New *Code* text added at **690.12(C)** to address cases where more than one initiation device is used on a single PV system
- Previous **informational note** following **690.12(D)**, *(inverter input circuit conductors often remain energized for up to 5 minutes with inverters not listed for rapid shutdown)* **deleted** as informational note no longer needed

690.12 Rapid Shutdown of PV Systems on Buildings

Rapid shutdown requirements revised extensive revision to emphases the primary existence of rapid shutdown requirements is to reduced shock hazard for fire fighters



Courtesy of ABB Electrification Products Division (Thomas & Betts)

690.13(A) PV System Disconnecting Means

- New requirement calling for the PV disconnecting means to be **lockable or require a tool to open** under certain conditions
- New requirement calls for any PV disconnect enclosure with a door or hinged cover that exposes live parts when open to be **locked or require a tool to open** where a disconnecting means of systems **above 30 volts are readily accessible to unqualified persons**
- Similar format to **110.31(D)** *(Enclosed Equipment Accessible to Unqualified Persons)* which addresses equipment accessible to unqualified persons
- Installation of PV systems has created numerous opportunities for PV disconnect switches to be located in positions that are **accessible by other than qualified personnel** *(children in some instances)*
- Same basic change occurred at **690.15(A)** for the isolating devices or disconnecting means for PV equipment and **705.20(5)** for the disconnecting means for interconnected electric power production sources

690.13(A) Photovoltaic System Disconnecting Means

PV system disconnecting means are required to be installed at a readily accessible location

Where PV disconnecting means (above 30 volts) are readily accessible to unqualified persons, any enclosure door or hinged cover that exposes live parts when open is now required to be locked or require a tool to open

690.13(E) Type of PV System Disconnecting Means

- Previous (3) List Items under "**Type of Disconnect**" removed and the revision summarizes the type of disconnects that may be used as a PV system disconnect with **lockability requirements** of **110.25** included
- Previous provisions at 690.13(F)(1), (F)(2) and (F)(3) pertaining to "**backfeed**" operations has been **removed** and referenced in a **new Informational Note** following 690.13(E)
- Revision clarifies that all **non-solidly grounded conductors** must be disconnected, but the **ac grounded (neutral) conductors** *(which are solidly grounded)*, are not required to be disconnected
- Type PV system disconnecting means allowed was put into a **list format** *[similar to the list that was found at previous 690.15(D)]*

690.15 Disconnecting Means for Photovoltaic Equipment

- Requirements for **disconnecting means** for **isolating PV equipment** of PV systems received **extensive revision** to emphasis isolation of equipment from energized conductors
- The original 1984 *NEC* title was changed from "**Disconnection of Photovoltaic Equipment**" to "**Disconnecting Means for Photovoltaic Equipment**"
  - Previous title was misleading and could be interpreted to refer to disconnecting means that is discussed at **680.13**
  - Section is intended to address isolation of equipment from energized conductors (isolated)
  - Does not necessarily have to be accomplished by an equipment disconnecting means

690.15 Disconnecting Means for Photovoltaic Equipment *(cont.)*

- Requirements for **disconnecting means** for **isolating PV equipment** of PV systems received **extensive revision** to emphasis isolation of equipment from energized conductors *(cont.)*
- Revision occurred at the parent text of **690.15** to point directly to 690.15(D) to clarify the types of disconnecting means allowed for isolation of PV equipment
- A provision was added at the end of **690.15(A)** requiring the disconnecting means of equipment operating above 30 volts and readily accessible to unqualified persons to be lockable and locked or require a tool to open
- **Previous 690.15(B)** titled, "Interrupting Rating" was **deleted** as this information is covered and better suited for the disconnecting means requirements of **690.13(D)** *[previously 690.13(E)]*

690.15 Disconnecting Means for Photovoltaic Equipment *(cont.)*

- Requirements for **disconnecting means** for **isolating PV equipment** of PV systems received **extensive revision** to emphasis isolation of equipment from energized conductors *(cont.)*
- **New 690.15(B)** *[previously 690.15(C)]* titled, "**Isolating Device**" had new language added to point out the fact that an isolating device is **not required** to have an **interrupting rating** *(can have an interrupting rating, but not required)*
- A new first sentence was added to **690.15(C)** to address the language removed from previous 690.15(B) on **interrupting ratings** and added fault current
- The lockability requirement of **690.15(C)** changed so that this would only be applicable to cases where the disconnecting means is **more than 3 m (10 ft)** from the equipment or not within site of the equipment

690.15 Disconnecting Means for Photovoltaic Equipment *(cont.)*

- Requirements for **disconnecting means** for **isolating PV equipment** of PV systems received **extensive revision** to emphasis isolation of equipment from energized conductors *(cont.)*
- A new **690.15(D)** added titled, "**Type of Disconnecting Means**," which is intended to clarify the requirements related to disconnection of equipment
- Two different requirements for these devices:
  - Circuits with a **maximum circuit current over 30 amperes** must have devices that comply with **new 690.15(D)** as these conversion devices can present a load to the fault current limited circuit
  - Circuits **under 30 amperes** where isolation is required for servicing equipment, *Code* language was added to make it clear that isolating devices are permitted

690.15 Disconnecting Means for Photovoltaic Equipment

Requirements for disconnecting means for isolating PV equipment of PV systems received extensive revision to emphasis isolation of equipment from energized conductors

690.31 Wiring Methods for Solar Photovoltaic (PV) Systems

- Revisions to **690.31** organized **PV wiring methods** into one section
- Wiring methods for PV installations were previously located in various areas
- New sentence added to **690.31(A)** to introducing a revised table [**Table 690.31(A)(a)**] and a **new Table 690.31(A)(b)**
  - Revision cleans up **Table 690.31(A)(a)** [formerly Table 690.31(A)] by only including correction factors for 105°C (221°F) and 125°C (257°F) as all other correction factors are in Article 310
  - The temperature ranges above 30°C are given in 5°C increments
  - New ampacity table for 105°C (221°F) and 125°C (257°F) has been added as **new Table 690.31(A)(b)**

690.31 Wiring Methods for Solar Photovoltaic (PV) Systems *(cont.)*

- Revisions to **690.31** organized **PV wiring methods** into one section *(cont.)*
- Additional clarity was needed at **690.31(B)** to address the most common application of this requirement for enforcers; installation of inverter dc input conductors and ac output conductors in the **same wireway** below an inverter
- **690.31(B)(2)** permitted the installation of those same conductors *(even if from different PV systems)* within the same raceway or junction box with a removable cover without a barrier or partition
- **Exception** to **690.31(B)(2)** even deleted the grouping requirement where the conductors enter the enclosure through separate means
- **690.31(B)** revised to provide needed **lines of demarcation** for conductors of dc and ac PV systems

690.31 Wiring Methods for Solar Photovoltaic (PV) Systems *(cont.)*

- Revisions to **690.31** organized **PV wiring methods** into one section *(cont.)*
- Several of the items in 690.31 are directly related to cables and those **cable requirements** were consolidated in the new and revised **690.31(C)**
- *Code* language added to the parent text of **690.31(C)** pertaining to the listing requirement for **Photovoltaic (Type PV) wire or cable** and **Distributed Generation (Type DG) cable** with a new informational note added to direct users of the *Code* to **UL 4703** *(Standard for Photovoltaic Wire)* and **UL 3003** *(Distributed Generation Cables)*
- Requirements of **690.31(C)(1)** for "**Single-Conductor Cable**" simplified to now call for single-conductor cable in exposed outdoor locations in PV system dc circuits within the PV array to be either PV wire or cable or single-conductor cable marked sunlight resistant and Type USE-2 and Type RHW-2

690.31 Wiring Methods for Solar Photovoltaic (PV) Systems *(cont.)*

- Revisions to **690.31** organized **PV wiring methods** into one section *(cont.)*
- **690.31(C)(2)** deals with single-conductor PV wire or cable installed in a cable tray with revision to this list item adding single-conductor **distributed generation (Type DG) cable** of all sizes to be permitted to be installed in a cable tray installed in outdoor locations *(with conditions)*
- **690.31(C)(3)** for multiconductor jacketed cables added new provisions for distributed generation (Type DG) cables
- Type DG cable is closely related to Type TC-ER, but it is better suited for the renewable energy and other distributed generation applications allowing for different variations in conductor combinations within a single jacket

690.31 Wiring Methods for Solar Photovoltaic (PV) Systems *(cont.)*

- Revisions to **690.31** organized **PV wiring methods** into one section *(cont.)*
- **690.31(C)(4), (5), and (6)** were existing requirements moved from previous 690.31(E),(H), and (F) respectfully with no technical change to group all single-conductor cables requirements together at **690.31(C)**
- **690.31(D)** title was shortened to be more descriptive of what it covers *(Direct-Current Circuits on or in a Buildings) [was 690.31(G)]* and extensively revised
- **690.31(D)** generally requires PV system dc circuits run inside a building to be contained in a metallic wiring system
- Purpose of revision was to acknowledge that the **physical protection requirements** of **690.31(D)** are related to the ability to detect ground faults and to protect from contact with higher voltage cables

690.31 Wiring Methods for Solar Photovoltaic (PV) Systems *(cont.)*

- Revisions to **690.31** organized **PV wiring methods** into one section *(cont.)*
- New **exception** was added for **690.31(D)** which addresses PV hazard control systems
- **Previous requirement at 690.31(G)(1)** that called for PV circuits that were embedded in built-up, laminate, or membrane roofing materials in roof areas *(not covered by PV modules and associated equipment)* to be clearly marked for its location has been **deleted** as these marking requirement referred to a wiring method that is no longer used *(embedded in building surfaces)*
- Revision also occurred at **690.31(D)(2)** ***(Marking and Labeling Required)*** by adding language to clarify that wiring methods need not be marked where their purpose is evident

690.31 Wiring Methods for Solar Photovoltaic (PV) Systems *(cont.)*

- Revisions to **690.31** organized **PV wiring methods** into one section *(cont.)*
- **690.31(E)** titled, "**Bipolar Photovoltaic Systems**," *[was 690.31(I)]* received slight revision by replacing the term "monopole subarray" with the term "monopole circuit" as the reference is to the circuits to these monopole subarrays so the term "circuit" was added in all five locations where monopole subarray was previously used
- New **690.31(F)** added pertaining to roof-mounted PV array mounting systems and their wiring methods
  - Permits the roof-mounted PV array to be held in place with an **approved means** other than those required by 110.13 *(Mounting and Cooling of Equipment)*

690.31 Wiring Methods for Solar Photovoltaic (PV) Systems

690.31 was revised and re-organized for clarity and to bring PV wiring methods for PV source and output circuits to one location

(A) Wiring Systems
(B) Identification and Grouping
  (1) Identification
  (2) Grouping
(C) Cables
  (1) Single-Conductor Cables
  (2) Cable Tray
  (3) Multiconductor Jacketed Cables
  (4) Flexible Cords and Cables Connected to Tracking PV Arrays
  (5) Flexible, Fine Stranded Cables
  (6) Small-Conductor Cables
(D) Direct-Cirrent on or in Buildings
  (1) Flexible Wiring Methods
  (2) Marking and labeling Required
(E) Bipolar Photovoltaic Systems

690.33 Mating Connectors Types for PV Systems

- New allowances added for mixing and matching brands of **PV mating connectors**
- Mating connectors **not of the identical type and brand** required to be "**listed and identified for intermatability**," as described in the manufacturer's instructions
- "**Intermatabilty**" is a term used in **UL 6703** (*Standard for Connectors for Use in Photovoltaic Systems)*
- Mating connectors required to be of the **latching or locking type** *(not new)*
- Mating connectors that are readily accessible and used in circuits operating at **over 30 volts dc or 15 volts ac** require a tool for opening *(not new)*
- Type of connector being described at 690.33 is clearly a mating connector, so the title of 690.33 was changed from "Connectors" to "**Mating Connectors**"
- Failures of connections made between mating connectors from different brands are well documented and represent a source of **electrical and fire hazard**

690.33(C) Mating Connector Types for PV Systems

Mating connectors shall be of the latching or locking type and where readily accessible and used in circuits operating at over 30 volts dc or 15 volts ac shall require a tool for opening

Mating connectors not of the identical type and brand are required to be "listed and identified for intermatability," as described in the manufacturer's instructions

