Board of Building Standards

ELECTRICAL SAFETY INSPECTOR ADVISORY COMMITTEE
REQUEST FOR RECOMMENDATIONS

DATE: MARCH 24, 2023
TIME: 10:00 AM
LOCATION: NO MEETING THIS MONTH

Personnel Certification Applications

P-1 Baum, Justin ESI
Certification ID: 9060
Current certifications- None
Staff notes- requested journeyman card 3/13
ESIAC Recommendations:
Committee recommendation:

P-2 Davet, Michael - BO, BI, MI, ESI, NRIUI
Certification ID# 6018
Current certifications- RBO, PE since 1997
Staff notes: Has passed ESI and BI, MI exams.
ESIAC Recommendations:
Committee Recommendation:

P-3 Fisher, Kyle - ESI
Certification ID: 9068
Current certifications: none
Staff notes: Appears to meet requirements for exam. Recommend approval.
ESIAC Recommendations:
Committee Recommendation:

P-4 Glenn, Kevin - ESI
Certification ID: 9075
Current certifications: none
Staff notes: Holds Electrical Contractor Certification, recommend approval
ESIAC Recommendations:
Committee Recommendation:

P-5 Helmer, Jason - ESI
Certification ID: 9056
Current certifications: none
Staff notes: Recommend approval. Has completed exams.
ESIAC Recommendations:
Committee Recommendation:

P-6 Lopez, Jimmy - ESI
Certification ID: 9061
Current certifications- none
Staff notes- Appears to meet certification requirements for exams. Recommend approval.
ESIAC Recommendations:
Committee Recommendation:

P-7 Lovett, Brandon - ESI
Certification ID: 9066
Current certifications- none
Staff notes: Application reflects 7+ years electrician experience, certification by ABC. Has completed his E1 exam
ESIAC Recommendations:
Committee Recommendation:

P-8 Melbar, Thomas - ESI
Certification ID: 6039
Current certifications- RBO, RPE, RMI, RBI
Staff notes- Appears to meet certification requirements: recommend approval.
ESIAC Recommendations:
Committee Recommendation:

P-9 Oeder, Charles - ESI
Certification ID: 5409
Current certifications- none, previously approved for ESI exams
Staff notes: OCILB contractor, meets criteria, recommend approval.
ESIAC Recommendations:
Committee Recommendation:

P-10 Sharpe III, John - ESI, MI
Certification ID: 9065
Current certifications- none
Staff notes: Appears to meet requirements: Recommend approval for exams.
ESIAC Recommendations:
Committee Recommendation:

Continuing Education Applications for Review

ER-1 Electric Vehicle Power Transfer Systems and the 2020 NEC Part 2 (Matthews Electrical Services)
All certifications (4 hours)
Staff Notes: Part 1 was approved in January.
ESIAC Recommendation:
Committee Recommendation:

ER-2 One- and Two-Family Dwelling (2017 NEC) (IAEI Central)
All certifications (five 2-hour sessions)
Staff Notes: The five sessions include one session already presented February 9, for which retroactive approval is sought. The Committee can ignore the session listed for the year 2024. It will be submitted at the proper time.
ESIAC Recommendation:
Committee Recommendation:

ER-3 Soares Grounding and Bonding (2017 NEC) (IAEI Central)
All certifications (five 2-hour sessions)
Staff Notes: The five sessions include two sessions presented on January 12 and March 9, for which retroactive approval is sought. The Committee can ignore the two sessions listed for the year 2024. They will be submitted at the proper time.
ESIAC Recommendation:
Committee Recommendation:

ER-4 Western Section IAEI Special Meeting (IAEI Western)
All certifications (18.5 hours)
Staff Notes: The submitter has made it clear that, despite the way he filled out the application, this two-and-a-half-day meeting is not a multisession course. If approved, it will receive one course number.
ESIAC Recommendation:
Committee Recommendation:

File Attachments for Item:

P-1 Baum, Justin ESI

Certification ID: 9060

Current certifications- None

Staff notes- requested journeyman card 3/13

ESIAC Recommendations:

Committee recommendation:

Baum	Justin	
Last Name	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				

Baum	Justin	
Last Name	First Name	BBS Certification ID

SECTION 3: EMPLOYMENT/EDUCATION

Formal Education	Date Graduated
Marlington High School	1997
Related Vocational or Technical Training	**Years' Experience**
4 year Journeyman Apprenticeship	20 years 7 mos.
U.S. Military construction experience (MOS or other designation):	**Years' Experience**
Place of Employment:	**Years' Employed**
City of Alliance	7 mos.
University of Mount Union	15

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)

Baum	Justin	
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)*
University of Mount Union - various projects - Stadium lighting, outdoor indoor lighting, panel work - residential wiring	1972 Clark Ave Alliance OH 44601 330-829-6800	June 2007 June 2022
Ruhl Electric - Freshmark factory electric	closed	Jan. 2002 June - 2007
Pauli Electric - Case Farms factory electrical work	475 E. State St. Alliance OH 44601 (330)821-7438	June 2012 - current as needed
Total Experience on This Page (In Months):		300 months

Albricht Electric various projects — 22501 ~~Bayton~~ Alden Ave Alliance OH 44601 330-821-4471 — 10 months - as needed — 36 months

Baum	Justin	
Last Name	*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: Justin Baum

Subscribed and duly sworn before me according to law, by the above named applicant this day 9th of FEBRUARY in the year 2023 at 504 E MAIN ALLIANCE County of STARK and State of OH.

Notary Public: Tatiana Crockett

NOTARIAL SEAL STATE OF OHIO
TATIANA CROCKETT
NOTARY PUBLIC - OHIO
COMMISSION NO. 2021-RE-835810
MY COMMISSION EXPIRES 08/22/2026

File Attachments for Item:

P-2 Davet, Michael - BO, BI, MI, ESI, NRIUI

Certification ID# 6018

Current certifications- RBO, PE since 1997

Staff notes: Has passed ESI and BI, MI exams.

ESIAC Recommendations:

Committee Recommendation:

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

DAVET	MICHAEL	6018
Last Name	*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)

Res	Non-Res	Description	Certificate Number	Date Received
		Architectural Registration		
		P.E. Registration	61816	8/8/1997
Res	Non-Res			
☐	☐	Building Official Certification		
☐	☐	Plans Examiner Certification		
☒	☐	Building Inspector Certification	6018	2/10/2020
☐	☐	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		

Last Name	First Name	BBS Certification ID
DAVET	MICHAEL	6018

SECTION 3: EMPLOYMENT/EDUCATION

Formal Education	Date Graduated
The Ohio State University (B.S.C.E.)	6/92
Washington University (M.C.M.)	8/93
Related Vocational or Technical Training	**Years' Experience**
U.S. Military construction experience (MOS or other designation):	**Years' Experience**
Place of Employment:	**Years' Employed**
Woolpert / Contech	12 yrs
Northeastern Incorporated	18 yrs

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)

Davet | Michael | 6018
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: 61816
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)*
EXPERIENCE ON Application.	FILE WITH PREVIOUS	
Total Experience on This Page (In Months):		

12

DAVET	MICHAEL	6018
Last Name	*First Name*	*BBS Certification ID*

List Each Construction Project AND Specific Type of Work Performed	Name of Employer, Contact, Address, Telephone Number	Project Time: From_ To _ (MM/YY)
Experience on File	with prior Applications	
	Total Experience on This Page (In Months):	

DAVET | MICHAEL | 6018
Last Name | 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: [signature]

Subscribed and duly sworn before me according to law, by the above named applicant this day 3RD of MARCH 2023 in the year 2023 at BAINBRIDGE TWP., County of GEAUGA and State of OHIO.

Notary Public: [signature]

DAVE SEESE
Notary Public, State of Ohio
My Comm. Expires May 10, 2023
Recorded in Cuyahoga County

ICC INTERNATIONAL CODE COUNCIL®

INTERNATIONAL CODE COUNCIL

MICHAEL DAVET

The International Code Council attests that the individual named on this certificate has satisfactorily demonstrated knowledge as required by the International Code Council by successfully completing the prescribed written examination based on codes and standards then in effect, and is hereby issued this certification as:

Commercial Electrical Inspector

Given this day February 16, 2023

Certificate No. 8715164

Michael Wich, CBO
President, Board of Directors

Dominic Sims, CBO
Chief Executive Officer

INTERNATIONAL CODE COUNCIL, INC.
CERTIFIED

This certificate is the property of ICC and must be returned to ICC in the event of suspension or revocation of the certificate.

ICC INTERNATIONAL CODE COUNCIL®

INTERNATIONAL CODE COUNCIL

MICHAEL DAVET

The International Code Council attests that the individual named on this certificate has satisfactorily demonstrated knowledge as required by the International Code Council by successfully completing the prescribed written examination based on codes and standards then in effect, and is hereby issued this certification as:

Commercial Building Inspector

Given this day January 23, 2023

Certificate No. 8715164

Michael Wich, CBO
President, Board of Directors

Dominic Sims, CBO
Chief Executive Officer

INTERNATIONAL CODE COUNCIL, INC.
CERTIFIED

This certificate is the property of ICC and must be returned to ICC in the event of suspension or revocation of the certificate.

ICC INTERNATIONAL CODE COUNCIL®

INTERNATIONAL CODE COUNCIL

MICHAEL DAVET

The International Code Council attests that the individual named on this certificate has satisfactorily demonstrated knowledge as required by the International Code Council by successfully completing the prescribed written examination based on codes and standards then in effect, and is hereby issued this certification as:

Commercial Mechanical Inspector

Given this day January 27, 2023

Certificate No. 8715164

Michael Wich, CBO
President, Board of Directors

Dominic Sims, CBO
Chief Executive Officer

INTERNATIONAL CODE COUNCIL, INC.
CERTIFIED

This certificate is the property of ICC and must be returned to ICC in the event of suspension or revocation of the certificate.

Ohio Building Code Academy Training 2.0

May 2, 2022

Certification of Completion

This is to certify that

Michael B. Davet

successfully completed the requirements of the Ohio Building Code Academy 2.0
for the BUILDING OFFICIAL track.

TIMOTHY P. GALVIN
CHAIRMAN

Ohio Board of Building Standards

BBS2022-381
HSW: Yes
APPROVED FOR ALL CERTIFICATIONS

R

10018

[redacted]

APPLICATION

FOR

CERTIFICATION OF RESIDENTIAL BUILDING DEPARTMENT PERSONNEL

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.ohio.gov/dico/BBS.aspx

This application is hereby submitted to the Board of Building Standards pursuant to the provisions of Section 3781.10 of the Ohio Revised Code and 4101:7-3-01 of the Ohio Administrative Code.