690.41(B) Ground-Fault Protection for PV Systems

- PV system dc circuits *(not just the arrays)* that exceed **30 volts** or **8 amperes** are now required to be provided with dc ground-fault protection (GFP)
- This section now consists of three subsections
  - (1) Ground-Fault Detection
  - (2) Faulted Circuits
  - (3) Indication of Faults (New)
- PV dc AFCI and GFP requirements in both **UL 1699-B** *[Standard for Photovoltaic (PV) DC Arc-Fault Circuit Protection]* and **IEC 62109-2** *(Safety of Power Converters for use in Photovoltaic Power Systems - Part 2)* acknowledge that only energy values above these levels pose an arcing or other fire risk

690.41(B) Ground-Fault Protection for PV Systems *(cont.)*

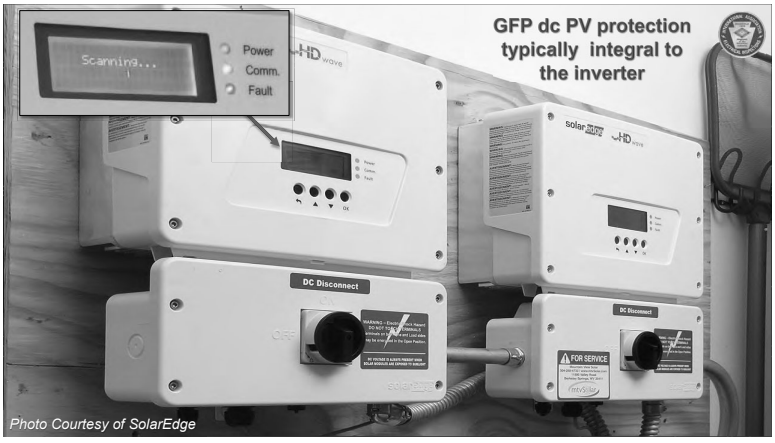
- PV system dc circuits *(not just the arrays)* that exceed **30 volts** or **8 amperes** are now required to be provided with dc ground-fault protection (GFP) *(cont.)*
- PV system circuits operating at lower voltage and power levels do not pose an arcing or other fire risk, therefore permitted to be installed **without GFP**
- Previous **exception** to **690.41(B)** permitted PV arrays with not more than two PV source circuits to be installed without GFP (where solidly grounded) as long as all PV system dc circuits were not on or in buildings has been reworded into positive language suitable for inclusion into the charging paragraph without changing the existing requirements
- New **informational note** has been added after the parent text of **690.41(B)** indicating that not all inverters, charge controllers, or dc-to-dc converters include GFP

690.41(B) Ground-Fault Protection for PV Systems *(cont.)*

- PV system dc circuits *(not just the arrays)* that exceed **30 volts** or **8 amperes** are now required to be provided with dc ground-fault protection (GFP) *(cont.)*
- Provisions for ground-fault detection at **690.41(B)(1)** have been revised to better align with the definitions in 690.2 and in particular, with the revised definition of "**Functionally Grounded**"
  - New language clarifies that either **GFP must be included in the converter**, or the converter and the equipment providing GFP must be **identified as being compatible** such that GFP of the circuit is maintained on either side of the converter
- Revised text at **690.41(B)(2)** concerning faulted circuits improves the application of these requirements to **any device providing GFP** *(not just inverters or charge controllers)* and clarifies the circuits to be controlled

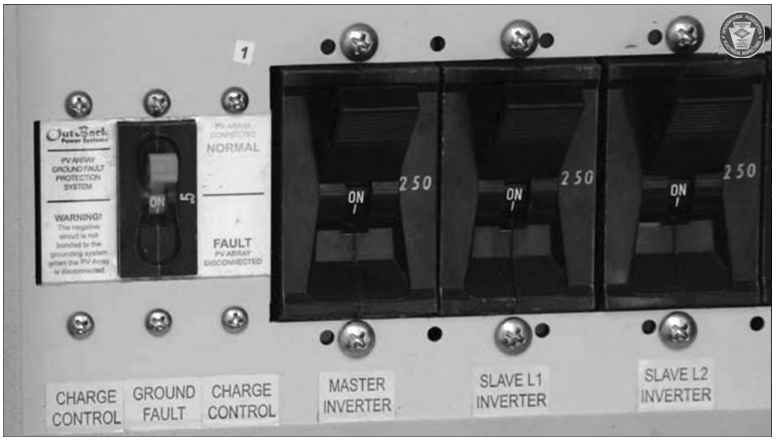
690.41(B) Ground-Fault Protection for PV Systems *(cont.)*

- PV system dc circuits *(not just the arrays)* that exceed **30 volts** or **8 amperes** are now required to be provided with dc ground-fault protection (GFP) *(cont.)*
- Changes at **690.41(B)(2)** also better align *NEC* requirements with those found in PV GFP equipment safety standards such as **UL 1741** *(Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources)*
- New **690.41(B)(3)** added titled, "**Indication of Faults**" states that any GFP equipment must provide an "**indication of ground faults at a readily accessible location**"
- **UL 1741** requires inverters to "identify, interrupt, and provide an indication of ground faults"
- New **690.41(B)(3)** giving examples of **indication devices** such as remote indicator light, display, monitor, signal to a monitored alarm system, or receipt of notification by web-based services



GFP dc PV protection typically integral to the inverter

Photo Courtesy of SolarEdge



690.51, ~~690.52~~, and 690.53 Marking Requirements of PV Modules and dc PV Circuits

- Information outlined at previous **690.51**, **690.52**, and **690.53** that is required as part of the listing requirement of this equipment has been deleted as it is being provided on the device by the manufacturer
- **690.51** revised to simply require modules and ac modules to be marked in accordance with their listing
- **Previous 690.52** was deleted entirely
- **690.53** was revised to require a permanent readily visible label indicating the highest maximum dc voltage in a PV system
- Desirable to remove these values from the required label in order to not inadvertently create conflict or confusion with any other required safety labeling such as may be required in Article 110

Marking Requirements for PV Modules and DC PV Circuits

Information outlined at previous 690.51, 690.52, and 690.53 that is required as part of the listing of this equipment has been deleted as it is being provided on the device by the manufacturer

A permanent readily visible label indicating the highest maximum dc voltage in a PV system is required by 690.53

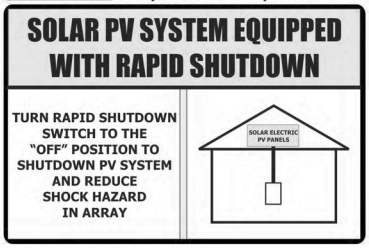
690.56(C) Identification of Power Sources for Buildings with Rapid Shutdown

- Several changes were made to **690.56(C)** to address the updated requirements in **690.12** *(Rapid Shutdown of PV Systems on Buildings)*
- Previous 690.56(C) contained **two figures** at 690.56(C)(1) illustrating labels required for the then two different types of rapid shutdown systems for a PV installation
- Remaining text of previous **690.56(C)(1)** has been changed to **remove** the option for the label and **previous Figure 690.56(C)(1)(b)**, previously listed under **690.56(C)(1)(b)**, since this label now describes a shutdown method that is no longer *Code* compliant
- The title of the remaining figure has been changed to identify this figure as an **informational note figure** to clarify that the label as shown is merely **an example** of a rapid shutdown system label

690.56(C) ID of Power Sources for Buildings with Rapid Shutdown

Buildings with PV systems shall have a permanent label located at each service equipment location to which the PV systems are connected or at an approved readily visible location and shall indicate the location of rapid shutdown initiation devices

Information Note Figure 690.56(C): Label for Roof-Mounted PV Systems with Rapid Shutdown



Label required by 690.56(C)(2)

Title of remaining figure has been changed to identify this figure as an informational note figure to clarify that the label as shown is merely an example of a rapid shutdown system label

691.1 Scope and I-Note Figure 691.1

- New **Informational Note No. 3** and **Informational Note Figure 691.1** were added to Article 691 as an aid in interpretation
- Title of **Article 691** was changed to "**Large-Scale Photovoltaic (PV) Electric Power Supply Stations**" with the **scope changed** to indicate that the article is intended to cover "the installation of large-scale PV electric supply stations with an inverter generating capacity of no less than 5000 kW, and not under exclusive utility control"
- Term "**supply station**" which was used 12 times throughout Article 691 in the 2017 *NEC* and 17 times in the 2020 *NEC*
- Utilizing the term "**supply station**" better aligns the *NEC* and **National Electrical Safety Code (NESC)** on this term, which is describing the same equipment set in both Codes

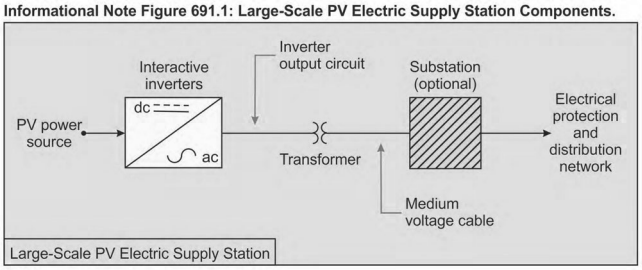
691.1 Scope and I-Note Figure 691.1 *(cont.)*

- New **Informational Note No. 3** and **Informational Note Figure 691.1** were added to Article 691 as an aid in interpretation *(cont.)*
- Scope of Article 691 was **updated** to align with the definition of "**Generating Capacity, Inverter**" located in Article 100
- This definitions states that Inverter Generating Capacity is defined as "the sum of parallel-connected inverter maximum continuous output power at 40°C in watts or kilowatts"
- **New informational note** was **added** after the scope of Article 691 directing users of the *Code* to a **new informational figure** intended to help in identification of unique system components related to large scale PV electrical supply stations

691.1 Scope and Informational Note Figure 691.1

This article covers the installation of large-scale PV electric ~~power production facilities with a~~ supply stations with an inverter generating capacity of no less than 5000 kW, and not under exclusive utility control.

Informational Note Figure 691.1: Large-Scale PV Electric Supply Station Components.



Notes:
(1) Custom designs occur in each configuration, and some components are optional.
(2) The drawing is for informational purposes only and is not representative of all potential configurations.

691.9 Disconnection Means for Isolating PV Equipment

- **Title revised** to be consistent with usage in Article 690, particularly 690.15
- First sentence allowing isolating devices to be located remotely from equipment was revised to align more closely with the defined term "**In Sight From (Within Sight From, Within Sight)**" in Article 100
- Provisions requiring **written safety procedures** and conditions of maintenance and supervision ensuring that only **qualified persons** service the equipment was **deleted**
- New text added requiring **documentation** of the disconnection procedures and means of isolating equipment required by the engineered design of 691.6

691.9 Disconnection Means for Isolating Photovoltaic Equipment

Isolating devices not required within sight of equipment and permitted to be located remotely from equipment

Engineered design required by 691.6 shall document disconnection procedures and means of isolating equipment

692.4(B) Identification of Power Sources (Fuel Cell System)

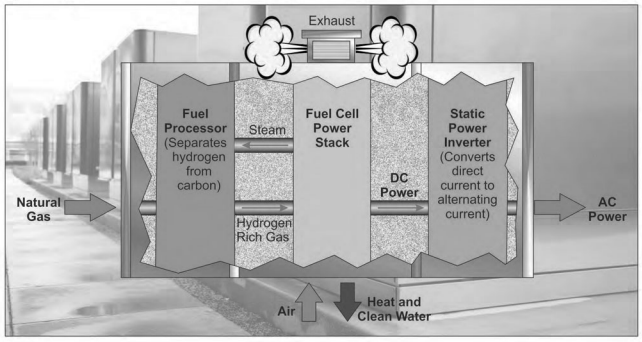
- Three separate **List Items** where **created** to clearly identify the requirements for different fuel cell system types to add clarity to the **placarding** of these systems
- Where these alternative energy systems are present, fuel cell systems are required to be **identified** depending upon the type of system involved;
  - (1) **Interconnected ac System** plaques or directories are required to be installed in accordance with **705.10**
  - (2) **dc Microgrid System** plaques or directories are required to be installed in accordance with **712.10**
  - (3) **Stand-Alone System** plaques or directories are required to be installed in accordance with **710.10**

692.4(B) Identification of Power Sources (Fuel Cell System) *(cont.)*

- Three separate **List Items** where **created** to clearly identify the requirements for different fuel cell system types to add clarity to the **placarding** of these systems *(cont.)*
- Ongoing concerns have been expressed by the **fire service** and other **first responders** on the need to secure on-site power sources during emergencies and ready awareness of where those alternative sources are located
- There has been a **lack of uniform procedures** from an *NEC* standpoint on how to effectively secure on-site power sources that may be at a premises due to the variety of different source types
- Changes implemented at 692.4(B) will correlate various sections of the *NEC* and consistently require this important marking be located at each service equipment location, or at an approved readily visible location
- Same basic change occurred at **694.54** for **Wind Electric Systems**

692.4(B) Identification of Power Sources (Fuel Cell Systems)

Three separate List Items where created to clearly identify the requirements for different fuel cell system types to add clarity to the placarding of these systems



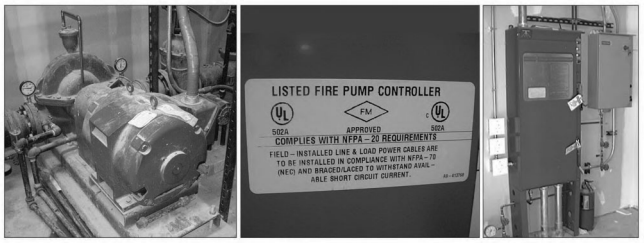
692.4(B) Identification of Power Sources for Fuel Cell Systems

695.3(C)(3) Selective Coordination (Fire Pumps)

- New provisions were added providing guidance for **selective coordination** of OCPD for fire pumps
- For fire pumps in multibuilding campus-style complexes, all overcurrent protective device(s) must be selectively coordinated with all supply-side overcurrent protective device(s)
- This selective coordination is required to be selected by **a licensed professional engineer** or **other qualified persons** engaged primarily in the design, installation, or maintenance of electrical systems with the selection documented and made available to those authorized to design, install, maintain, and operate the system
- Selective coordination is not required between two overcurrent devices located in series if no loads are connected in parallel with the downstream device

695.3(C)(3) Selective Coordination (Fire Pumps)

Fire pumps in multibuilding campus-style complexes require all overcurrent protective device(s) to be selectively coordinated with all supply-side overcurrent protective device(s)



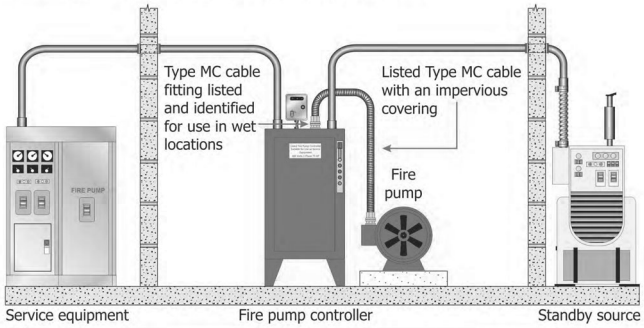
Selective coordination required to be selected by a licensed professional engineer or other qualified persons engaged primarily in the design, installation, or maintenance of electrical systems

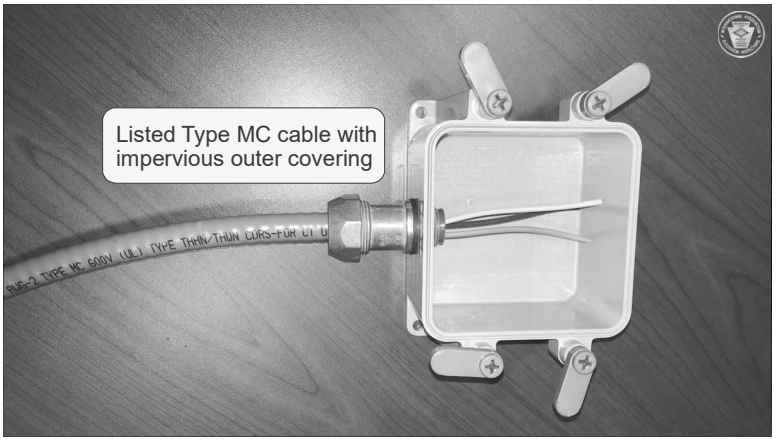
695.6(J) ~~Raceway~~ Terminations (Fire Pumps)

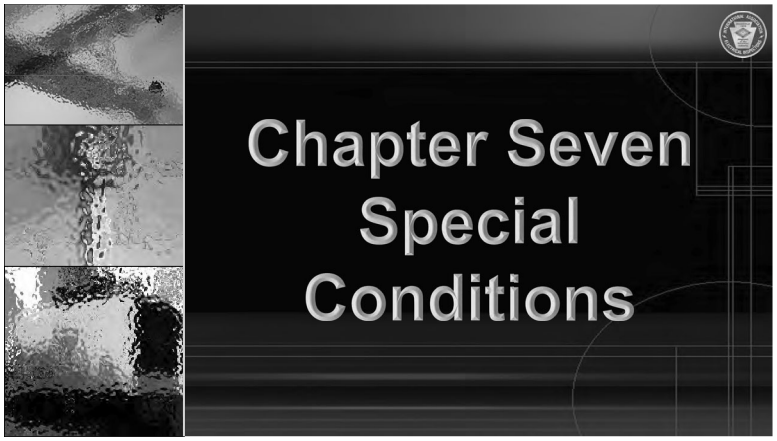
- Revision were made to align the **allowable wiring methods** in 695.6(D) with the required **terminations fittings** at a fire pump controller
- Cable fittings that are listed for the wiring method used and with a type rating at least equal to that of the fire pump controller are appropriate for these installations
- The installation instructions of the manufacturer of the fire pump controller must be followed
- Alterations to the fire pump controller *(other than raceway or cable terminations)* are required to be approved by the authority having jurisdiction

695.6(J) ~~Raceway~~ Terminations

Where raceways or cable are terminated at a fire pump controller, terminations must be a raceway or cable fittings listed and identified for use in wet locations with the type rating of the raceway or cable fittings being at least equal to that of the fire pump controller.





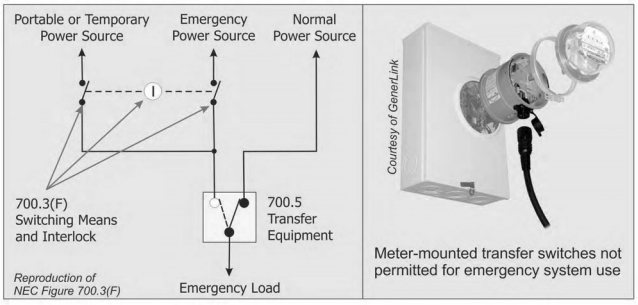


700.5(A) Transfer Equipment (Emergency Systems)

- A new last sentence is added to clarify that **meter mounted transfer switches** are not permitted for use in emergency systems
- Where emergency system is required, means must be provided to switch critical loads from normal utility source to standby emergency power source
- Several types of device are available for this operation
- A meter-mounted transfer switch is installed in the meterbase between the glass plug-in meter and the base unit
- Meter mounted transfer switch allows a typical homeowner to connect a portable generator to their home with relative ease via the electric meter located on the outside of the building
- **Same basic change** pertaining to listing and marking requirement and prohibiting meter-mounted transfer equipment occurred at **701.5(A)** *(Legally Required Systems)*

700.5(A) Emergency Systems Transfer Equipment

Transfer equipment ~~(including automatic transfer switches)~~ shall be automatic, ~~identified~~ listed, and marked for emergency use



700.12(B) Emergency Systems Equipment Design and Location

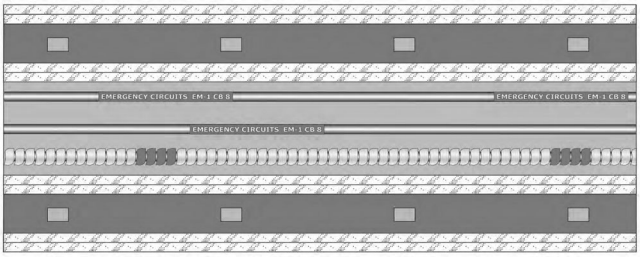
- Reference to "spaces with a **1-hour fire rating**" revised to **2-hour**, to correlate with the requirements of **700.10(D)** and **NFPA 110**
- **NFPA 110** *(Standard for Emergency and Standby Power Systems)* indicates this same 2-hour fire rating
- Emergency system equipment for sources of power now required to be installed either in spaces **fully protected by approved automatic fire protection systems** or in spaces with a **2-hour fire rating** where located within:
  - (1) Assembly occupancies for more than 1000 persons
  - (2) Buildings above 23 m (75 ft) in height with any of the following occupancy classes; assembly, educational, residential, detention and correctional, business, and mercantile
  - (3) Educational occupancies with more than 300 occupants

700.12(B) Emergency Systems Equipment Design and Location *(cont.)*

- Previous editions of the *Code* called for this 1-hour fire rating (now 2-hour) to be applied to four specific locations
- One of these locations was previous List item (3) addressing "**health care occupancies where persons are not capable of self-preservation**"
- This list item was **deleted** to resolve conflicts between 700.12(B) and **NFPA 99** *(Health Care Facilities Code)*
- Conflict between NFPA documents [700.12(B)(3) and NFPA 99] could have resulted in AHJ being unable to determine which of the standards takes precedence

700.12(B) Emergency System Equipment Design and Location

Equipment for sources of power required to be installed either in spaces fully protected by approved automatic fire protection systems or in spaces with a 2-hour fire rating where located within:

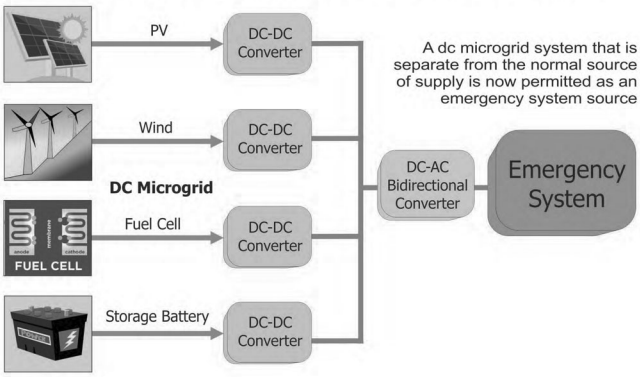


(1) Assembly occupancies for more than 1000 persons, (2) Buildings above 23 m (75 ft) in height with any of the following occupancy classes; assembly, educational, residential, detention and correctional, business, and mercantile, ~~(3) Health care occupancies where persons are not capable of self-preservation,~~ and (3) Educational occupancies with more than 300 occupants

700.12(H) DC Microgrid Systems as Emergency System

- New List Item (H) added to clarify that a **dc microgrid system** that is separate from the normal source of supply is permitted as an emergency system source
- Several systems are identified at **700.12** that can serve as an emergency system source such as storage batteries, generator sets, uninterruptible power supplies (UPS), additional separate services, fuel cell systems, and unit equipment
- In order for a **dc microgrid system** to qualify as an emergency system, it must be capable of being **isolated from all non-emergency sources** and must also have a suitable rating and capacity to supply and maintain the total emergency load for not less than **2 hours of full-demand operation**
- Where a dc microgrid system source serves as the **normal supply** for the building or group of buildings concerned, it **cannot serve as the sole source of power** for the emergency standby system

700.12(H) DC Microgrid Systems as Emergency System

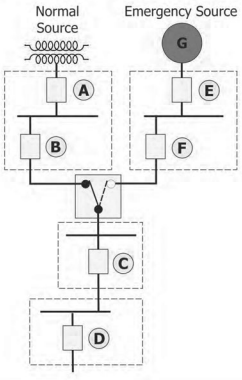


A dc microgrid system that is separate from the normal source of supply is now permitted as an emergency system source

Informational Note Figure 700.32 Emergency System Selective Coordination

- A **new informational note** was added at 700.32 giving reference to a **new Informational Note Figure 700.32**, which gives an **example** of how emergency system overcurrent protective devices (OCPDs) selectively coordinate with all supply-side OCPDs
- Emergency system(s) overcurrent devices are required to be selectively coordinated with all supply-side overcurrent protective devices
- Selective coordination is the ability of a system to isolate a fault or overload to a branch circuit or feeder panelboard without effecting the service equipment
- Addition of new figure provides **significant clarity** the determination of how emergency system OCPDs selectively coordinate comes together to protect upstream loads
- Very same change occurred at **708.54** for Critical Operations Power Systems (COPS)

I-Note Figure 700.32 Emergency System Selective Coordination



Example of how emergency system overcurrent protective devices (OCPDs) selectively coordinate with all supply-side OCPDs

OCPD D selectively coordinates with OCPDs C, F, E, B, and A

OCPD C selectively coordinates with OCPDs F, E, B, and A

OCPD F selectively coordinates with OCPD E

OCPD B is not required to selectively coordinate with OCPD A because OCPD B is not an emergency system OCPD

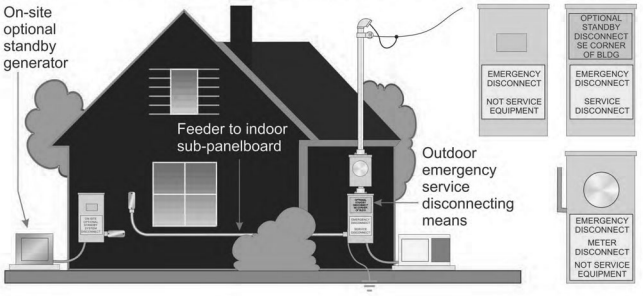
702.7(A) Signs for Optional Standby Systems

- A sign is required to be placed at the **residential emergency disconnecting means** required by **230.85** that indicates the location of each permanently installed **on-site optional standby power source disconnect**
- An emergency disconnecting means *(which could include the service disconnecting means)* for a one- or two-family dwelling is now required to be installed and located on the outside of the structure *(see 230.85)*
- If the outdoor first responder 230.85 emergency disconnect is **not the service disconnect**, then the **on-site optional standby system signage** would be located at this equipment rather than the service equipment
- Same requirement would apply to an **on-site optional generator** to identify the shutdown means of the prime mover as required in **445.18(D)**

702.7(A) Sign for On-Site Optional Standby Systems

A sign is required to be placed at the residential emergency disconnecting means required by 230.85 that indicates the location of each permanently installed on-site optional standby power source disconnect.