1. APPLICANT INFORMATION:

Name: MICHAEL B. DAVET

[redacted]

2. SPECIFIC CERTIFICATE(S) BEING REQUESTED: (Please check appropriate box for certification(s) being sought.)

- [x] Res. Building Official
- [ ] Res. Plans Examiner
- [ ] Res. Plns. Ex. Trainee
- [ ] Res. Building Insp.
- [ ] Res. Bldg. Insp. Trainee
- [ ] Res. Mechanical Insp.
- [ ] Res. Mech. Insp. Trainee
- [ ] Res. I.U. Inspector

- [ ] Interim Application on File; All Interim Requirements Completed – Seek Full Certification

3. LIST ANY OHIO LICENSE, CERTIFICATE, OR REGISTRATION HELD: (mark "T" if trainee):

Description	Certificate Number	Date Received
Architectural Registration		
P.E. Registration	61816	8/97
Res. / Non-Res.		
[ ] Res. [ ] Non-Res. Building Official Cert.		
[ ] Res. [ ] Non-Res. Plans Examiner Cert.		
[x] Res. [ ] Non-Res. Building Inspector Cert.	871516 4	2/17
[ ] Res. [ ] Non-Res. Mechanical Inspector Cert.		
Electrical Plans Examiner Cert.		
Plumbing Plans Examiner Cert.		
Mechanical Plans Examiner Cert.		
Fire Protection Inspector Cert.		
Electrical Safety Inspector Cert.	8715164	2/17
Plumbing Inspector Cert.		
Fire Safety Inspector Cert.		
Fire Protection System Designer Cert.		
Medical Gas Piping Inspector		
Other Certification/License		

4. EMPLOYMENT/EDUCATION:

a. Formal Education:	Date Graduated
The Ohio State University - B.S.C.E	6/92
Washington University - MSCM	8/93
b. Related Vocational or Related Technical Training:	**Years Experience**
	-
	-
c. U.S. Military construction experience (MOS or other designation):	**Years Experience**
	-
	-
d. Place of Employment: Woolbert Consultants	Years Employed 3
Contech Engineered Solutions	9
Northeastern Inc.	13

RECEIVED
AUG 16 2018
BOARD OF BUILDING STANDARDS

Board of Building Standards

APPLICATION FOR CERTIFICATION OF BUILDING DEPARTMENT PERSONNEL

Page 2

5. EXPERIENCE AS AN EMPLOYEE OF A BBS CERTIFIED RES/NON-RES BUILDING DEPARTMENT:

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

6. EXPERIENCE : Refer to Experience Requirements Listed in 4101:7-3-01 OAC and 3783 ORC (**DO NOT SUBSTITUTE WITH OTHER RESUMES**). **State the specific duties and type of work performed for each position listed. Give only information which relates directly to the information you provide. Provide letters from certified inspectors, employers, or contractors verifying your experience. Submit copies of any certificates, diplomas, licenses, or DD Form 214 received.**

List Each Construction Project AND **Specific Type of Work Performed**	Name of Employer, Contact, Address, Telephone Number	Project Time: From_To_ (MM/DD/YY)
• SITE CIVIL DESIGN ENGINEER ON MULTIPLE OF LARGE AND SMALL CONSTRUCTION PROJECTS • MEIJER • WRIGHT STATE • TNT TRUCKING • WALMART	WOOLPERT 4454 IDEA Center Blvd DAYTON, Ohio 45430 937-461-5660	11/93 - 6/96
• ENGINEER ON MULTIPLE LARGE COMMERCIAL/RESIDENTIAL PROJECTS. Specification Compliance, ASTM, AWWA AASHTO.	CONTECH ENGINEERED SOLUTIONS 9025 Center Pt Dr. West Chester, Twp, Ohio 45069 1-800-338-1122	6/96 - 11/05
TOTAL EXPERIENCE ON THIS PAGE (IN MONTHS):		128

NOTE: Only experience **DIRECTLY** related to the types of buildings or structures regulated by the Ohio Building Codes shall be acceptable for credit for any certification, pursuant to rule 4101:7-3-01.

Board of Building Standards

APPLICATION FOR CERTIFICATION OF BUILDING DEPARTMENT PERSONNEL

 (You may make additional copies of this page if necessary.)

6. **EXPERIENCE (CONT.):** Refer to Experience Requirements Listed in 4101:7-3-01 OAC and 3783 ORC (**DO NOT SUBSTITUTE WITH OTHER RESUMES**). **State the specific duties and type of work performed for each position listed. Give only information which relates directly to the information you provide. Provide letters from certified inspectors, employers, or contractors verifying your experience. Submit copies of any certificates, diplomas, licenses, or DD Form 214 received.**

List Each Construction Project AND **Specific Type of Work Performed**	Name of Employer, Contact, Address, Telephone Number	Project Time: From_To_ (MM/DD/YY)
OWNER : GENERAL CONTRACTING COMPANY, MULTIPLE RESIDENTIAL / COMMERCIAL PROJECTS COMPLETED. BOTH PUBLIC AND PRIVATE, OPEN SHOP. BONDABLE TO 2MM DOLLARS	NORTHEASTERN INC P.O. BOX 23676 CHAGRIN FALLS, OHIO 44023 216.533.3779	11/05 - present
	TOTAL EXPERIENCE ON THIS PAGE (IN MONTHS):	157

NOTE: Only experience **DIRECTLY** related to the types of buildings or structures regulated by the Ohio Building Codes shall be acceptable for credit for any certification, pursuant to rule 4101:7-3-01.

Board of Building Stands

APPLICATION FOR CERTIFICATION OF BUILDING DEPARTMENT PERSONNEL

7. OFFENSES:

a. Have you ever been convicted of any felony or crime involving moral turpitude ? YES ☐ NO ☒
If you answered "Yes" please explain below:

b. If you have served in the U.S. armed services, have you been discharged under honorable conditions? YES ☐ NO ☒
If you answered "No" please explain below:

8. CERTIFICATION:

I solemnly swear or affirm that the answers I have made to each and all of the questions in this application are complete and true to the best of my knowledge and belief. I hereby waive all provisions of law forbidding colleges or universities that I have attended, or past employers, from disclosing any knowledge or information which they thereby acquired relevant to my employment and I hereby consent that they may disclose such knowledge or information to the 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

of ______________ in the year __________ at ______________, County of ______________

and State of ____________.

SEAL

Notary Public ______________________

[redacted]

WORK EXPERIENCE

Northeastern, Inc., Chagrin Falls, Ohio **11/2005 – Present**
Senior Project Manager

- Responsible for bidding, buying, building , gaining final approval of commercial and residential projects
- Manage annual revenues of $500K-$1MM
- Plan and design all stages of construction projects, managing subcontractors, equipment and materials procurement
- Obtain required permits from local authorities
- Supervise crews of up to 25 master carpenters, journeyman drywall hangers, foundation, masonry and general laborer employees
- Proven excellence with multiple repeat customer (public/private) projects

Contech Engineered Solutions, Cleveland, Ohio **06/1995 – 11/2005**
Business Development Manager (Technical Sales)

- Managed $20M of business within multi-state area
- Prepared design recommendations for civil engineering projects
- Consulted and assisted with governmental municipalities, civil engineers, contractors, and private developers to ensure compliances with specifications and delivery
- Managed site civil interaction to assure specification, installation, and design conformance
- ASTM / AWWA standards development

Woolpert Consultants, Dayton, Ohio **11/1993 – 06/1995**
Project Engineer – Land Development Group

- Involved in site civil design and analysis
- Project specification and blueprint development involving earthworks, storm water control (NPDES), and underground conduit system (water/wastewater) design, including roadway design
- Obtained governmental agency approvals, including zoning, through contractor inspection and completion

ORGANIZATIONS AND VOLUNTEERISM

Member – American Society of Civil Engineers (ASCE)
Member – Construction Management Association of America (CMAA)
Registered Professional Engineer – State of Ohio
Member – Ohio Onsite Wastewater Association
Certified CYO Youth Athletics Coach (coach football, basketball and baseball)
Attended several SEAK courses
ICC Certified B1 and E1 Inspector

EDUCATION/CERTIFICATION

Washington University, St. Louis, Missouri **06/1992 – 08/1993**
Masters of Science in Construction Management (M.S.C.M.)
(Dual M.S.C.E. and M.B.A. program)

The Ohio State University, Columbus, Ohio **08/1987 – 06/1992**
Bachelors of Science in Civil Engineering (B.S.C.E.)

State of Ohio

Be It Known That

Michael Bryan Davet

having submitted satisfactory evidence of fitness as to age, character, ability, education and practical experience in accordance with the provisions of the Ohio Revised Code, is granted this

Certificate of Registration

and is hereby authorized to practice in this State as a

Professional Engineer

as long as this Certificate is not revoked and is renewed acc[illegible] [illegible]low.

In Testimony Whereof *[illegible] hand and seal this* 8th *day of* [illegible] 19[illegible]

ISSUED BY THE
OHIO STATE BOARD OF REGISTRATION
FOR PROFESSIONAL ENGINEERS
AND SURVEYORS

SERIAL NO. 61816

CHAIRMAN

SECRETARY

INTERNATIONAL CODE COUNCIL

MICHAEL B DAVET

The International Code Council attests that the individual named on this certificate has satisfactorily demonstrated knowledge as required by the International Code Council by successfully completing the prescribed written examination based on codes and standards then in effect, and is hereby issued this certification as:

Residential Building Inspector

Given this day of February 8, 2017

Certificate No. 8715164

M Dwayne Garriss
President, Board of Directors

Dominic Sims
Chief Executive Officer

INTERNATIONAL CODE COUNCIL, INC.
CERTIFIED

ICC INTERNATIONAL CODE COUNCIL

This certificate is the property of ICC and must be returned to ICC in the event of suspension or revocation of the certificate.

INTERNATIONAL CODE COUNCIL

MICHAEL B DAVET

The International Code Council attests that the individual named on this certificate has satisfactorily demonstrated knowledge as required by the International Code Council by successfully completing the prescribed written examination based on codes and standards then in effect, and is hereby issued this certification as:

Residential Electrical Inspector

Given this day of March 2, 2017

Certificate No. 8715164

M Dwayne Garriss
President, Board of Directors

INTERNATIONAL CODE COUNCIL, INC.
CERTIFIED

Dominic Sims
Chief Executive Officer

ICC INTERNATIONAL CODE COUNCIL

File Attachments for Item:

P-3 Fisher, Kyle - ESI

Certification ID: 9068

Current certifications: none

Staff notes: Appears to meet requirements for exam. Recommend approval.