Same requirement to identify shutdown means of generator prime mover as required in 445.18(D)



Article 705 Interconnected Electric Power Production Sources

- Article 705 was **extensively reorganized and revised**
- Article 705 covers installation of one or more electric power production sources operating in parallel with a primary source(s) of electricity
- Article has been revised and now contains (2) Parts
  - Part I-General
  - Part II-Microgrid Systems
- Previous Part II and Part III have been deleted as part of the restructuring of Article 705 for the 2020 *NEC* (*deleted or incorporated into other sections of Article 705)*

Article 705 Interconnected Electric Power Production Sources *(cont.)*

- Article 705 was **extensively reorganized and revised** *(cont.)*
- Title of **705.10** was changed from "Directory" to "**Identification of Power Sources**" to align with related changes to identification of power sources in other articles in a continued effort to harmonize all directory requirements for onsite sources under a variety of applications
- New **705.11** was added to address connections made by electric power production sources on the **supply side of the service disconnecting means** as permitted by **230.82(6)**
- New requirements of **705.11(B)** sets a minimum conductor size of **6 AWG copper** and **4 AWG aluminum** for connections on the supply side of the service disconnecting means

Article 705 Interconnected Electric Power Production Sources *(cont.)*

- Article 705 was **extensively reorganized and revised** *(cont.)*
- New requirements of **705.11(C)** sets forth the requirements for overcurrent protection of the power source output conductors
  - Overcurrent protection be located in a readily accessible location either outside of a building or at the first point of entry
  - If the service is inside a building, two options are available for the location of overcurrent protection:
    - within **3 m (10 ft)** of conductor length in dwelling units
    - within **5 m (16.5 ft)** at other than dwelling units *[within 20 m (71 ft) with current limiters at other than a dwelling unit]*

Article 705 Interconnected Electric Power Production Sources *(cont.)*

- Article 705 was **extensively reorganized and revised** *(cont.)*
- New **705.11(D)** deals with the grounding and bonding of metal equipment associated with conductors connected on the supply side of the service disconnect ***(This subdivision was removed from the 2020 NEC by CAM 70-45)***
- Type of connections that are permitted for conductors are addressed by new **705.11(E)** ***(This subdivision is now 705.11(D) in the 2020 NEC)***
- **705.11(F)** clarifies that a power source disconnecting means shall not be considered as one of the service disconnecting means as required by 230.70 ***(This subdivision was removed from the 2020 NEC by CAM 70-46)***
- New requirements of **705.11(G)** *(Ground-Fault Protection)*, gives a reference to 230.95 ***(This subdivision is now 705.11(E) in the 2020 NEC)***

Article 705 Interconnected Electric Power Production Sources *(cont.)*

- Article 705 was **extensively reorganized and revised** *(cont.)*
- New **705.13** titled, "**Power Control Systems**" was added calling for **power control system (PCS)** to be listed and evaluated to control the output of one or more power production sources, energy storage systems (ESS), and other equipment
- New **705.13(E)** titled, "**Access to Settings**" calls for access to settings of the PCS to be restricted to qualified personnel in accordance with the requirements of 240.6(C) (Restricted Access Adjustable-Trip Circuit Breakers), which achieves this restricted access by location behind bolted equipment enclosure doors, location behind locked doors accessible only to qualified personnel, etc.

Article 705 Interconnected Electric Power Production Sources *(cont.)*

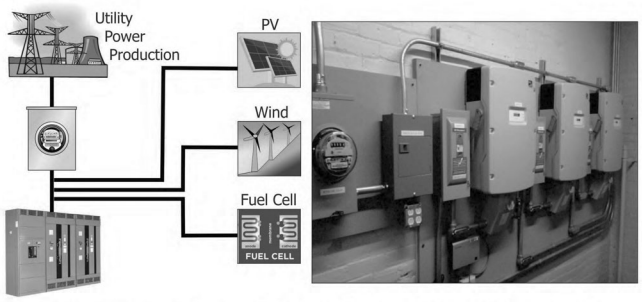
- Article 705 was **extensively reorganized and revised** *(cont.)*
- Existing *Code* language at **705.20** was revised and expanded upon for clarity and usability to use proper terminology as this section discusses a singular means of disconnection *(Disconnecting Means, Source)*
- A new section titled, "**Wiring Methods**" was added at **705.25** indicating that all raceway and cable wiring methods included in Chapter 3 of the *NEC* and other wiring systems and fittings specifically listed, intended, and identified for use with power production systems and equipment are permitted to be used
- New **705.28** titled, "**Circuit Sizing and Current**" has been added, which is previous 705.60 revised, consolidated, and relocated into 705.28 to be consistent with Article 690

Article 705 Interconnected Electric Power Production Sources *(cont.)*

- Article 705 was **extensively reorganized and revised** *(cont.)*
- New **705.30** titled, "**Overcurrent Protection**" is previous language from 705.65 and combined into this new section
- Previous Part II and Part III have been deleted as part of the restructuring of Article 705 *(sections of these previous parts have been deleted or incorporated into other sections of Article 705)*
- *N*ew provisions of **705.45** ***(Unbalanced Interconnections)***, which was previous 705.100 have been restored and relocated at the end of Part I of Article 705

Article 705 Interconnected Electric Power Production Sources

Article 705 covers installation of one or more electric power production sources operating in parallel with a primary source(s) of electricity



Article 705 was extensively reorganized and revised for the 2020 *NEC Code* cycle

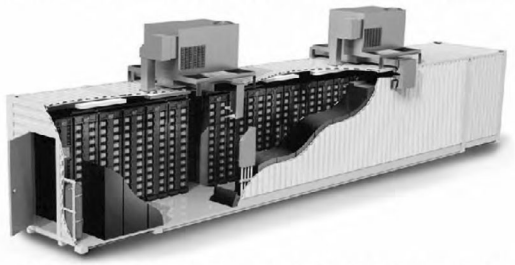
706.1 Scope (Energy Storage Systems)

- **Scope of Article 706** has been **revised** to provide clarity and to better express what is covered by the article
- Previously, an energy storage system may have been confused with an **uninterruptible power supply (UPS) system** or a **large battery system** that is used only when power is lost to the building
- Revised scope and definition of an "**Energy Storage System**" provides additional clarity that an ESS can store and provide energy during normal operating conditions
- Previous scope identified an ESS as one "operating at over 50 volts ac or 60 volts dc," which has been revised to "**having a capacity greater than 3.6 MJ (1 kWh)**" *[MJ = megajoule, kWh = kilowatt hour]*
- Scope was also revised to make it clear that Article 706 will not only apply to a **permanently installed ESS**, but those used in **temporary applications** also

706.1 Scope of Article 706 (Energy Storage Systems)

This article applies to all energy storage systems (ESS) having a capacity greater than 3.6 MJ (1 kWh) that may be stand-alone or interactive with other electric power production sources.

These systems are primarily intended to store and provide energy during normal operating conditions.



The scope of Article 706 has been revised to provide clarity and to better express what is covered by the article

706.2 Definitions: Energy Storage System (ESS)

- Revision occurred to the previous definition of an **Energy Storage System (ESS)** to better define what an ESS is and is not
- **Energy Storage System (ESS).** One or more components assembled together capable of storing energy and providing electrical energy into the premises wiring system or an electric power production and distribution network.
- The **different classifications** of ESS that were in the 2017 *NEC* were **deleted** as these terms are no longer used in the ESS industry
- **UL 9540** *(Standard for Energy Storage Systems and Equipment)* does not specify or define any specific system classification terminology
- Improvements to the definition of an energy storage system will help users of the *Code* better apply Article 706 to electrical installations

706.2 Definition: Energy Storage System (ESS)

One or more components assembled together capable of storing energy and providing electrical energy into the premises wiring system or an electric power production and distribution network.

ESS(s) can include but is not limited to batteries, capacitors, and kinetic energy devices (e.g., flywheels and compressed air) and can include inverters or converters to change voltage levels or to make a change between an ac or a dc system

706.4 System Requirements (Energy Storage Systems)

- New **marking requirements** ***(nameplate information)*** added for energy storage systems (ESS)
- Marking requirement in this revision correlates with the marking requirements found in **UL 9540** *(Standard for Energy Storage Systems and Equipment)*
- ESS to be provided with a **nameplate plainly visible after installation** and marked with **(8) specific pieces of information** provided on the nameplate
- The classifications of an ESS have been **deleted** *(no longer used in the ESS industry)*
- During the development of **NFPA 855** *(Standard for the Installation of Energy Storage Systems)* the ESS classifications that were indicted at 706.4 were initially used but are no longer used in NFPA 855

706.4 System Requirements (Energy Storage System)

Each ESS shall be provided with a nameplate plainly visible after installation and marked with (8) specific pieces of information provided on the nameplate

IAEI ENERGY STORAGE SYSTEM			
KVA	68 kVA	% IMP. 4.2	NO. OF PHASES 3
RATED FREQUENCY	50 Hz ; 60 Hz	Hz	60
MAXIMUM OUTPUT/INPUT CURRENT			1040 A
MAXIMUM OUTPUT/INPUT VOLTAGE			850 V
AVAILABLE FAULT CURRENT			23.2 kA
UTILITY INTERACTIVE CAPABILITY			N/A
NORMAL PHASE-TO-PHASE VAC			380 V
MAX. DC OPERATING CURRENT			
EFFICIENCY (@ 50 Hz)	98.7%		
OUTPUT POWER (S)	630 kVA		

Listed ESS

(1) Manufacturer's name, trademark, or other descriptive marking (2) Rated frequency (3) Number of phases, if ac (4) Rating (kW or kVA) (5) Available fault current derived by the ESS at the output terminals (6) Maximum output and input current of the ESS at the output terminals (7) Maximum output and input voltage of the ESS at the output terminals (8) Utility-interactive capability, if applicable

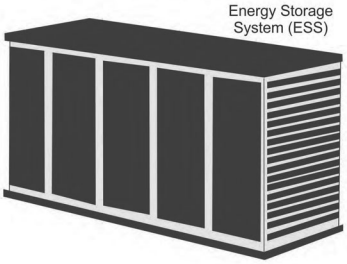
706.7 Maintenance of Energy Storage Systems (ESS)

- New provisions added calling for **maintenance** of energy storage systems (ESS)
- Energy storage systems (ESS) are required to be maintained in proper and safe operating condition
- This required maintenance is to be performed in accordance with the **manufacturer's requirements** and industry standards
- A **written record** of the system maintenance is required to be kept and shall include records of repairs and replacements necessary to maintain the system in proper and safe operating condition
- New informational note gives reference to **NFPA 70B-2016** *(Recommended Practice for Electrical Equipment Maintenance)* and **ANSI/NETA ATS-2017** *(Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems)*

706.7 Maintenance of Energy Storage Systems (ESS)

ESS required to be maintained in proper and safe operating condition with required maintenance performed in accordance with the manufacturer's requirements and industry standards

Maintenance Personnel



Energy Storage System (ESS)