ESIAC Recommendations:

Committee Recommendation:

Fisher — *Last Name* | Kyle — *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				

Fisher	Kyle	
Last Name	*First Name*	*BBS Certification ID*

SECTION 3: EMPLOYMENT/EDUCATION

Formal Education	Date Graduated
Norton High school	2013
Related Vocational or Technical Training	**Years' Experience**
Fortis college	1
U.S. Military construction experience (MOS or other designation):	**Years' Experience**
Place of Employment:	**Years' Employed**
Thompson electric	3
Blind and sons heating, cooling, plumbing, electric	5

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)

Fisher	Kyle	
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)*
Portage Tower Apartments Cuyahoga Falls, Retro Fitting new panels	Thompson electric, 49 North moreland Ave Munroe Falls, OH, 44262 330-686, 2300	November 2022- Febuary 2023 (4 months)
Summit county HWAP Install exhaust Fant switch	Thompson electric, 49 North more land Ave M. Falls, OH, 44262 330.686. 2300	12/11/22 (1 day)
Total Experience on This Page (In Months):	4 months	

Fisher	Kyle	
Last Name	*First Name*	*BBS Certification ID*

List Each Construction Project AND Specific Type of Work Performed	Name of Employer, Contact, Address, Telephone Number	Project Time: From_ To _ (MM/YY)
DMR Beauty LLC 34 1/2 Munroe Falls Ave, Munroe Falls OH 44262 Rough and Finish + panel	Thompson electric, 49 North moreland Ave M. Falls, OH, 44262 330-686-2300	August 8th 2022-September 13th 2022 (1.2 months)
Summit County land Bank. 2644 Kilcore st Barberton OH 44203 panel, service, and re-wire home + find and repair stolen wire	Thompson electric 49 Northmoreland Ave M. Falls, OH, 44262 330-686-2300	September 1st 2021 - October 1st 2021 (1 month)
Jeff Purrell 6060 Beston Rd Vally City Set temp pole + wire new home	Thompson electric 49 North more land Ave. M. Falls, OH, 44262 330-686-2300	December 17th 2019 - January 12th 2020 (1 month)
Jacob Grimm 3199 Fallen Brook Dr Brunswick wire pool	Thompson electric 49 North moreland Ave M. Falls, OH, 44262 330-686-2300	September 3rd 2020 - September 5th 2020 (3 days)
Dan Mc Shane 1860 Parker LN Twinsburg, wire new addition	Thompson electric 49 North moreland Ave M. Falls, OH, 44262 330-686-2300	August 24th 2020 - September 2nd 2020 (10 Days)
	Total Experience on This Page (In Months):	4 months

Fisher	Kyle	
Last Name	*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: Kyle Fisher

Subscribed and duly sworn before me according to law, by the above named applicant this day 27th of February in the year 2023 at Summit 4:43pm, County of Summit and State of OHIO.

Notary Public: Mary L Fisher

NOTARIAL SEAL

Mary L. Fisher
Resident Summit County
Notary Public, State of Ohio
My Commission Expires: 5.23.2024

Date: 6/15/2015

Fortis College

2545 Bailey Road
Cuyahoga Falls, OH 44221

Student: Kyle Fisher **Student ID:** [redacted] **LDA:** 6/11/2015

Address: [redacted]

Grade History

Course Code	Course Description	Class End Dt	Credits Atmpt	Credits Earned	Grade	Quality Points
Program:	Electrical Systems Technician					
Enrollment#:	F14070757	Enroll Status: Graduate				
Start Date:	9/22/2014	Grad Date: 6/13/2015				
Term: 09/22/2014	**TECHNICAL 09/22/2014**					
EL 100	Introduction to Electrical Technician Trades	10/31/2014	8.00	8.00	A-	29.60
			8.00	8.00		29.60
Term GPA: 3.70	Cum GPA: 3.70					
Term: 11/03/2014	**TEHCNICAL 11/03/2014**					
EL 105	Introduction to Electrical Technician Trades II	12/12/2014	8.00	8.00	A	32.00
			8.00	8.00		32.00
Term GPA: 4.00	Cum GPA: 3.85					
Term: 12/15/2014	**TECHNICAL 12/15/2014**					
EL 170	Electronics for Electricians II	2/6/2015	8.00	8.00	A	32.00
			8.00	8.00		32.00
Term GPA: 4.00	Cum GPA: 3.90					
Term: 02/09/2015	**TECHNICAL 02/09/2015**					
EL 150	Electronics for Electricians	3/19/2015	8.00	8.00	A	32.00
			8.00	8.00		32.00
Term GPA: 4.00	Cum GPA: 3.93					
Term: 03/23/2015	**TEHCNICAL 03/23/2015**					
EL 180	Home Systems Integration II	4/30/2015	8.00	8.00	A	32.00
			8.00	8.00		32.00
Term GPA: 4.00	Cum GPA: 3.94					
Term: 05/04/2015	**Technical 05/04/2015**					
EL 175	Home Systems Integration	6/11/2015	8.00	8.00	A	32.00

Course Code	Course Description	Credits Attempted	Credits Earned	Grade	Quality Points
		8.00	8.00		32.00
Term GPA: 4.00	Cum GPA: 3.95				
Electrical Systems Technician	GPA: 3.95	48.00	48.00		

Degrees awarded for Electrical Systems Technician enrollment

Degree	Date Awarded	Date Cleared
Diploma	6/13/2015	6/14/2015

*** End of Transcript ***

Authorized Signature Sharon Keeper Registrar Date 6/16/2015

** Indicates Retaken Course
R* Indicates Retaken Override

Not official unless signed by registrar.

Fortis College

On the recommendation of the Faculty of the
Electrical Systems Department
of the College does hereby confer upon

Kyle J. Fisher

the diploma of

Electrical Systems Technician

with all the rights and privileges appertaining thereto. Given at Cuyahoga Falls, Ohio
this thirteenth day of June, two thousand and fifteen.

Carson Burke
Campus President

FORTIS
COLLEGE

Stephanie Newman
Dean of Education

Kyle J. Fisher

[redacted] [redacted]

Objective:

To find an employer where I can utilize my varied knowledge of the electrical trade, enabling me to continue to build a career in the electrical field.

Education:

Fortis College, Cuyahoga Falls, OH — Graduated: June 2015
Diploma, Electrical Systems Technician
Awards Received: Dean's List, President's List & Perfect Attendance

10 Hour OSHA Safety Training Course — August 2014

Norton High School, Norton OH — Graduated: June 2013
Web Programming & Design

Skills:

- Residential & Commercial Wiring, Pipe Bending & Troubleshooting
- Testing and Maintaining Generator Systems
- Digital Home Integration systems & Networks
- Repair of low voltage electronic systems
- Audio, Video, Security, Fire Alarm, and Tele-data
- Ability to follow electrical code manuals to install and repair electrical systems
- Understanding of electrical codes
- Competent with hand tools, power tools, electronic testing equipment and understanding schematics and blueprints
- Trained in Next Star Service system and salesS

Experience:

Thompson Electric
August 2020 - Present
Responsibilities include:

- Working with Customers to understand their situations and providing them with proactive solutions for their residential and commercial electrical systems
- Quoting work for customers
- New home wiring
- Understanding blue prints and requirements for system integrations
- Re-wiring homes
- Troubleshooting electrical systems
- Ordering parts and materials
- Clearing fire damaged properties
- Teaching apprentices safe common practices in the electrical field
- Installing lighting, ceiling fans, outlets, switches, timers etc.

Blind and Sons Heating, Cooling, Plumbing & Electric
July 2015 – August 2020
Responsibilities include:

- Quoting work for customers and point of sales
- Ordering parts and materials
- Installing electrical service and panel systems
- Re-wiring homes
- Generator installations and Maintenance
- Troubleshooting electrical systems
- Installing lighting, ceiling fans, outlets, switches, timers etc.

Akron Design and Costume
(Seasonal) October 2009 – 2014
Responsibilities include:

- Shipping and Receiving
- Stock, Inventory and Bar coding
- Maintenance
- Maintaining Website
- Running Cash Register

File Attachments for Item:

P-4 Glenn, Kevin - ESI

Certification ID: 9075

Current certifications: none

Staff notes: Holds Electrical Contractor Certification, recommend approval

ESIAC Recommendations:

Committee Recommendation:

Board of Building Standards

Application for Interim Certification, Building Department Personnel

Glenn
Last Name

Kevin
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)

Res	Non-Res	Description	Certificate Number	Date Received
		Architectural Registration		
		P.E. Registration		
☐	☐	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		
		State of OH Fire Protection	54.45.0016	1982
		Ohio Electrical contractors	17422	1983

Glenn
Last Name

Kevin
First Name

BBS Certification ID

SECTION 3: EMPLOYMENT/EDUCATION

Formal Education Walnut Ridge HS.	Date Graduated
	1974
Related Vocational or Technical Training ABC 4yr	Years' Experience
Apprenticeship Electrical Course	78-79-80-81
U.S. Military construction experience (MOS or other designation):	Years' Experience
FT Leonard Wood Electrician	81-83
Course (Army Reserves)	
Place of Employment:	Years' Employed
G & G Electric LLC	1990-2022
D+M Electric LLC	2022-2023

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)

Board of Building Standards

Application for Interim Certification, Building Department Personnel

Glenn
Last Name

Kevin
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)*
Owner of G+G Electric - Residential Houses, ~~wiring~~, Services, undergrounds, Temps, Low Voltage. Light Commercial work Subway + Etna, Licking County Township Hall. MC Cable + EMT	7180 Palmer Rd SW Pataskala, OH 43062 614-207-4920	32 YRS
Total Experience on This Page (In Months):		32 yrs

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

Glenn	Kevin	
Last Name	*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: Kevin A Glenn

Subscribed and duly sworn before me according to law, by the above named applicant this day 8 of March in the year 2023 at Pataskala, County of Licking and State of Ohio.

Notary Public:

COLIN E MINKOS - NOTARY PUBLIC
COMM EXP: JUL 19, 2027
STATE OF OHIO

Any changes in information must be submitted within 30 days to:

Bureau of Testing & Registration
PO BOX 529
Reynoldsburg, Ohio 43068
614-752-7126
614-995-4206 (fax)
webfmtr@com.state.oh.us

This license shall be carried on your person while performing the listed activities.

State of Ohio
Department of Commerce
Division of State Fire Marshal

FIRE PROTECTION LICENSE
KEVIN G GLENN
54.45.0016
Expiration Date: 01/02/2024

Signature ______________________________
This card shall be on your person while performing listed activities.

Ohio Department of Commerce
Division of State Fire Marshal
Bureau of Testing & Registration
8895 E Main Street, PO Box 529

Department of Commerce

Division of Industrial Compliance
Ohio Constructions Industry
Licensing Board O.C.I.L.B.