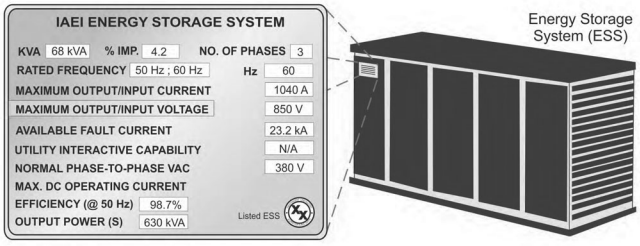
A written record of the system maintenance is required to be kept including records of repairs and replacements necessary to maintain the system in proper and safe operating condition

706.9 Maximum Voltage (Energy Storage Systems)

- New section added to provide prescriptive requirements for the determination of **maximum voltage** of an energy storage system (ESS)
- Maximum voltage of an ESS is determined by the rated ESS input and output voltage(s) indicated on the **ESS nameplate(s)** or system listing
- This requirement is in alignment with the new requirements of **706.4**, which calls for an ESS to be provided with a nameplate plainly visible after installation and marked with (8) specific pieces of information provided on the nameplate
- One of the pieces of information now required on the **ESS nameplate** is the "maximum output and input voltage of the ESS at the output terminals"
- New requirements of 706.9 provides clear guidance on how to determine maximum voltage of an ESS

706.9 Maximum Voltage (Energy Storage Systems)

The maximum voltage of an ESS shall be the rated ESS input and output voltage(s) indicated on the ESS nameplate(s) or system listing



Energy Storage System (ESS)

New section added to provide prescriptive requirements for the determination of maximum voltage of an ESS

706.30(A)(1) Nameplate-Rated Circuit Current for ESS

- Revision occurred to clarify that an energy storage system (ESS) may have **two nameplates**, each respectively indicating input or output circuit rating, or one nameplate showing input and output circuit ratings
- Previous *Code* text at 706.20(A)(1) [now **706.30(A)(1)**] stated that the nameplate(s) rated circuit current was to be the rated current indicated on the ESS nameplate(s) or system listing for pre-engineered or self-contained systems of "**matched components**" intended for field assembly as a system
- Neither the *NEC* or **UL 9540** *(Standard for Energy Storage Systems and Equipment)* contain a definition for "**matched components**"
- The term "**matched components**" was removed from 706.30(A)(1) to align with revised definitions used in conjunction with Article 706

706.30(A)(1) Nameplate-Rated Circuit Current for ESS *(cont.)*

- Not uncommon to see an ESS with **two separate nameplates**, each respectively indicating input or output circuit rating, or one nameplate showing input and output circuit ratings
- **706.30(A)(1)** was revised for clarity and to recognize the fact that an ESS can indeed have **two separate nameplates**
- Where an ESS has separate input (charge) and output (discharge) circuits or ratings, these ratings are to be considered individually
- Where the same terminals on the ESS are used for charging and discharging, the rated current would be considered the greater of the two

706.30(A)(1) Nameplate-Rated Circuit Current (ESS)

Circuit current is the rated current indicated on an energy storage systems (ESS) nameplate(s) or system listing ~~for pre-engineered or self-contained systems of matched components intended for field assembly as a system~~

Courtesy of ABB Electrification Products Division (Thomas & Betts)

Where an ESS has separate input (charge) and output (discharge) circuits or ratings, these ratings are to be *considered individually* ***(possibly two nameplates)***

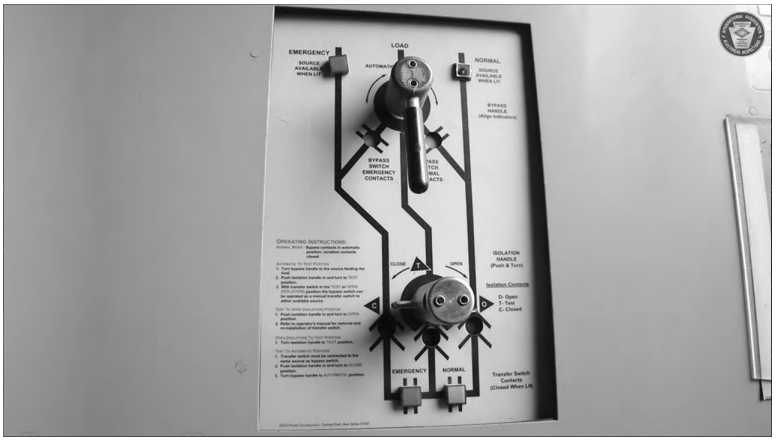
Where the same terminals on the ESS are used for charging and discharging, the rated current would be considered the *greater of the two*

708.24(D) Bypass Isolation Automatic Transfer Switches (COPS)

- New List Item (D) added to address **bypass isolation automatic transfer switches** where necessary for a designated **Critical Operations Power Systems (COPS)** buildings
- Transfer equipment *[including automatic transfer switches (ATS)]* used in conjunction with a COPS system is required to be automatic and identified for emergency use
- COPS transfer equipment is required to be designed and installed to prevent the inadvertent interconnection of normal and critical operations sources of supply in any operation of the transfer equipment
- In some cases, design criteria call for a means to put an **automatic transfer switch** in an **electrically safe work condition** so that **maintenance** can be performed safely on the automatic transfer switch without losing power to the critical loads associated with a COPS designated building

708.24(D) Bypass Isolation Automatic Transfer Switches (COPS) *(cont.)*

- New List Item (D) added to address **bypass isolation automatic transfer switches** where necessary for a designated **Critical Operations Power Systems (COPS)** buildings *(cont.)*
- If a COPS design has loads that can only be supplied via one automatic transfer switch, the **maintenance may not get done** or if it is done, it is performed in an **unsafe non-compliant NFPA 70E** *(Electrical Safety in the Workplace)* **manner**
- **Bypass isolation switches** provide redundancy and **continuous powering of the loads** while the automatic transfer switch is de-energized so that proper maintenance can be performed under safe compliant NFPA 70E work conditions
- However, while in the bypass mode, if the connected power source fails, it would be necessary to quickly transfer between power sources (this can be achieved by an **automatic bypass isolation switch**)

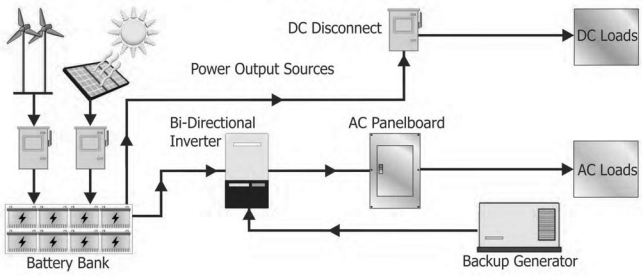


710.15 General Requirements for Stand-Alone Systems

- New Code language has been added at 710.15 to recognize that stand-alone systems can deliver power to **three-phase applications** as well as single-phase systems
- 2017 *NEC* seemed to have indicated that a stand-alone system was reserved for a single-phase system only
- Several manufacturers design and sell products such as inverters, dc disconnects, battery banks, and generators that are capable of delivering and receiving a **three-phase application** as well and a single-phase system
- Existing systems can meet the definition of a stand-alone or islanded system that deliver power to **three-phase applications** such as mid-size server rooms, networks, telecommunication systems, and industrial processes

710.15 General Requirements for Stand-Alone Systems

New provisions added to 710.15 to recognize that stand-alone systems can deliver power to three-phase applications as well as single-phase systems



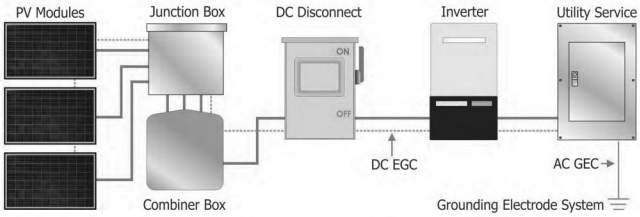
710.15(D): Three-phase Supply. Stand-alone and microgrid systems are permitted to supply three-phase, 3-wire or 4-wire systems

712.2 Definitions: ~~Resistively~~ Grounded, Functionally

- The term "Resistively Grounded" in Article 712 was revised to "**Grounded, Functionally**" to correlate with the same definition in Article 690
- The term "**Grounded, Functionally**" is defined at both 712.2 and 690.2 as "a system that has an electrical ground reference for operational purposes that is not solidly grounded"
- Some users of the *Code* would argue that only one definition is need and that definition needs to be located in Article 100, especially since these definitions mirror each other
- That is a battle for another day and perhaps that is the direction this issue will be heading toward in the 2023 *NEC* revision cycle

712.2 Definition: Grounded, Functionally

The term "Resistively Grounded" in Article 712 was revised to "Grounded, Functionally" to correlate with the same definition in Article 690



Grounded, Functionally. A system that has an electrical ground reference for operational purposes that is not solidly grounded.

Informational Note: Examples of operational reasons for functionally grounded systems include ground-fault detection and performance-related issues for some power sources.

712.10(B) Building Directory (Direct Current Microgrids)

- New **outdoor plaque or directory** requirement added to denote **all sources of dc power** to a building installed at each outside service equipment location or at an **approved readily visible location**
- This outdoor plaque or directory must denote the location of each power source disconnecting means on or in the building or be grouped with other plaques or directories for other on-site sources
- This provision brought on by ongoing concern expressed by the **fire service** and other **first responders** concerning the need to secure all on-site power sources during emergencies and awareness of where those sources are installed and utilized
- Provide warnings to first responders about the **presence and location of on-site power sources** prior to entering a building
- This new outdoor plaque or directory requirement for dc microgrids aligns with similar *Code* language at **705.10** *(Interconnected Electric Power Production Sources)* and **710.10** *(Stand-Alone Systems)*, with the goal to harmonize these similar requirements

712.10(B) Building Directory (DC Microgrids)

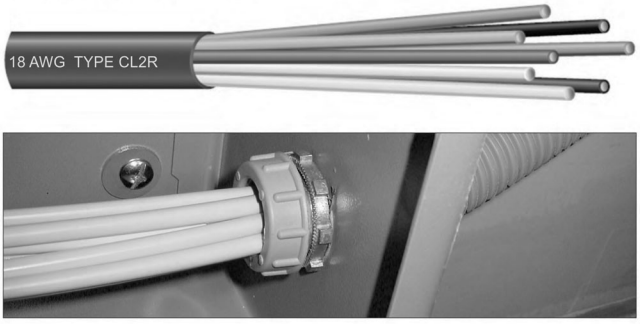
A building supplied by a dc microgrid system shall have a permanent plaque or directory installed outside the building at each service equipment location or at an approved readily visible location

725.3(O) Temperature Limitation of Class 2 and Class 3 Cables

- New text clarifies that the **temperature limitations for conductors** of 310.14(A)(3) apply to Class 2 and Class 3 cables as well *(not just conductors)*
- New **725.3(O)** ***(Temperature Limitation of Class 2 and Class 3 Cables)*** states that requirements of **310.14(A)(3)** *[previous 310.15(A)(3)] (temperature limitation of conductors)* shall apply to Class 2 and Class 3 cables
- Because Class 2 and Class 3 circuits are typically installed in a cable rather than individual conductors, some argued that the temperature limitations of conductors of **310.14(A)(3)** did not apply to Class 2 and Class 3 cables
- To put this argument to rest, a new subsection was added to Article 725 at 725.3(O)
- Same change occurred at **760.3(N)** for **fire alarm system Class 2 and Class 3 cables**

725.3(O) Temperature Limitation of Class 2 and Class 3 Cables

The requirements of 310.14(A)(3) on the temperature limitation of conductors shall apply to Class 2 and Class 3 cables *(not just conductors)*

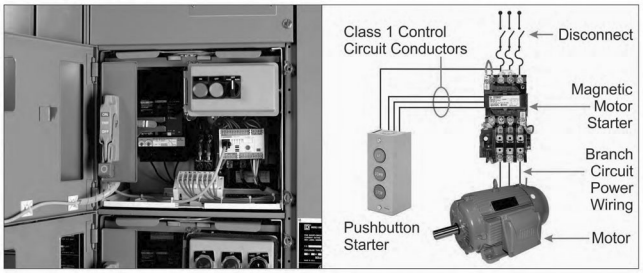


725.48(B)(1) Class 1 Circuits with Power-Supply Circuits

- Revision permits **Class 1 circuits** to share enclosure space with conductors of electric light, power, non–power-limited fire alarm and medium power network-powered broadband communications circuits as long as separated by a **barrier**
- Previously, Class 1 circuits and power-supply circuits were only permitted to occupy the same cable, enclosure, or raceway ***without a barrier*** only where the equipment powered was ***functionally associated*** *(still applies)*
- The "barrier" requirement for Class 1, Class 2, and Class 3 circuits is not specific as to the type of material required