Mike DeWine
Sheryl Maxfield

GLENN, KEVIN G
[redacted]

Mike DeWine
Governor

Sheryl Maxfield
Director

Electrical
CONTRACTOR'S LICENSE

Ohio License # 17422
Expiration Date: 03/31/2023

KEVIN G GLENN
D & M ELECTRIC LLC
EMPLOYEE

Carol A. Ross
Board Secretary

William Koester
Administrative Chairperson

This is YOUR license. Plan Approvals obtained with YOUR license and posting of YOUR license indicates that YOU and YOUR liability insurance are assuming all responsibility for any projects performed under this license.

Mike DeWine
Governor

Sheryl Maxfield
Director

LICENSE MUST BE POSTED ON JOB SITE

OHIO CONSTRUCTION INDUSTRY LICENSING BOARD

Electrical

CONTRACTOR'S LICENSE

KEVIN G GLENN

D & M ELECTRIC LLC

EMPLOYEE

Ohio License# **17422**

Expiration Date: **March 31, 2023**

STATE OF OHIO

LICENSE MUST BE POSTED ON JOB SITE

Carol A. Ross
Board Secretary

William Koester
Administrative Chairperson

DIC 3530 Rev 3/2020

File Attachments for Item:

P-5 Helmer, Jason - ESI

Certification ID: 9056

Current certifications: none

Staff notes: Recommend approval. Has completed exams.

ESIAC Recommendations:

Committee Recommendation:

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

Helmer	Jason	
Last Name	*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	

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(Mark "T" If Trainee)

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☐	☐	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			Ky ESI 2B2587, ME65797	10/22/20-9/4/20
Plumbing Inspector Certification				
Fire Safety Inspector Certification				
Fire Protection System Designer Certification				
Medical Gas Piping Inspector Certification				

Helmer	Jason	
Last Name	*First Name*	*BBS Certification ID*

SECTION 3: EMPLOYMENT/EDUCATION

Formal Education	Date Graduated
Associates in Applied Science, Electrical Technology	March, 2020
Associate in Applied Science, Industrial Maintenance Technician	May, 2015
Related Vocational or Technical Training	Years' Experience
Gateway Community Technical College	4 years
U.S. Military construction experience (MOS or other designation):	Years' Experience
Place of Employment:	Years' Employed
Electric Inspection, 2012 Callie Way, Ste. #102, Union, Kentucky 41091	2 yrs., 10 months

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)

Helmer	Jason	
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)*
Total Experience on This Page (In Months):		

Helmer	Jason	
Last Name	*First Name*	*BBS Certification ID*

List Each Construction Project AND Specific Type of Work Performed	Name of Employer, Contact, Address, Telephone Number	Project Time: From_ To _ (MM/YY)
Worked as an electrical inspector trainee and then on my own as an electrical inspector inspecting and approving residential, commercial and light industrial projects.	Inspection Bureau LLC dba: Electric Inspection 2012 Callie Way, Suite #102 Union, Kentucky 41091 Steve Helmer 859.746.9111 859.393.8870 shelmer@nkyei.com	4/06/2020 to present.
During my employment and as part of my normal job responsibility, I worked on the electrical and instrumentation systems of the industrial power generating facility in maintaining, trouble shooting, repairing, replacing, installing and calibrating the electrical and instrumentation systems, wiring and components.	Kentucky Utilities Ghent power Station 9485 US 41 Ghent, Kentucky 41045 Larry Handcock 812.599.2565	3/28/2016 - 2/27/2020
Installation of electrical wiring, equipment and components in commercial facilities.	Kraft Electrical and Communication Services 5710 Hillside Drive Cincinnati, Ohio 45233 513.467.0500 Danny Kraft	5/14/2014-8/15/2014 10/5/2015-3/25/2016
Installation of electrical wiring in residential and light commercial facilities.	Santoro Electric 12094 Jockey Club Drive Union, Kentucky 41091 Sal Santoro 513.227.8840 santoroelect@zoomtown.com	4/04/2010 - 5/02/2014
	Total Experience on This Page (In Months):	139

Helmer	Jason	
Last Name	*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:

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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: Jason Helmer

Subscribed and duly sworn before me according to law, by the above named applicant this day 13th of February in the year 2023 at 3:50pm, County of Boone and State of Kentucky.

Notary Public: Debbie S. Helmer Boone County, Ky
KYNP13717

SEAL

ME65797 Master Electrician

Contact (mailto:?subject=[License %23ME65797])

Business:	Status:	Effective: 9/4/2020
Jason E Helmer	Inactive	**Expired: 3/31/2021**

Contacts

Contacts

Licensee: Jason E Helmer

Employer: Jason E Helmer

2B0002587 Electrical Inspector General

Contact (mailto:?subject=[License %232B0002587])

Business:	Status:	Effective: 4/1/2022
Jason E Helmer	Active	Expires: 3/31/2023

Contacts

Contacts

Licensee: Jason E Helmer

National Certification Program for Construction Code Inspectors

Name: Jason Helmer
[redacted]

Exam: Electrical Inspector – One- and Two-Family Dwellings
Test Date: 7/23/2020
Status: Pass

Congratulations! You have passed the Electrical Inspector – One- and Two-Family Dwellings examination for the National Certification Program for Construction Code Inspectors (NCPCCI). A score of 70% or higher is required for passing. **Please Note: Numerical total score and diagnostic code information are not reported to passing candidates to avoid the potential misuse of scores in the workplace.**

In order to obtain your license or certificate, please contact the appropriate code organization listed in the front of the NCPCCI Candidate Information Bulletin. They will provide you with the information and/or application you need to apply for your certificate or license.

If you have any questions or need a copy of the Registration Form or Bulletin, please visit our Web site at www.prometric.com, call 800.864.5309, or write to:

Prometric
ATTN: NCPCCI Registration
1260 Energy Lane
St. Paul, MN 55108

7/23/2020
P.C.

National Certification Program for Construction Code Inspectors

Name: Jason Helmer
[redacted]

Examination: Electrical General
Exam Date: 9/9/2020
Status: Pass

Congratulations! You have passed the Electrical General examination for the National Certification Program for Construction Code Inspectors (NCPCCI). A score of 70% or higher is required for passing. **Please Note: Numerical total score and diagnostic code information are not reported to passing candidates to avoid the potential misuse of scores in the workplace.**

In order to obtain your license or certificate, please contact the appropriate code organization listed in the front of the NCPCCI Candidate Information Bulletin. They will provide you with the information and/or application you need to apply for your certificate or license.

If you have any questions or need a copy of the Registration Form or Bulletin, please visit our Web site at www.prometric.com, call 800.864.5309, or write to:

Prometric
ATTN: NCPCCI Registration
7941 Corporate Drive
Nottingham, MD 21236

9.9 2020

(/Public/Home)

Sign Up (https://dept-hbc-ky smartgovcommunity.com/Public/OpenIdConnectAuthorizationCodeFlow/InitiateAuthorizationCodeFlow)
or Log In (https://dept-hbc-ky smartgovcommunity.com/Public/OpenIdConnectAuthorizationCodeFlow/InitiateAuthorizationCodeFlow)

Advanced Search

jason e helmer

SEARCH

Enter at least 2 characters

2 results

2B0002587
Electrical Inspector General — Jason E Helmer
Issued, 10/22/2020

ME65797
Master Electrician — Jason E Helmer
Issued, 9/4/2020

National Student Clearinghouse®
2300 Dulles Station Blvd., Suite 220, Herndon, VA 20171
PH (703) 742-4200 FX (703) 318-4058
www.studentclearinghouse.org

DegreeVerify Certificate

Transaction ID#:	213459445	**Date Requested:**	07/15/2020 14:06 EDT
Requested By:	JASON HELMER	**Date Notified:**	07/15/2020 14:08 EDT
Status:	Confirmed		
Fee:	$12.50		

INFORMATION YOU PROVIDED

Subject Name:	**JASON** First Name	**EDWARD** Middle Name	**HELMER** LastName
Name Used While Attending School: (if different from above)	**JASON** First Name	Middle Name	**HELMER** LastName
Date of Birth:	**03/12/1979** mm/dd/yyyy		
School Name:	**GATEWAY COMMUNITY AND TECHNICAL COLLEGE**		
Degree Award Year:	**2020**		
Attempt To:	**Verify a degree**		

INFORMATION VERIFIED

Name On School's Records:	**JASON EDWARD HELMER**
Date Awarded:	**05/10/2020**
Degree Title:	**AAS**
Official Name of School:	**GATEWAY COMMUNITY AND TECHNICAL COLLEGE**
Major Course(s) of Study:	**ELECTRICAL TECHNOLOGY**
(and NCES CIP Code, if available):	**460302**

INFORMATION VERIFIED

Name On School's Records:	**JASON EDWARD HELMER**
Date Awarded:	**12/15/2019**

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www.studentclearinghouse.org

DegreeVerify Certificate

Degree Title:	CERT
Official Name of School:	GATEWAY COMMUNITY AND TECHNICAL COLLEGE
Major Course(s) of Study:	RESIDENTIAL ELECTRICITY I
(and NCES CIP Code, if available):	460302

INFORMATION VERIFIED

Name On School's Records:	JASON EDWARD HELMER
Date Awarded:	12/15/2019
Degree Title:	CERT
Official Name of School:	GATEWAY COMMUNITY AND TECHNICAL COLLEGE
Major Course(s) of Study:	ELECTRICIAN TRAINEE LEVEL I
(and NCES CIP Code, if available):	460302

INFORMATION VERIFIED

Name On School's Records:	JASON EDWARD HELMER
Date Awarded:	12/15/2019
Degree Title:	CERT
Official Name of School:	GATEWAY COMMUNITY AND TECHNICAL COLLEGE
Major Course(s) of Study:	ELECTRICIAN TRAINEE LEVEL II
(and NCES CIP Code, if available):	460302

INFORMATION VERIFIED

Name On School's Records:	JASON EDWARD HELMER
Date Awarded:	12/15/2019
Degree Title:	CERT
Official Name of School:	GATEWAY COMMUNITY AND TECHNICAL COLLEGE
Major Course(s) of Study:	RESIDENTIAL ELECTRICITY II
(and NCES CIP Code, if available):	460302

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DegreeVerify Certificate

INFORMATION VERIFIED

Name On School's Records:	JASON EDWARD HELMER
Date Awarded:	12/09/2018
Degree Title:	CERT
Official Name of School:	GATEWAY COMMUNITY AND TECHNICAL COLLEGE
Major Course(s) of Study:	INTEGRATED MANUFACTURING TECHN
(and NCES CIP Code, if available):	150613

INFORMATION VERIFIED

Name On School's Records:	JASON EDWARD HELMER
Date Awarded:	05/22/2015
Degree Title:	CERT
Official Name of School:	GATEWAY COMMUNITY AND TECHNICAL COLLEGE
Major Course(s) of Study:	IND MAIN MACHINISTS MECHANIC
(and NCES CIP Code, if available):	470303