725.48(B)(1) Class 1 Circuits with Power-Supply Circuits

Class 1 circuits and power-supply circuits permitted to occupy the same cable, enclosure, or raceway without a barrier only where the equipment powered is functionally associated



Class 1 circuits permitted to be installed with conductors of electric light, power, non-power-limited fire alarm, etc. *where separated by a barrier*

725.144 and Table 725.144 Transmission of Power and Data

- Extensive revision occurred for 725.144, Table 725.144, 725.144(A), and 725.144(B) dealing with **transmission of power and data** on Class 2, Class 3, Class 2-LP, or Class 3-LP cables
- Requirements of parent text of 725.144 did not change, just revised for clarity
- New ***Informational Note No. 3 and No. 4*** were added to identify the unique nature of the type of conductors and cables specified at Table 725.144 and to provide the appropriate reference standards that address the cables covered in the Table
- New ***Informational Note No. 5*** was added since Power over Ethernet (PoE) lighting is a very important application covered by 725.144

725.144 and Table 725.144
Transmission of Power and Data *(cont.)*

- Extensive revision occurred for 725.144, Table 725.144, 725.144(A), and 725.144(B) dealing with **transmission of power and data** on Class 2, Class 3, Class 2-LP, or Class 3-LP cables *(cont.)*
- New ***Informational Note No. 6*** was added to clarify that the rated current for power sources covered in 725.144 is the output current per conductor the power source is designed to deliver to an operational load at normal operating conditions, as declared by the manufacturer
- At Table 725.144, the undefined term "Data Cables" has been replaced with "**Balanced Twisted-Pair Cables**," which is language that is consistent with relevant industry standards *(such as **ANSI/TIA-568-C.2-2009** Balanced Twisted-Pair Telecommunications Cabling and Components Standards)* and is also consistent with language in other parts of Article 725

725.144 and Table 725.144
Transmission of Power and Data *(cont.)*

- Extensive revision occurred for 725.144, Table 725.144, 725.144(A), and 725.144(B) dealing with **transmission of power and data** on Class 2, Class 3, Class 2-LP, or Class 3-LP cables *(cont.)*
- All the ampacity adjustment factors in **previous Table 725.144** were expressed to **one tenth values** *(i.e. 1.4, 1.7. 0.6, etc.)* except for the ampacity adjustment factors of whole numbers, such as "1, 2 and 3" amperes
- Based on **Note 2 to the table**, an ampacity of 1 ampere could be interpreted to be 1.4 amperes as this note states that where only half of the conductors in each cable are carrying current, the values in the table are permitted to be increased by a factor of 1.4
- The table ampacity adjustment factors of "1, 2 and 3" needed to be revised to "1.00, 2.00 and 3.00" respectively to avoid incorrectly interpreting these numbers

725.144 and Table 725.144
Transmission of Power and Data *(cont.)*

- Extensive revision occurred for 725.144, Table 725.144, 725.144(A), and 725.144(B) dealing with **transmission of power and data** on Class 2, Class 3, Class 2-LP, or Class 3-LP cables *(cont.)*
- **Table 725.144** ampacity adjustment factors are now expressed in double digit values
- Some of the ampacity values have been updated in **Table 725.144** to reflect new ampacity values for 23 AWG cables after recreating and reaffirming the data from the substantiation that generated this table in the 2017 *NEC*
- **725.144(A)**, covering the use of Class 2 or Class 3 cables to transmit power and data was **revised** to enhance the usability of this subsection by identifying applications where Table 725.144 need not be consulted

725.144 and Table 725.144
Transmission of Power and Data *(cont.)*

- Extensive revision occurred for 725.144, Table 725.144, 725.144(A), and 725.144(B) dealing with **transmission of power and data** on Class 2, Class 3, Class 2-LP, or Class 3-LP cables *(cont.)*
- The requirements of **725.144(B)**, titled "**Use of Class 2-LP or Class 3-LP Cables to Transmit Power and Data**" was revised with a new sentence added pertaining to **bundled LP cables**
- **725.144(B)** now states that where bundled LP cables number **192 or less** and the selected ampacity of the cables in accordance with Table 725.144 exceeds the marked current limit of the cable, the ampacity determined from the table is permitted to be used

Table 725.144

Table 725.144 Ampacities of Each Conductor in Amperes in 4-Pair Class 2 or Class 3 ~~Data~~ Balanced Twisted-Pair Cables Based on Copper Conductors at an Ambient Temperature of 30°C (86° F) with All Conductors in All Cables Carrying Current, 60°C (140°F), 75°C (167°F), and 90°C (194°F) Rated Cables

	Number of 4-Pair Cables in a Bundle																	
	1-7			8-19			20-37			38-61			62-91			92-192		
	Temperature Rating			Temperature Rating			Temperature Rating			Temperature Rating			Temperature Rating			Temperature Rating		
AWG	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C	60°C	75°C	90°C
26	1.00	1.23	1.42	0.71	0.87	1.02	0.55	0.68	0.78	0.46	0.57	0.67	0.45	0.55	0.64	N/A	N/A	N/A
24	1.19	1.46	1.69	0.81	1.01	1.17	0.63	0.78	0.91	0.55	0.67	0.78	0.46	0.56	0.65	0.40	0.48	0.55
23	1.24	1.53	1.78	0.89	1.11	1.28	0.77	0.95	1.10	0.66	0.80	0.93	0.58	0.71	0.82	0.45	0.55	0.63
22	1.50	1.86	2.16	1.04	1.28	1.49	0.77	0.95	1.11	0.66	0.82	0.96	0.62	0.77	0.89	0.53	0.63	0.72

Note 1: For bundle sizes over 192 cables, or for conductor sizes smaller than 26 AWG, ampacities shall be permitted to be determined by qualified personnel under engineering supervision.

Note 2: Where only half of the conductors in each cable are carrying current, the values in the table shall be permitted to be increased by a factor of 1.4.

Informational Note No. 1: Elevated cable temperatures can reduce a cable's data transmission performance. For information on practices for 4-pair balanced twisted pair cabling, see TIA-TSB-184-A and 6.4.7, 6.6.3, and Annex G of ANSI/TIA-568-C.2, which provide guidance on adjustments for operating temperatures between 20°C and 60°C.

Informational Note No. 2: The per-contact current rating of connectors can limit the maximum allowable current below the ampacity shown in Table 725.144.

760.121(B) Power Sources for PLFA Circuits *(Fire Alarm Systems)*

- New sentence added to permit the fire alarm branch-circuit disconnecting means for power limited fire alarm (PLFA) circuits to be **secured in the "on" position**
- The fire alarm circuit disconnect for non-power-limited fire alarm (NPLFA) circuits was already permitted to be secured in the "on" position *[see 760.41(A)]*
- Change provides consistency with NPLFA circuits and PLFA circuits
- While this practice was not prohibited by **760.121**, it was not specifically permitted either
- Installing **breaker locks** is already a common industry practice on fire alarm circuits

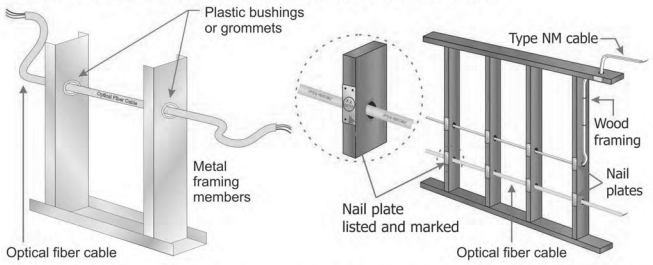
Courtesy of TC Life Safety

770.24 Mechanical Execution of Work (Optical Fiber Cable)

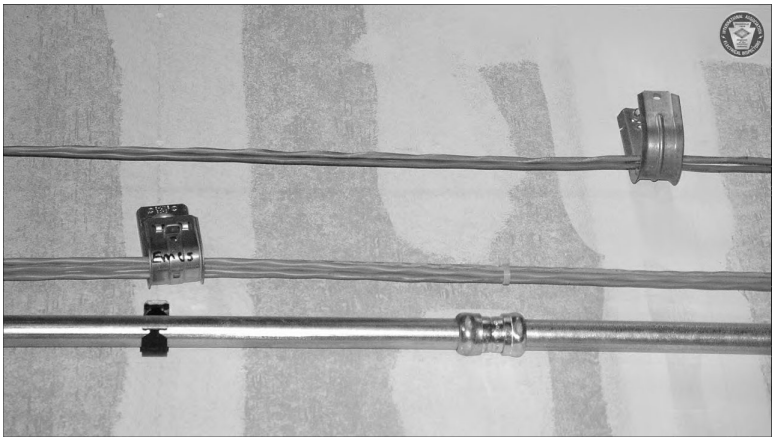
- Revision will require optical fiber cable to conform to **all of 300.4 and 300.11** *[not just 300.4(D) through (G)]*
- Previously, optical fiber cables were to be installed and protected from physical damage in accordance with 300.4(D) through (G) and 300.11
- Optical fiber cables not limited to communications installations and need protection against physical damage regardless if they can be a shock hazard or not
- Even if optical fiber cable is not carrying any current, the equipment being supplied by this cable in several situations are critical to **life and safety**
- The installation of these optical fiber cables should conform to **all of 300.4**

770.24 Mechanical Execution of Work for Optical Fiber Cable

Optical fiber cables are now required to be installed and protected from physical damage in accordance with all of 300.4 and 300.11 *[not just 300.4(D) through (G)]*



Where driven nails or screws can penetrate optical fiber cable installed through wood or metal studs, a steel sleeve, steel nail plate or steel clip not less than 1.6 mm (1/16 in.) in thickness is required to be installed *(Thinner steel plates permitted if listed and marked)*



770.110(D) Cable Trays for Optical Fiber Cables

- New section added permitting **optical fiber cables** to be installed in metal or listed nonmetallic **cable tray systems**
- Previously, permission to install optical fiber cable in a cable tray was given in several locations across Article 770
- This revision will make it easier to find this cable tray rule with it located in the same section that permits optical fiber cables to be installed in raceways and cable routing assemblies
- New requirement limits the allowance for optical fiber cables to be installed in a cable tray to **metal and listed nonmetallic cable trays** in order to address flame spread concerns
- Same change occurred for **communications cables and raceways** at **800.110(D)**

770.133 Installation of Optical Fibers and Electrical Conductors

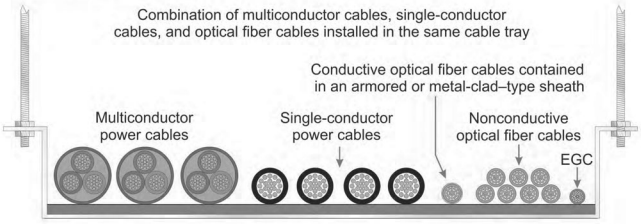
- Previous requirements of **770.133(A)** has been reorganized and relocated throughout **770.133(A)** and new **770.133(B)**
- Previous exceptions rewritten into positive *Code* language
- Previous 770.133(A) permitted optical fiber cables to occupy the same cable tray and raceway as conductors for electric light, power, Class 1, non-power-limited fire alarm, etc. *(with five exceptions)*
- Almost all of the 2017 *NEC* requirements of 770.133 are still there for the 2020 *NEC* but **relocated for a better flow of the information**
- Permission to allow nonconductive optical fiber cables to occupy the same cable tray as conductors for electric light, power, Class 1, non-power-limited fire alarm, etc. operating at 1000 volts or less was moved to the second paragraph of new 770.133(B)

770.133 Installation of Optical Fibers and Electrical Conductors *(cont.)*

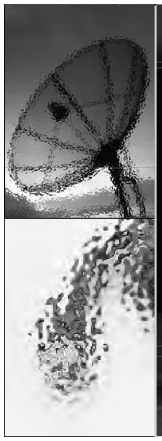
- Previous requirements of **770.133(A)** has been reorganized and relocated throughout **770.133(A)** and new **770.133(B)** *(cont.)*
- First paragraph of **770.133(A)** was updated to permit **conductive optical fiber cables** contained in an armored or metal-clad-type sheath and **nonconductive optical fiber cables** to occupy the same cable tray with conductors for electric light, power, Class 1, non-power-limited fire alarm, etc. operating at 1000 volts or less
- **Conductive optical fiber cables without an armored or metal-clad-type sheath** not permitted to occupy the same cable tray as power conductors, etc. unless separated by a **permanent barrier** or listed divider

770.133 Installation of Optical Fibers and Electrical Conductors

Optical fiber cables permitted to occupy the same cable tray and raceway *(with conditions)* as conductors for electric light, power, Class 1, non-power-limited fire alarm, etc. *(information reorganized for 2020 NEC)*



Conductive optical fiber cables contained in an armored or metal-clad–type sheath and nonconductive optical fiber cables shall be permitted to occupy the same cable tray or raceway with conductors for electric light, power, Class 1, non–power-limited fire alarm, etc.