INFORMATION VERIFIED

Name On School's Records:	JASON EDWARD HELMER
Date Awarded:	05/22/2015
Degree Title:	CERT
Official Name of School:	GATEWAY COMMUNITY AND TECHNICAL COLLEGE
Major Course(s) of Study:	INDUSTRIAL MAINTEN ELECTR MECH
(and NCES CIP Code, if available):	470303

INFORMATION VERIFIED

Name On School's Records:	JASON EDWARD HELMER
Date Awarded:	05/22/2015
Degree Title:	CERT

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PH (703) 742-4200 FX (703) 318-4058
www.studentclearinghouse.org

DegreeVerify Certificate

Official Name of School:	GATEWAY COMMUNITY AND TECHNICAL COLLEGE
Major Course(s) of Study:	INDUSTRIAL MAINT MECH LVL I
(and NCES CIP Code, if available):	470303

INFORMATION VERIFIED

Name On School's Records:	JASON EDWARD HELMER
Date Awarded:	05/22/2015
Degree Title:	AAS
Official Name of School:	GATEWAY COMMUNITY AND TECHNICAL COLLEGE
Major Course(s) of Study:	INDUSTRIAL MAINTENANCE TECH
(and NCES CIP Code, if available):	470303

INFORMATION VERIFIED

Name On School's Records:	JASON EDWARD HELMER
Date Awarded:	05/22/2015
Degree Title:	CERT
Official Name of School:	GATEWAY COMMUNITY AND TECHNICAL COLLEGE
Major Course(s) of Study:	INDUSTRIAL MAINT MECH LVL II
(and NCES CIP Code, if available):	470303

INFORMATION VERIFIED

Name On School's Records:	JASON EDWARD HELMER
Date Awarded:	05/20/2014
Degree Title:	CERT
Official Name of School:	GATEWAY COMMUNITY AND TECHNICAL COLLEGE
Major Course(s) of Study:	EXPLORATORY MACHINING I
(and NCES CIP Code, if available):	480503

Affidavit

State of Ohio)

) S.S.

County of Hamilton)

I, Kelly DeGregorio, of Kraft Electrical & Telecommunications Services, MAKE OATH AND AFFIRM AND SAY THAT:

1. Jason Helmer was an employee of Kraft Electrical & Telecommunications Services.
2. That his dates of employment were 5/14/2014 to 8/15/2014, 10/5/2015 to 3/25/2016.
3. That his work experience consisted of the installation of building electrical wiring, equipment and components in commercial properties.

STATE OF OHIO

COUNTY OF HAMILTON

SUBSCRIBED AND SWORN TO BEFORE ME, on the)
28, day of August, 2020)
)
Kathy M. Dinkelacker)
Signature

Signature

Kelly DeGregorio
Name

Seal

NOTARIAL SEAL STATE OF OHIO

KATHY M. DINKELACKER
Notary Public, State of Ohio
My Commission Expires 09-04-2022

NOTARY PUBLIC

My Commission Expires: 9/4/22

Affidavit

Commonwealth of Kentucky)

) S.S.

County of Jeffferson)

I, Danielle Stallard, Human Resources Manager, ________, MAKE OATH AND AFFIRM AND SAY THAT:

1. Jason Helmer was employed by Kentucky Utilities from 3/28/16 through 2/27/2020 at the Ghent Ky. Generating station.
2. Jason worked in the I & E department at the Ghent Kentucky power generating facility.
3. That during his employment and as part of his normal job responsibility he worked on the electrical and instrumentation systems of the industrial power generating facility in maintaining, trouble shooting, repairing, replacing, installing, and calibrating the electrical and instrumentation systems, wiring and components.
4. That all of the above is true, correct and complete and is an accurate representation of his employment duties, responsibility, experience and work history.

COMMONWEALTH OF KENTUCKY

COUNTY OF Jefferson

SUBSCRIBED AND SWORN TO BEFORE ME, on the)

3 , day of September 2020) Danielle Stallard

Signature

Betty L. Brinly

Signature

Seal

Danielle Stallard

Print Name

NOTARY PUBLIC

My Commission Expires: June 21, 2022

BETTY L. BRINLY STATE OF KENTUCKY NOTARY PUBLIC JEFFERSON COUNTY

MY COMMISSION EXPIRES: JUNE 21, 2022

Affidavit

Commonwealth of Kentucky)

) S.S.

County of Boone)

I, Steve Helmer, of Inspection Bureau LLC, dba: Electric Inspection, 2012 Callie Way, Suite #102, Union, Kentucky, Boone County, Kentucky, MAKE OATH AND AFFIRM AND SAY THAT:

1. Jason Helmer has been employed by Electric Inspection as an Electrical Inspector trainee and then as a full-time electrical inspector from 4/06/2020 to present,
2. That his duties have consisted in training and then on his own of assisting the four electrical inspectors in conducting electrical inspections in residential, commercial, and industrial properties and facilities, verifying compliance, and identifying deficiencies with installed electrical work, writing defective work notices with itemized violations and code sections, resolving field problems with site electricians, and maintaining required documentation of all electrical inspections.
3. That all the above is true, correct, and complete and is an accurate representation of his employment duties, responsibility, experience, and work history.

COMMONWEALTH OF KENTUCKY

COUNTY OF BOONE

SUBSCRIBED AND SWORN TO BEFORE ME, on the)

13th, day of February, 2023) Steve Helmer

) Signature

Steve Helmer, Chief Electrical Inspector

Debbie L. Helmer Boone County, Ky

Signature KYNP13717 Seal

NOTARY PUBLIC

My Commission Expires: August 24, 2024

File Attachments for Item:

P-6 Lopez, Jimmy - ESI

Certification ID: 9061

Current certifications- none

Staff notes- Appears to meet certification requirements for exams. Recommend approval.

ESIAC Recommendations:

Committee Recommendation:

Lopez
Last Name

Jimmy
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				

Lopez — *Last Name*

Jimmy — *First Name*

BBS Certification ID

SECTION 3: EMPLOYMENT/EDUCATION

Formal Education	Date Graduated
Franklin High School - Franklin, New Jersey	2007
Related Vocational or Technical Training	**Years' Experience**
U.S. Military construction experience (MOS or other designation):	**Years' Experience**
Place of Employment:	**Years' Employed**
Select Electric	2012 - current
Delaware County Regional Sewer District	2017 - current

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)

Lopez — *Last Name*
Jimmy — *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)*
Truberry Custom Homes, Hilliard Rough wire completed to print. Service installed w/ proper feeder size and grounding/barding installed to code.	Select Electric 112 Miners CT Delaware, OH, 43015 (614) 207-1077 - Don Highman	Jan 2016 - June 2016 (6 months)
Kirby Ventures LLC, Delaware Demo of existing BX wiring ~~4 ?-lore~~ Elimination of non-use circuits Rough wire completed to print / code	" "	Jan 2016 - Feb 2016 (1 month)
Total Experience on This Page (In Months):		7 Months

65

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

Lopez	Jimmy	
Last Name	*First Name*	*BBS Certification ID*

List Each Construction Project AND Specific Type of Work Performed	Name of Employer, Contact, Address, Telephone Number	Project Time: From_ To _ (MM/YY)
Memmer Homes, New Albany Rough electric completed to print/code. Service installed with proper sized feeders and grounding/bonding completed to code.	Select Electric 112 Miners CT Delaware, OH, 43015 (614) 207-1077 - Don Highman	July 2016 – Feb 2017 (7 months)
Maplecaft, New Albany Rough electric completed to print/code including extras requested by Home Owner. Service installed w/ grounding/bonding to code.	" "	Mar 2017 – May 2017 (2 months)
Memmer Homes, New Albany Rough electric completed to print/code including extras added by Home owner. Service installed w/ proper Feeders and grounding/bonding installed.	" "	June 2017 – Aug 2017 (2 months)
Maplecraft, Columbus Condos remodeled to print. All electrical brought up to current code w/ Arc Fault breakers or GFCI devices where required.	" "	July 2017 – June 2018 (11 months)
Bob Webb, Plain City Rough electric completed to print/code including extras added on by home owner. Service installed w/ proper size feeders and grounding/bonding installed.	" "	July 2018 – Sept 2018 (2 months)
	Total Experience on This Page (In Months):	24

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

Lopez	Jimmy	
Last Name	*First Name*	*BBS Certification ID*

List Each Construction Project AND Specific Type of Work Performed	Name of Employer, Contact, Address, Telephone Number	Project Time: From_ To _ (MM/YY)
Bob Webb, Plain City Rough electric completed to print/code. Service installed w/ proper size feeders and proper grounding/bonding installed.	Select Electric 112 Miners CT Delaware, OH, 43015 (614) 207-1077 - Don Highman	Sept 2018 - Oct 2018 (1 month)
Bob Webb, Plain City Rough electric completed to print/code including extras added by home owners. Service installed w/ proper feeders and grounding/bonding installed.	" "	Oct 2018 - Nov 2018 (1 month)
Bob Webb, Dublin Rough electric completed to print/code including extras added by owners. Service completed w/ proper feeders, grounding/bonding installed.		Nov 2018 - Dec 2018 (1 month)
Bob Webb, Plain City All custom homes rough electric completed to print/code along w/ extras added by home owners. All services completed to code w/ proper feeder sizes, grounding/bonding installed.		Oct 2018 - Mar 2020 (17 months)
	Total Experience on This Page (In Months):	20 months

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

Lopez	Jimmy	
Last Name	*First Name*	*BBS Certification ID*

List Each Construction Project AND Specific Type of Work Performed	Name of Employer, Contact, Address, Telephone Number	Project Time: From_ To _ (MM/YY)
Bob Webb, Plain City Rough electric completed to print/code. Service installed w/ proper size feeders and proper grounding/bonding.	Select Electric 112 Miners CT Delaware, OH, 43015 (614) 207-1077 - Don Highman	Feb 2020 – Mar 2020 (1 month)
Memmer Homes, New Albany Rough electric completed to print/code including all extras added by home owners. Service installed w/ proper feeders and grounding/bonding installed.	" "	Mar 2020 – Jun 2020 (3 months)
Paragon Maintenance, Columbus Multi-unit building rough electric completed to print/code. Demo of existing circuits required. Electric brought up to current code. Multi-gang meter pack installed to code. Proper feeder size along w/ proper grand/bonding installed.		May 2020 – Aug 2020 (3 months)
Bob Webb, Dublin Rough electric completed to print/code, including extras added by home owners. Service installed to code, including proper feeder size and ground/bonding.		July 2020 – Sept 2020 (2 months)
	Total Experience on This Page (In Months):	9 months

Lopez | Jimmy |
Last Name | *First Name* | *BBS Certification ID*

List Each Construction Project AND Specific Type of Work Performed	Name of Employer, Contact, Address, Telephone Number	Project Time: From_ To _ (MM/YY)
Bob Webb, Dublin Rough electric completed to print/code including all extras added. Service installed per code, proper grounding/bonding installed.	Select Electric 112 Miners CT Delaware, OH, 43015 (614) 207-1077 - Don Highman	Sept 2020 - Nov 2020 (2 months)
Paragon Maintenance, Columbus Multi-unit home. Existing circuits Demo'd / brought up to code. Rough electric completed to print/code. 2 gang meter pack installed to code, along with proper grounding/bonding.	" "	Nov 2020 - Jan 2021 (2 months)
Bob Webb, Dublin Rough electric completed to print/code. Service installed w/ proper feeder size along w/ proper grounding/bonding.		Jan 2021 - Mar 2021 (2 months)
Servpro, Columbus Existing electric brought up to code. Rough electric completed to print/code including extras added by home owner.		Feb 2021 - Apr 2021 (2 months)
Paragon Maintenance, Columbus Rough electric completed to print/code. Proper grounding/bonding installed, Panel breakers exchanged for proper Arc fault breakers to satisfy code requirements.		Apr 2021 - June 2021 (2 months)
	Total Experience on This Page (In Months):	10 months

69

Last Name: Lopez

First Name: Jimmy

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)
Servpro, Columbus Rough electric completed to code/print. Existing electric brought up to code, existing Push-matic panel removed, new SQ-D installed to code with proper grounding/bonding.	Select Electric 112 Miners CT Delaware, OH, 43015 (614) 207-1077 - Don Highman	Jun 2021 – July 2021 (1 month)
Memmer Homes, Plain City Rough electric completed to print/code including extras added. Service installed to code, proper grounding/bonding installed.	" "	July 2021 – Aug 2021 (1 month)
Servpro, Columbus Existing electric brought up to code. Rough electric completed to code/print. Service brought up to code.	" "	Aug 2021 – Sept 2021 (1 month)
Gladman Homes, Del County Rough electric completed to print/code. Service installed to code including proper grounding/bonding.	" "	Sept 2021 – Nov 2021 (2 months)
Bob Webb, Del County Rough electric completed to print/code including extras added by owners. Service installed to code including grounding/bonding.	" "	Sept 2021 – Dec 2021 (3 months)
	Total Experience on This Page (In Months):	8 months

Last Name: Lopez

First Name: Jimmy

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)
Bob Webb, Plain City Rough electric completed to print/code including extras added by owners. Service installed to code including grounding/bonding.	Select Electric 112 Miners CT Delaware, OH, 43015 (614) 207-1077 - Don Highman	July 2021 – Mar-2022 (8 months)
Bob Webb, Plain city Rough electric completed to print/code. Service installed to code including proper grounding/bonding.	" "	Feb 2022 – Apr 2022 (2 months)
Maplecraft, Delaware County Rough electric completed to print/code including extras added by owner. Service installed to code including proper grounding/bonding.		Apr 2022 – July 2022 (3 months)
Bob Webb, Delaware County Rough electric completed to print/code. Service installed with proper grounding/bonding.		Apr-2022 – June 2022 (2 months)
Bob Webb, Delaware County Rough electric completed to print/Code including extras added. Service installed to code.		June 2022 – Nov 2022 (5 months)
Memmer Homes, Delaware County Rough electric completed to print/code including extras. Service installed to code including feeder size and proper grounding/bonding.		Oct 2022 – Feb 2023 (4 months)
	Total Experience on This Page (In Months):	24 months

Lopez | Jimmy |
Last Name | *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: [signature]

Subscribed and duly sworn before me according to law, by the above named applicant this day 17 of February in the year 2023 at Delaware, County of Delaware and State of Ohio.

Notary Public: Deborah L Highman

NOTARIAL SEAL STATE OF OHIO
DEBORAH L HIGHMAN
NOTARY PUBLIC, STATE OF OHIO
DELAWARE COUNTY
My Comm. Expires 12-03-2027

Select Electric
112 Miners Ct.
Delaware, Ohio 43015
Ph: 614-207-1077
Fax 740-369-2042

Attn: To Whom it Concerns

Jimmy Lopez has worked with Select Electric Since March of 2012. He operated a truck on his own doing residential, commercial and service work. He ran crews when we did multi family condo buildings which required setting large meter packs and disconnects. He now works for me part time since he works full time with Delaware county. Jimmy has always been reliable and good at completing the work given to him. If you have any questions please fill free to call me and will be happy to answer any questions you might have. Thank you

Don Highman(owner)

Donald Hyhman 2-17-23

File Attachments for Item:

P-7 Lovett, Brandon - ESI

Certification ID: 9066

Current certifications- none

Staff notes: Application reflects 7+ years electrician experience, certification by ABC. Has completed his E1 exam

ESIAC Recommendations:

Committee Recommendation:

Board of Building Standards

Application for Interim Certification, Building Department Personnel

Lovett	Brandon	
Last Name	First Name	BBS Certification ID

SECTION 1: CHECK INTERIM CERTIFICATION(S) BEING REQUESTED

☐ Res. Building Official	☐ Res. Plans Examiner	☐ Res. Building Inspector
	☐ Res. Industrial Unit Inspector	☐ Res. Mechanical Inspector

✓ Electrical Safety 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				

Section 3: Employment/Education

a. Formal Education	Date Graduated
Washington High School	2012
Washington Court House, Ohio	
b. Related Vocational or Technical Training	**Years' Experience**
Pickaway-Ross CTC Electrical Trades	1
ABC of Central Ohio Electrical	2
c. U.S. Military construction experience (MOS or other designation):	**Years' Experience**
d. Place of Employment:	**Years' Employed**
Remington Electric LTD.	7-present
Washington Court House, Ohio	
Romanoff Residential Electric	2 years

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

Lovett — Last Name

Brandon — First Name

BBS Certification ID

SECTION 4: OBC/RCO 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)

SECTION 5: 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.

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* See attached experience Packet	*July 2013-May 2014* *(10 months)*
Total Experience on This Page (In Months):		

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

Last Name	First Name	BBS Certification ID

SECTION 5 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)
	See attached experience Packet	
	Total Experience on This Page (In Months):	

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

Lovett	Brandon	
Last Name	*First Name*	*BBS Certification ID*

SECTION 6: PERSONAL HISTORY

1. Have you ever been convicted of any felony, or any crime involving moral turpitude? ☐ Yes ☒ No
2. If you answered "Yes" please explain below:
3. Have you served in the U.S. armed services? (If No, skip question 3) ☐ Yes ☒ No
4. If YES, were you discharged under honorable conditions? ☐ Yes ☐ No
   If you answered "No" please explain below:

SECTION 7: 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 23rd of february in the year 2023 at Washington Court House, County of Fayette and State of Ohio.

Notary Public: ______________________

NOTARIAL SEAL STATE OF OHIO

OLIVIA MAE CLAY
NOTARY PUBLIC
STATE OF OHIO
Comm. Expires
04-04-2024

Ohio | Department of Commerce

BOARD OF BUILDING STANDARDS

Application for Full Certification of Residential Building Department Personnel

This application is submitted to the Board of Building Standards as specified in the provisions of Section 3781.10 of the Ohio Revised Code and 4101:7-3-01 of the Ohio Administrative Code.

Applicant Information

Name: Brandon Michael Lovett	BBS Certification ID:

[redacted]

To apply for full certification from interim or trainee certification:

__ Complete the application
__ Include examination results and Ohio Building Code Academy Certificate
__ Mail to BBS, 6606 Tussing Road, PO Box 4009, Reynoldsburg, OH 43068

Approval process:

- Full Certification granted administratively once certification requirements (tests, Code Academy) are met.

Section 1: Check Full Certification(s) Being Requested

☐ Res. Building Official	☐ Res. Plans Examiner	☐ Res. Building Inspector
	☐ Res. Industrial Unit Inspector	☐ Res. Mechanical Inspector

✓ electrical safety inspector

Section 2: 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:

Section 3: 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: [signature]

Ohio | Department of Commerce

BOARD OF BUILDING STANDARDS

Application for Full Certification of Non-Residential Building Department Personnel

This application is submitted to the Board of Building Standards as specified in the provisions of Section 3781.10 of the Ohio Revised Code and 4101:7-3-01 of the Ohio Administrative Code.

Applicant Information

Name: Brandon Michael Lovett	BBS Certification ID:

[redacted]

To apply for full certification from interim or trainee certification:

__ Complete the application

__ Include examination results and Ohio Building Code Academy Certificate

__ Mail to BBS, 6606 Tussing Road, PO Box 4009, Reynoldsburg, OH 43068

Approval process:

- Full Certification granted administratively once certification requirements (tests, Code Academy) are met.

Section 1: Check Full 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: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:

Section 3: 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: [signature]

ICC INTERNATIONAL CODE COUNCIL®

INTERNATIONAL CODE COUNCIL

BRANDON LOVETT

The International Code Council attests that the individual named on this certificate has satisfactorily demonstrated knowledge as required by the International Code Council by successfully completing the prescribed written examination based on codes and standards then in effect, and is hereby issued this certification as:

Residential Electrical Inspector

Given this day January 21, 2023

Certificate No. 10268112

Michael Wich, CBO
President, Board of Directors

Dominic Sims, CBO
Chief Executive Officer

INTERNATIONAL CODE COUNCIL, INC.
CERTIFIED

This certificate is the property of ICC and must be returned to ICC in the event of suspension or revocation of the certificate.

STATE OF OHIO

Certificate of Completion of Apprenticeship

ISSUED BY
THE OHIO STATE APPRENTICESHIP COUNCIL

This is to certify that: **BRANDON LOVETT**

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 pertain thereto,

In testimony Whereof, the Ohio State Apprenticeship Council of the Ohio Department of Job and Family Services in cooperation with the Office Of Apprenticeship, U.S. Department of Labor, do affix the Great Seal of the State of Ohio.

Witnessed Over Our Signatures and Seal:

THE GREAT SEAL OF THE STATE OF OHIO

Sponsored by:

ABC Inc. Central Ohio

Columbus, Ohio

Given at Columbus in the State of Ohio,

this 7th ***day of*** November ***A.D.*** 2016

DIRECTOR, OHIO STATE APPRENTICESHIP COUNCIL

CHAIRMAN, OHIO STATE APPRENTICESHIP COUNCIL

JOHN R. KASICH
GOVERNOR OF OHIO

Certificate of

COMPLETION

Issued by the Education Committee of
Associated Builders and Contractors, Inc. - Central Ohio Chapter

This is to certify that:

Brandon Lovett

has fulfilled the terms of the apprenticeship agreement in accordance with the registered standards and requirements, with related instruction, and is hereby recognized as a craft professional, having completed the Electrical apprenticeship training program.