Chapter Eight Communications Systems

Stopped Here

Article 800 General Requirements for Communications Systems

- **New Article 800** *(General Requirements for Communications Systems)* combines **common requirements** previously found in Articles 800, 820, 830 and 840 into a **new "general" article** that applies to all of these articles
- **Previous Article 800** *(Communications Circuits)* was moved to **Article 805** to make room for this new Chapter 8 article
- **Common requirements** would include such things as mechanical execution of work, abandoned cables, spread of fire or products of combustion, and temperature limitations of wires and cables
- In previous editions of the *Code*, if a change in one of the Chapter 8 articles occurred, it was a good bet that the same change would be occurring in the other Chapter 8 articles as well
- New article for communication circuits significantly improves clarity and usability while removing redundant requirements from each of the articles throughout Chapter 8

Article 800 General Requirements for Communications Systems

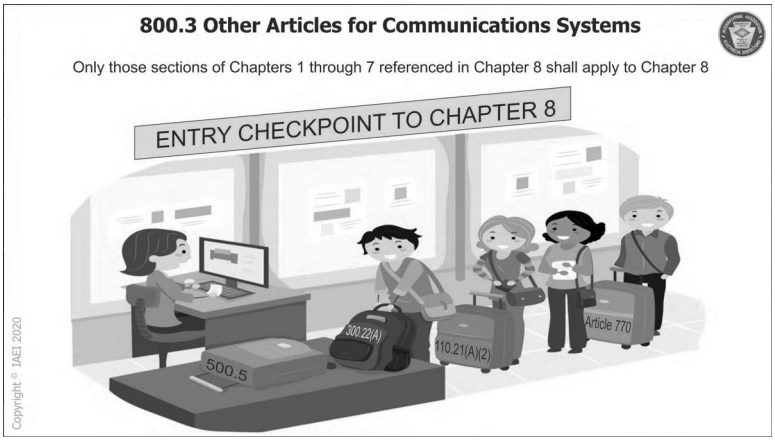
800.1 Scope. This article covers general requirements for communications systems. These general requirements apply to communication circuits, and equipment community antenna television and radio distribution systems, network-powered broadband communication systems, and premises-powered broadband communication systems unless modified by Articles 805, 820, 830, or 840.

800.2 Definitions: Communications Circuit

- **Communications Circuit.** The circuit that extends service from the communications utility or service provider to and including the customer's communications equipment.
- The definition of a "**Communications Circuit**" was revised to remove the "list" of service types offered by a communications circuit
- List was problematic as it did not allow for new technologies to be included in this definition without a *Code* change, which only happens every three years

800.3 Other Articles for Communications Systems

- New text was added to reinforce the **independence of Article 800 and Chapter 8** which stipulates that only those sections of Chapters 1 through 7 referenced in Article 800 shall apply to communications systems
- Opening sentence of 800.3 now reads, "**Only those sections of Chapters 1 through 7 referenced in Chapter 8 shall apply to Chapter 8**."
- Requirements of **90.3** state that Chapter 8 of the *NEC* is a **"stand-alone" article** and "is not subject to the requirements of Chapters 1 through 7 except where the requirements are specifically referenced in Chapter 8"
- In order for a requirement from Chapters 1 through 7 to apply to Chapter 8, there must be a clear reference or "**road map**" in Chapter 8 to a specific requirement in Chapters 1 through 7



800.27 Temperature Limitation of Wire and Cables (Communications Systems)

- New section added to specify that no communication wire or cable be used in such a manner that its **operating temperature** exceeds that of its rating
- When the previous requirements of 800.3 were moved to new Article 800, it was felt that this **temperature limitation requirement** deserved its own section in Article 800
- Previous temperature limitations of 800.3(H) were moved to a **new 800.27** and titled "**Temperature Limitation of Wires and Cables**"
- New text at 800.27 makes it clear that this temperature limitations in Chapter 8 **apply to cables** *(not just conductors)*
- New text simplifies the *Code* by including the temperature limitation requirement **directly in Article 800**, rather than have a cross-reference in Article 800 to the temperature limitation requirements of **Article 310**

800.27 Temperature Limitation of Wire and Cables *(Communications Systems)*

No communications wire or cable is permitted to be used in such a manner that its operating temperature exceeds that of its rating

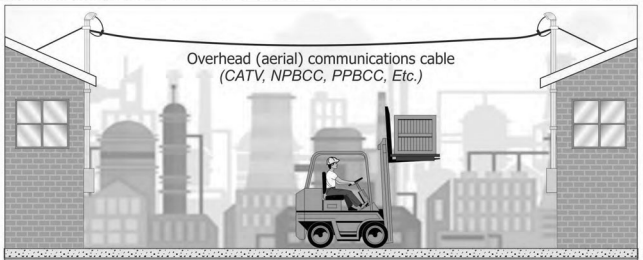
Plenum, riser, general-purpose, and limited-use communications cables required to have a temperature rating of not less than 60°C (140°F) *(see 800.179)*

800.44 Overhead (Aerial) Communications Wires and Cables

- Requirements were added for ***all*** communications circuits pertaining attachment to **above-the-roof raceway mast** and cables extending between buildings or structures
- Previously, **Article 820** contained provisions for attaching coaxial cables to an **above-the-roof raceway mast** that did not enclose or support conductors of electric light or power circuits *(none of the other Chapter 8 article contained this mast rule)*
- Previously, **Articles 820 and 830** contained requirements pertaining to coaxial cables and network-powered broadband communications **cables extending between buildings** or structures *(other Chapter 8 articles did not have such rules)*
- These two rules were perfect candidates to be placed in **new Article 800** to prevent repeating these rules in four different articles *(needed consistency)*

800.44 Overhead (Aerial) Communications Wires and Cables

Overhead (aerial) communications and CATV type coaxial cables permitted to be attached to above-the-roof raceway mast that does not enclose or support conductors of electric light or power circuits



Communications and CATV type coaxial cables extending between buildings or structures *(along with the supports or attachment fixtures)* shall be identified and shall have sufficient strength to withstand the loads to which they might be subjected *(Ex. for supporting messenger cable)*

805.179(D) Limited Power (LP) Cables

- Provisions were added to permit **limited power (LP) cables** to act as a **substitute** for Class 2 and Class 3 cables
- Previously, communications cables were permitted as substitutes for Class 2 and Class 3 cables, but the *Code* **did not specifically address** limited power (LP) cables as a substitute for Class 2 and Class 3 cables
- **725.144** and **Table 725.144** gives designers, installers and AHJs the assurance that 4-pair data cables can safely carry power as well as data when bundled together in cable trays or cable routing assemblies
- This revision recognizes the fact that an **LP cable** is a specific type of Class 2, Class 3, and communications cable and explicitly permits these cable types as **substitutes** for Class 2 and Class 3 LP cables *(vast majority of LP cables are listed as communications cables)*
- LP cables are listed under the UL product categories of Communications Cable (**DUZX**) and Power Limited Circuit Cable (**QPTZ**)

805.179(D) Limited Power (LP) Cables

Provisions added at to permit limited power (LP) cables to act as a substitute for Class 2 and Class 3 cables as well as the previous provisions allowing communications cables as substitutes for Class 2 and Class 3 cables

Cable Sample Courtesy of Belden

840.2 Definitions for Premises-Powered Broadband Communications Systems

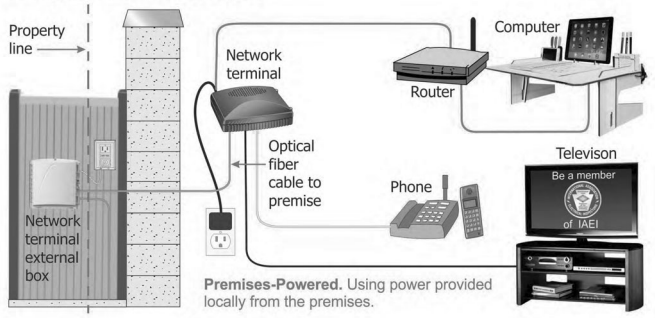
- Two new definitions were added to 840.2 to define the terms "**Broadband**" and "**Premises-Powered**"
- **Broadband.** Wide bandwidth data transmission that transports multiple signals, protocols, and traffic types over various media types.
- **Premises-Powered.** Using power provided locally from the premises.
- Previously, neither "**Broadband**" or "**Premises-Powered**" were defined in Article 840 *(Premises-powered Broadband Communications Systems)* or the *NEC*
- Definition for "**Broadband**" was added to provide an appropriate description of the circuits covered under Article 840
- Term "**Premises-Powered**" had to be defined as it now applies to more than one type of system

840.2 Definitions for Premises-Powered Broadband Communications Systems *(cont.)*

- Two new definitions were added to 840.2 to define the terms "**Broadband**" and "**Premises-Powered**" *(cont.)*
- Premises powered basically means that the power used by the communications system is **derived from the local premises power**, and this power source has **no limits on the power crossing a premises property line** or boundary
- **Example:** Network terminal being powered from a 125-volt, 15- or 20-ampere ac wall receptacle outlet or an uninterruptible power supply (UPS)/battery backup unit where the network terminal is a few feet from a structure
- This location is not necessarily "**on the premises**" based on prescribed property lines, legal boundaries, and/or utility definitions
- New definition of "**Premises-Powered**" would cover such an installation even though the network terminal might not be technically on the premise and keep this type of installation under the scope of Article 840

Article 840 Definitions: Premises-Powered Broadband Communications Systems

Broadband. Wide bandwidth data transmission that transports multiple signals, protocols, and traffic types over various media types.



840.94 and 840.102 Premises Circuits Leaving the Building

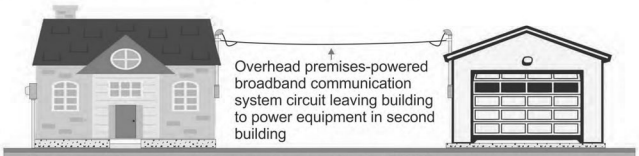
- Two new sections (840.94 and 840.102) added to provide requirements for **premises-powered broadband communication system (PPBCS) circuits** when they **leave the building** to power equipment **remote to that building**
- Previously, 840.101 contained provisions for PPBCS circuits where they **did not leave the building**, but no provisions existed for when PPBCS circuits **did leave the building**
- PPBCS circuits are being installed by utilities or service providers that provide power to exterior equipment such as an asymmetric digital subscriber line (ADSL), which is a type of digital subscriber line (DSL) technology
- The circuits are equipment on the network being powered from the premises which ultimately would power circuits going to **other premises**

840.94 and 840.102 Premises Circuits Leaving the Building *(cont.)*

- Two new sections (840.94 and 840.102) added to provide requirements for **premises-powered broadband communication system (PPBCS) circuits** when they **leave the building** to power equipment **remote to that building**
- These circuits are derived from the premises power to avoid having to run copper cable to the exterior location, avoid establishing a meter point, and/or avoid providing backup batteries ***[sometimes referred to as "reverse powering (RP)"]***
- These added circuits are potentially exposed to lightning events and/or electric power ground faults
- They deserve and require the same protection and grounding and bonding means as other aerial, buried, or underground communications cables entering a building

840.94 and 840.102 Premises Circuits Leaving the Building

840.94: Requires circuits leaving a building to power equipment remote to that building or outside the exterior zone of protection defined by a 46 m (150 ft) radius rolling sphere, to comply with 805.90 *(Protective Devices)* and 805.93 *(Grounding, Bonding, or Interruption of Non-Current-Carrying Metallic Sheath Members of Communications Cables)*



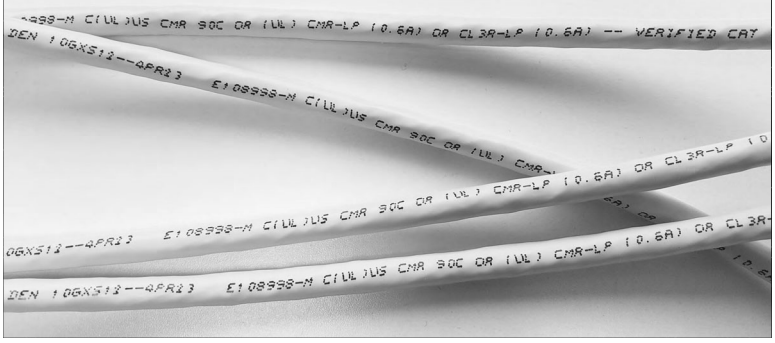
If coaxial cables are present, required to comply with 820.100 *(Cable Bonding and Grounding) (which references 800.100)* and 800.106

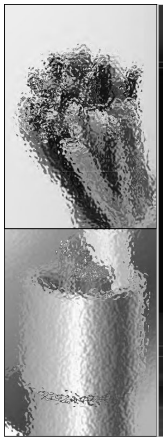
840.102: Requires communications wires and cables circuits leaving the building to power equipment remote to the building or outside the exterior zone of protection defined by a 46 m (150 ft) radius rolling sphere to comply with 800.100 *(Cable and Primary Protector Bonding and Grounding)* and 800.106 *(Primary Protector Grounding and Bonding at Mobile Homes)*

840.160 Powering Circuits (Premises-Powered Broadband Communication Systems)

- Revised text identifies **listing provisions** for communications cables, powered communications equipment, and the power source
- Communications cables that are listed in accordance with **805.179** are permitted to carry circuits for powering communications equipment *(in addition to carrying the communications circuit)*
- Communications equipment has to be listed in accordance with **805.170**
- Power source required to be listed in accordance with **840.170(G)**
- Installation of listed 4-pair communications cables for a communications circuit or installation where 4-pair communications cables are substituted for Class 2 and Class 3 cables in accordance with **725.154(A)** is required to comply with **725.144** with an exception *where the rated current of the power source does not exceed 0.3 amperes in any conductor 24 AWG or larger*

Communications cables listed in accordance with 805.179





Chapter Nine Tables

Chapter 9, Notes to Tables, Note (2)

- Revision to Note (2) now indicates that **Table 1** does not apply to exposed wiring ***and cable*** when used in incomplete sections of conduit or tubing to protect from physical damage
- Previously, Note (2) to the Chapter 9 tables only referenced "**exposed wiring**" *(and not cable)*
- Revision to make it clear that protection from physical damage is for "**exposed wiring**" **includes cables** as well
- Should have been fairly evident with the title of Table 1 of Chapter 9 being "Percent of Cross Section of Conduit and Tubing for Conductors ***and Cables***" with a subheading of "Number of Conductors and/***or Cables***"
- Proper conductor fill will avoid conductor overheating and possible insulation damage due to excessive heat

Chapter 9, Notes to Tables, Note (2)

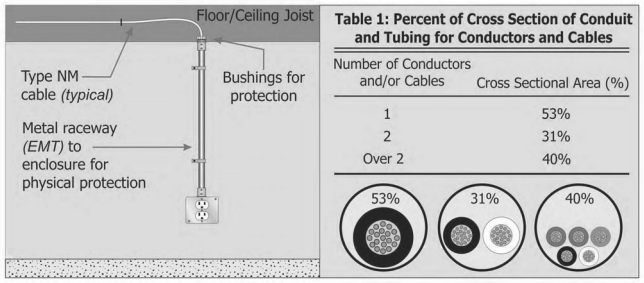


Table 1: Percent of Cross Section of Conduit and Tubing for Conductors and Cables

Number of Conductors and/or Cables	Cross Sectional Area (%)
1	53%
2	31%
Over 2	40%

Note (2): Table 1 applies only to complete conduit or tubing systems and is not intended to apply to sections of conduit or tubing used to protect exposed wiring and cable from physical damage.

Informative Annexes

Informative Annex A- Product Safety Standards

- Informative Annex A was reformatted to provide and add ***NEC*** **article numbers** and **appropriate product standards were added and updated**
- Previously, Informative Annex A had **two columns** of information; **(1)** the name of the product standard and **(2)** the product standard number
- Informative Annex A now has **three columns** of information; **(1)** the *NEC* article number where the referenced product standard can be found, **(2)** the product standard number, and **(3)** the name of the product standard
- **2017 *NEC*:** Informative Annex A referenced **236 product standards**
- **2020 *NEC*:** Informative Annex A references **352 product standards**
- Previous tabular format of Informative Annex A did not provide **correlation with various *Code* Articles** (*where can these product standard references be found throughout the NEC?)*

Informative Annex A - Product Safety Standards

Informative Annex A was reformatted to provide *NEC* article numbers and appropriate product standards were added

2017 *NEC* Informative Annex A *(in part)*		2020 *NEC* Informative Annex A *(in part)*		
Product Standard Name	**Product Standard Number**	**Article**	**Standard Number**	**Standard Title**
Antenna-Discharge Units	UL 452	110	UL 943	Ground-Fault Circuit-Interrupters
Arc-Fault Circuit-Interrupters	UL 1699	210	UL 1699	Arc-Fault Circuit-Interrupters
Armored Cable	UL 4	230	UL 1053	Ground-Fault Sensing and Relaying Equipment
Attachment Plugs and Receptacles	UL 498			
Audio, Video and Similar Electronic Apparatus — Safety Requirements	UL 60065	240	UL 2735	Electric Utility Meters
			UL 198M	Mine-Duty Fuses
Audio/Video, Information and Communication Technology Equipment — Part 1: Safety Requirements	UL 62368-1		UL 248-1	Low-Voltage Fuses — Part 1: General Requirements
			UL 248-2	Low-Voltage Fuses — Part 2: Class C Fuses
Automatic Electrical Controls	UL 60730-1	250	UL 467	Grounding and Bonding Equipment

Informative Annex C - Conduit, Tubing, and Cable Tray Fill Tables for Conductors and Fixture Wires of the Same Size

- Informative Annex C revised to include conductor fill tables for **cable trays** as well and for conduits and tubing
- Previous Informative Annex C contained **26 tables** for determining the maximum number of conductors or fixture wires permitted in various conduits and tubings
- New Informative Annex C is now contains **33 tables** for determining the maximum number of conductors or fixture wires permitted in various conduits, tubings **and cable trays**
- Rules and tables provided in Article 392 *(Cable Trays)* for determining the sizing of various cable tray types and sizes can be intimidating and complicated to some users of the *Code*
- **New tables** in Informative Annex C allows for **simplified determination** of the maximum number of cables or conductors allowed in a particular cable tray width and serve to **enhance safety** due to reductions of errors pertaining to incorrect cable selection and erroneous cable tray sizing calculations

Informative Annex C - Conduit, Tubing, and Cable Tray Fill Tables for Conductors and Fixture Wires of the Same Size

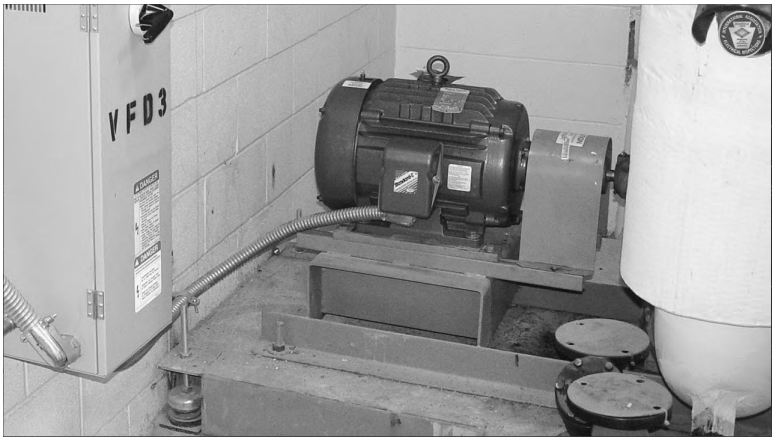
C.1 - Electrical Metallic Tubing (EMT)
C.1(A)* - Electrical Metallic Tubing (EMT)
C.2 - Electrical Nonmetallic Tubing (ENT)
C.2(A)* - Electrical Nonmetallic Tubing (ENT)
C.3 - Flexible Metal Conduit (FMC)
C.3(A)* - Flexible Metal Conduit (FMC)
C.4 - Intermediate Metal Conduit (IMC)
C.4(A)* - Intermediate Metal Conduit (IMC)
C.5 - Liquidtight Flexible Nonmetallic Conduit (Type LFNC-A)
C.5(A)* - Liquidtight Flexible Nonmetallic Conduit (Type LFNC-A)
C.6 - Liquidtight Flexible Nonmetallic Conduit (Type LFNC-B)
C.6(A)* - Liquidtight Flexible Nonmetallic Conduit (Type LFNC-B)
C.7 - Liquidtight Flexible Nonmetallic Conduit (Type LFNC-C)
C.7(A) - Liquidtight Flexible Nonmetallic Conduit (Type LFNC-C)
C.8 - Liquidtight Flexible Metal Conduit (LFMC)
C.8(A)* - Liquidtight Flexible Metal Conduit (LFMC)
C.9 - Rigid Metal Conduit (RMC)
C.9(A)* - Rigid Metal Conduit (RMC)
C.10 - Rigid PVC Conduit, Schedule 80
C.10(A)* - Rigid PVC Conduit, Schedule 80
C.11 - Rigid PVC Conduit, Schedule 40 and HDPE Conduit
C.11(A)* - Rigid PVC Conduit, Schedule 40 and HDPE Conduit
C.12 - Type A, Rigid PVC Conduit
C.12(A)* - Type A, Rigid PVC Conduit
C.13 - Type EB, PVC Conduit
C.13(A)* - Type EB, PVC Conduit
C.14- Type MC Cables Allowed in Cable Tray
C.15- Type MC Cables *(4C Multiconductor)*
C.16- Type TC Cables *(3C Multiconductor)*
C.17- Type TC Cables *(4C Multiconductor)*
C.18- Single Conductor Cables Allowed in Cable Tray
C.19- Single Conductor Cables Allowed in Cable Tray
C.20- Single Conductor Cables Allowed in Cable Tray

Informative Annex D Example D5(b) Optional Calculation for Multifamily Dwelling Served at 208Y/120 Volts, Three Phase

- Example D5(b) has been revised to accurately reflect the **neutral load calculation** for a three-phase system
- Previously, the **neutral load calculation** was based on a **single-phase system**
- The neutral load used in Example D5(b) was extracted from Example D4(a)
- The problem is that **Example D4(b)** is a **single-phase example** and calculations and **Example D5(b)** is a **three-phase example**

Informative Annex D Example D8 Motor Circuit Conductors, Overload Protection, and Short-Circuit and Ground Fault Protection

- Example D8 was revised to include the **30 hp motor as the largest motor** and the **example was expanded**
- Previous example was based on a 25 hp motor, which was not the largest motor in the circuit
- This mishap has been corrected and the calculations are now based on one of the 30 hp motors for the largest motor
- Text was also added to distinguish between the type motors considered in the calculations *(squirrel-cage vs. wound-rotor)*
- There is a difference in calculations between squirrel cage and wound rotor motors



Informative Annex H – Administration and Enforcement

- Revision to the opening paragraph of **Article 80** informs users of the Code that **Informative Annex H** is intended to provide a **template and sample language** for local jurisdictions adopting the *NEC*
- The opening paragraph of Article 80 now states that "Informative Annex H is not a part of the requirements of this NFPA document and is included for informational purposes only. **Informative Annex H is intended to provide a template and sample language for local jurisdictions adopting the *National Electrical Code*®.**"
- This revision provides **additional clarity** and **removes redundant language** and is intended to help in the process of local jurisdictions adopting the latest edition of the *NEC* in a timely manner

Informative Annex H - Administration and Enforcement

Informative Annex H is not a part of the requirements of the *NEC* (informational purposes only) and is intended to provide a template and sample language for local jurisdictions adopting the *NEC*

Analysis of Changes – 2020 *NEC*

End of Part 2 – NEC Chapters 5 through 9

INTERNATIONAL ASSOCIATION OF ELECTRICAL INSPECTORS
Established 1928
Keystone of the Electrical Industry

Training Presentation By:
International Association of Electrical Inspectors

INSTRUCTOR: Michael Thompson

Assistant Bureau Chief/ Electrical Supervisor for the Department of Commerce

I have 25 years' experience in training employees on the National electric code and safety. I carried contractor license in all 5 disciplines until fall of 2014. My ESI # 2705, I am also a member of the International Inspectors Association (IAEI). One of my duties with being the Supervisor is to keep our inspectors up to Standards with their code knowledge and this program is just one of others we will do to reach these goals. I can provide a complete resume upon request. Thank You.