ABC
Associated Builders and Contractors, Inc.

Central Ohio Chapter

Given at Columbus in the State of Ohio,
this 18th day of June 2015.

Vice President of Education

COMPLETION

Electrical Experience Brandon Lovett

Construction project/ work performed	**name of employer/ contact/address/phone number**	**project time/ date**
Huntington Bank Drive Thru Washington Court House,Ohio install underground conduit for power and low voltage foe new atm	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street Washington Court House, Ohio	2018 16 HOURS
Taco Bell Remodel Washington Court house, Ohio reroute and add new kitchen circuits for remodel	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street Washington Court House, Ohio	2018 1 week
Taco bell Remodel Smithville Rd. Dayton,Ohio install wire new lobby lighting, all new ribbon outdoor lighting, replace all light fixture in kitchen to LED	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street Washington Court House, Ohio	2018 3 weeks
Fayette County Historical Society Washington Court House, Ohio	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street	2019 1 week

install lighting and receptacle circuits for new newspaper viewing room in carriage house	Washington Court House, Ohio	
American Legion post 25 Washington Coutrt House, Ohio install new 200 amp 3 phase kitchen panel and multiply branch circuits	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street Washington Court House, Ohio	2021-2022 1 month
KFC Jeffersonville, Ohio remodel install new lobby lighting, install new exterior and rooftop lighting	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street Washington Court House, Ohio	2017 2 weeks
Supersport pizza and wings, Washington Court House,Ohio install new branch circuits for new pizza kitchen and ventilation unit	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street Washington Court House, Ohio	2020 1 week
Vinyl Coffee Washington Court House, Ohio replace service from 100 to 20 amp and replace panel	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street Washington Court House, Ohio	2021 8 hours
526 Albin Ave	Remington Electric	2021

Washington Court House, Ohio replace service and panel to 200 amp with outside disconnect and generator hookup	Shawn Remington 740-463-1108 225 W Temple Street Washington Court House, Ohio	12 hours
B and B Creative Marketing Washington Court House, Ohio replace all lighting throughout building to LED light fixtures	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street Washington Court House, Ohio	2021 16 hours
Jacks Burgers Washington Court House, Ohio rough in and finish electrical for new burger shop and commercial kitchen	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street Washington Court House, Ohio	2019 1 month
The Farmers Pantry Washington Court House, Ohio convert garage to small commercial caterin g kitchen	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street Washington Court House, Ohio	2016 3 weeks
Hattie Jackson Apartments Washington Court House, Ohio install 400 amp emergency backup generator	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street Washington Court House, Ohio	2015 1 week
Optique Family Vision Care, Washington Court	Remington Electric Shawn Remington 740-	2020 2 weeks

House, Ohio convert old bank into opticians doctors office	463-1108 225 W Temple Street Washington Court House, Ohio	3 weeks
Phantom Fireworks Bloomingburg Ohio repair florescent lighting, replace 80' sign lighting	Remington Electric Shawn Remington 740- 463-1108 225 W Temple Street Washington Court House, Ohio	2016-2022 1 week
Prism Fireworks Jeffersonville, Ohio replace main exhaust fan motor and phase converter	Remington Electric Shawn Remington 740- 463-1108 225 W Temple Street Washington Court House, Ohio	2019 1week
bloomingburg, Ohio post office replace service and fuse box, upgrade lighting throughout and install new branch circuits	Remington Electric Shawn Remington 740- 463-1108 225 W Temple Street Washington Court House, Ohio	2021 1 week

Electrical Experience Brandon Lovett

CONSTRUCTION PROJECT/ WORK PERFORMED	NAME OF EMPLOYER/ CONTACT/ ADDRESS/ PHONE NUMBER	PROJECT TIME/DATE
Ethereum Kitchen, Destination Outlet mall Jeffersonville, Ohio remodel retail space to a coffee shop and baked goods kitchen	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street Washington Court House, Ohio	2021 1month
Farm and Family Home Washington Court House, Ohio install branch circuit for trash compactor and sales floor receptacles	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street Washington Court House, Ohio	2022 12 hours
North Shore Primitives Washington Court House, Ohio exterior lighting project on historic depot building, replace 200 amp service	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street Washington Court House, Ohio Vanessa Blevins 740-335-2578	2020 1 month
Vanessa Blevins CPA Washington Court House, Ohio light fixture repair and replacement	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street	2015-2018 1 month

spread out over 3 years	Washington Court House, Ohio Vanessa Blevins 740-335-2578	
449 E East Street Washington Court House, Ohio replace light fixtures throughout house, partial house rewire, replace 200 amp service and panel	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street Washington Court House, Ohio Vanessa Blevins 740-335-2578	2015-2022 2 months
Veronica Duff House, 3530 Old Springfield Rd. NE Complete rewire 150 year old brick house, re-feed barn	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street Washington Court House, Ohio Ryan May 740-463-8767	2015-2022 3 months
Ted Lewis Park, Circleville,Ohio new construction, site lighting, re-feed existing shelter houses, 400 amp service, new shelter house power and lights, new restroom building with mechanical room, rough in and finish, bonding of splash pad	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street Washington Court House, Ohio	2022-present 2 months
City of Washington Court	Remington Electric Shawn Remington 740-	2017 and 2022

House Splash pad bond splash pad grid, install underground power to control device	Shawn Remington 740-463-1108 225 W Temple Street Washington Court House, Ohio	2 weeks
Richelieu Foods Inc Washington Court House, Ohio infrared test on whole facility electric, disconnect and reconnect equipment	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street Washington Court House, Ohio	2018 and 2022 2 weeks
YUSA research and Development Washington Court House, Ohio install power and control circuits for new equipment	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street Washington Court House, Ohio	2018 2019 2021 2022 1 month
Blue Ribbon Building Washington Court House, Ohio replace 2 200 amp services on old downtown building	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street Washington Court House, Ohio	2021 1 week
Heritage Church, Washington Court House, Ohio re-feed septic tanks and pumps underground electrical, re-feed pole lights due to damaged underground conduit.	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street Washington Court House, Ohio Matt Cockerill 740-505-8652	2021-2022 2 weeks

Lily Building Washington House,Ohio re-feed 100 panel for coffee shop and install new can lighting in offices	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street Washington Court House, Ohio	2021 2 weeks
222 Short Street, Washington Court House, Ohio 200 amp service and panel replacement, partial rewire	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street Washington Court House, Ohio	2018 1 week
503 E East Street Washington Court House, Ohio 200 amp panel and service replacement, install new kitchen circuits during remodel	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street Washington Court House, Ohio	2022 1 week
25250 Shoemaker Rd. Circleville, Ohio 200 amp panel and service replacement convert from overhead to underground service feeder, re-feed out buildings	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street Washington Court House, Ohio	2022 1 week
The Village Apartments, Washington Court House, Ohio replace 6 pack meter board	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street Washington Court House, Ohio	2022 1 week
Cheap Tobacco	Remington Electric	2022

Cheap Tobacco Washington Court House, Ohio install 2 120v branch circuits for sales floor lighting	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street Washington Court House, Ohio	[illegible] 8 hours
Yoder construction 3 Spec homes, Wilmington,Ohio rough in and finish 3 2,500 square foot spec homes	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street Washington Court House, Ohio Mark Yoder 816-596-3394	2017 2018 2019 3 months
Starbucks Jeffersonville Jeffersonville,Ohio new construction rough in and finish	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street Washington Court House, Ohio	2016 1month
Starbucks Dublin Rd Columbus,Ohio new construction, underground, rough in finish electric	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street Washington Court House, Ohio	2017 1 month
Starbucks 665 Grove City, Ohio new construction, underground, rough in , finish	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street Washington Court House, Ohio	2018 1 month
Starbucks Canal Whinchester,Ohio	Remington Electric Shawn Remington 740-	2018

complete building remodel, underground and finish electrical	463-1108 225 W Temple Street Washington Court House, Ohio	2 weeks
Lancaster warehouse install 400 amp service and panel on warehouse,with overhead riser	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street Washington Court House, Ohio	2017 1 week
Sephora JC Penny Chillicothe,Ohio rough in, underground, data,finish for new make up department	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street Washington Court House, Ohio	2017 1 month
Sephora JC Penny Lancaster,Ohio rough in, underground, data,finish for new make up department	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street Washington Court House, Ohio	2018 1 month
Sephora JC Penny Heath,Ohio rough in, underground, data,finish for new make up department	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street Washington Court House, Ohio	2018 1 month
8730 Old Charleston Road Leesburg,Ohio new construction 3,000 squarefoot home. rough	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street Washington Court	2017 1 month

in, service, finish	House, Ohio	

Lovett Brandon

First Notebook file:///

Electrical Experience

[redacted]

construction project/work performed	name of employer/contact/address/phone number	project time/date	
600 w. Goodale st. Columbus, Ohio residential apartment complex rough in and finish electrical	Romanoff Residential Electric, Chris Thompson 740-603-8220 1288 Research Rd. Gahanna, Ohio	2013 6 months	
801 Polaris Parkway, Columbus, Ohio residential apartment complex rough in and finish electrical	Romanoff Residential Electric, Chris Thompson 740-603-8220 1288 Research Rd. Gahanna, Ohio	2014 6 months	
2015 Avery Rd. Hilliard, Ohio residential apartment rough in and finish electrical	Romanoff Residential Electric, Chris Thompson 740-603-8220 1288 Research Rd. Gahanna, Ohio	2015 4 months	
516 W. Broad Street, Columbus, Ohio residential apartment rough in and finish electrical	Romanoff Residential Electric, Chris Thompson 740-603-8220 1288 Research Rd. Gahanna, Ohio	2014 2 months	
6681 Kodiak Drive, Canal	Romanoff Residential	2014	

Whinchester, Ohio residential apartment rough in and finish electrical	Electric, Chris Thompson 740-603-8220 1288 Research Rd. Gahanna, Ohio	3 months	
1600 W. Lane Ave Upper Arlington, Ohio residential apartment rough in and finish electrical	Romanoff Residential Electric, Chris Thompson 740-603-8220 1288 Research Rd. Gahanna, Ohio	2014 1 month	
Comfort Dental Xenia, Xenia Ohio demo and complete rewire for dentist office, rough in finish electric	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street Washington C.H.,Ohio PETRA construction Chip Wilt 740-572-0090	2015 1 month	
Comfort Dental Hilliard, Hilliard Ohio complete rewire for new dentist office, rough in and finish electric	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street Washington C.H.,Ohio PETRA construction Chip Wilt 740-572-0090	2015 1 month	
Comfort Dental Circleville Circleville, Ohio remodel office space into dentist office, rough in and finish electric	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street Washington C.H.,Ohio PETRA construction	2016 4 months	

	Chip Wilt 740-572-0090		
Comfort Dental Lancaster, Lancaster Ohio remodel existing space into dentist office, rough in and finish electric, wired for a health care facility	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street Washington C.H.,Ohio PETRA construction Chip Wilt 740-572-0090	2017 6 months	
Comfort Dental Bellefontaine, Bellefontaine, Ohio remodel existing space into dentist office, rough in and finish electric, wired for a health care facility	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street Washington C.H.,Ohio PETRA construction Chip Wilt 740-572-0090	2020 6 months	
Comfort Dental Hamilton, Hamilton, Ohio remodel existing space into dentist office, rough in and finish electric, wired for a health care facility	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street Washington C.H.,Ohio PETRA construction Chip Wilt 740-572-0090	2019 6 months	
Comfort Dental West Broad, Columbus, Ohio remodel existing space into dentist office, rough in and finish electric, wired for a health care facility	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street Washington C.H.,Ohio PETRA construction Chip Wilt 740-572-0090	2021 6 months	
Comfort Dental	Remington Electric	[illegible]	

Comfort Dental Whitehall, Columbus,Ohio dentist office expansion, rough in and finish electric, wired as a heath care facility	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street Washington C.H.,Ohio PETRA construction Chip Wilt 740-572-0090	2018 5 months	
comfort Dental Delaware, comfort Dental Heath, Comfort Dental Springfield, Comfort Dental North Columbus, Comfort Dental Gahanna, Comfort Dental Marion install dedicated branch circuits for new x-ray equipment at each location listed.	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street Washington C.H.,Ohio PETRA construction Chip Wilt 740-572-0090	2015-2020 3 months	
Lowes flatbed Distribution center #975, Washington Court House, Ohio install new pole lights through out entire facility, underground conduit repairs, replace all emergency lights throughout entire facility, perform infrared panel inspections yearly	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street Washington C.H.,Ohio Don Porter 740-636-2100	2015-2021 8 months	

Ohio Living Cape May retirement community Wilmington, Ohio electrical service calls, back up generator work, pole light repair/replace, court yard underground remodel, branch circuits added for various new equipment all over a 7 year time period	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street Washington C.H.,Ohio Steve Rowe 937-728-1624	2015-2022 8 months	
Historic Washington Auditorium, Washington Court House, Ohio prepare building for partial demo, re-route 800 amp 3phase service to different part of building, temperary hook up to a generator	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street Washington C.H.,Ohio	2022-present 4 months	
Fayette County Family YMCA Washington Court House, Ohio Gymnasium addition along with wellness center expansion, rough in and finish electrical	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street Washington C.H.,Ohio Keith Eckles Marquee Construction 740-333-3410	2020 5 months	
Sonic Fast food Restaurant, Washington Court House, Ohio new construction rough in, finish, 800 amp 3	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street Washington C.H.,Ohio	2018 4 months	

phase service, site lighting and underground			
City of Washington Court House Water Tower, Washington Court House, Ohio complete rough in of interior, install controls to operate VFD, site lighting, service, install aviation beacon on very top of tower (100'+)	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street Washington C.H.,Ohio	2017 3 months	
1094 Austin Rd. Washington Court House, Ohio rewire entire 3,000 square foot 200 year old farm house, all exposed conduit.	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street Washington C.H.,Ohio	2019-2020 3 months	
121 Taylor Lane Washington Court House, Ohio custom new construction 8,000 square foot home with backup generator and 400 amp service	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street Washington C.H.,Ohio	2016-2017 4 months	
900 Mt. Olive Road, Washington Court House, Ohio Custom New Construction 3,000 square foot house, rough in and finish electrical	Remington Electric Shawn Remington 740-463-1108 225 W. Temple St. Washington C.H., oHio	2021 2021 2 months	

Washington High School Washington Court house, Ohio replace 24 Light fixtures to LED in Gymnasium	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street Washington C.H.,Ohio	2022 1 week	
Boutique on Main 109 S main Street, Washington Court House, Ohio complete rewire and finish, install multipack service for 4 separate spaces, also complete rewire and finish electrical on 2 other retail spaces next door	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street Washington C.H.,Ohio	2021 3 months	
Gordon Plumbing Shop/office Washington Court House,Ohio rewire office area and shop area, rough in and finish, various other projects over the last 6 years	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street Washington C.H.,Ohio	2015-2022 2 months	
Salty Broads Patio, Washington Court House, Ohio New construction bar and sandwich shop, rough in, 200 amp service and finish electrical	Remington Electric Shawn Remington 740-463-1108 225 W Temple Street Washington C.H.,Ohio	2019 1 month	

File Attachments for Item:

P-8 Melbar, Thomas - ESI

Certification ID: 6039

Current certifications- RBO, RPE, RMI, RBI

Staff notes- Appears to meet certification requirements: recommend approval.

ESIAC Recommendations:

Committee Recommendation:

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

Melbar	Thomas	#6039
Last Name	*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	#6039	03/2019
☒	☐	Plans Examiner Certification	#6039	03/2019
☒	☐	Building Inspector Certification	#6039	10/2018
☒	☐	Mechanical Inspector Certification	#6039	10/2018
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				

Melbar	Thomas	#6039
Last Name	*First Name*	*BBS Certification ID*

SECTION 3: EMPLOYMENT/EDUCATION

Formal Education	Date Graduated
K-12	6/1980
Related Vocational or Technical Training	**Years' Experience**
U.S. Military construction experience (MOS or other designation):	**Years' Experience**
Place of Employment:	**Years' Employed**
City of Sheffield Lake Building Dept.	2018 to PRESENT

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)
City of Sheffield Lake	Residential Building inspector	Residential Building Inspections Residential mechanical Insp. Residential Plans Examiner	2018 to PRESENT

Melbar	Thomas	#6039
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.

*I have not been an official trainee but have been on numorous inspections with ESI Tim Golden BBS #540

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)*
Employed By Patrick Electric 3 separate times. Patric Electric LLC PO Box 3027 Lorain, OH, 44052 (440)396-5781	In charge of many commercial electric projects. In charge of layout, estimating, Install on many Drug Mart Stores, Pizza Hut Build outs, many small commercial buildings.	1977-78 12 months 1996-2000 3yrs 6mo. 2007-2008 1 yr 3 mo.
Total Experience on This Page (In Months):		69

Melbar	Thomas	#6039
Last Name	*First Name*	*BBS Certification ID*

List Each Construction Project AND Specific Type of Work Performed	Name of Employer, Contact, Address, Telephone Number	Project Time: From_ To _ (MM/YY)
Installation of Residential and commercial HVAC systems. Design hydronic heat and Chilled water systems.	Lakewood Furnace Co. 18502 Detroit Rd. Lakewood, OH, 44107 216-221-2036	7/1978 to 1996 2000 to 2007
Design build additions, bathrooms/Kitchens. make STRUCTURAl changes to homes	T melbar Remodeling 4120 Knickerbocker Rd. Sheffield Lake, OH, 44054 440-714-4394	4/2007 to 10/2018
Property maintenance officer. Part Time	City of Sheffield Lake 609 Harris Rd. Sheffield Lake, OH, 44054	4/2016 10/2018
Residential Building Inspector. #6039	City of Sheffield Lake 609 Harris Rd. Sheffield Lake, OH, 44054 440-949-5787	10/2018 to PRESENT
	Total Experience on This Page (In Months):	~~[illegible]~~ 480

Melbar	Thomas	#6039
Last Name	*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: Thomas Melbar

Subscribed and duly sworn before me according to law, by the above named applicant this day 23 of February in the year 20 23 at Sheffield Lake, County of Lorain and State of Ohio.

Notary Public: Kelsey Leftwich

SEAL

NOTARIAL SEAL STATE OF OHIO
KELSEY LEFTWICH
Notary Public, State of Ohio
My Commission Expires
04/21/2024

CITY OF SHEFFIELD LAKE

609 HARRIS ROAD
SHEFFIELD LAKE, OHIO 44054
Phone: 440-949-7141
Fax: 440-949-5169

Friday, February 3, 2023

Ohio Board of Building Standards
6606 Tussing Road
Reynoldsburg, Ohio 43068

RE: Thomas Melbar.

To whom it may concern:

My name is Tom Carleton, and I am the Building Official of Sheffield Lake. I started my employment with the City of Sheffield Lake, where I met Tom Melbar, who had been hired to handle Residential Inspections. Tom also addresses zoning and property maintenance issues. Tom and I have completed many inspections together in the last five years.

During his tenure at the city, Tom has shown interest in obtaining his Electrical Safety Inspector's certification. Sheffield Lake's Electrical Inspector, Tim Golden #540, indicated that Tom is well-versed in the electrical industry and remembers him when he worked for one of our local electrical contractors. He stated that Tom would be a great addition to the City if he became an Electrical Safety Inspector.

Therefore, I recommend Tom Melbar to the Board of Building Standards and to permit him the opportunity to obtain his Electrical Safety Inspection certification.

Thank you for your time and attention to this matter,

Tom Carleton BO
City of Sheffield Lake
#216

Friday, 20 January 2023

Timothy D. Golden
124 Bentley Drive
Elyria, Ohio 44035

Ohio Board of Building Standards
6606 Tussing Road
Reynoldsburg, Ohio 43068

RE: Thomas Melbar

To Whom It May Concern:

I am currently the Electrical Safety Inspector, Building Inspector, and Residential Building Official with many certified departments in the Northern Ohio area. I have held these positions for over 25 years. Furthermore, I served on the Ohio Building Officials Association as a board member and served as the President for over eight years with the North Central Ohio Building Officials Association. I am writing this letter on behalf of one of my colleagues, Thomas Melbar, with whom I have had the pleasure of working alongside.

In 2018, I became employed with the City of Sheffield Lake, where I met up with Tom Melbar. His position with the City is a Residental Inspector. It became evident after speaking with Tom that I knew him when he worked for one of our local Electrical Contractors.

Tom and I have completed many inspections in the last few years together. During that time, Tom has shown a strong desire to move into the Electrical Safety Inspectors role. I gave Tom some self-study books to help him better understand the upcoming tests.

Now that Tom has completed the self-study course and taken many practice tests, I recommend that the board grant him approval to take the required tests as laid out in section 4101:7-3-01 of the Ohio Administrative Code.

If you have any further questions, feel free to contact me at 440-263-8843, and I will be glad to answer any questions you have.

Respectfully submitted,

Timothy D. Golden
BBS # 540

HEATING AND COOLING
LAKEWOOD FURNACE CO.
QUALITY SINCE 1914

18502 DETROIT AVENUE, LAKEWOOD, OHIO 44107 • (216) 221-2036 • (216) 221-6100
LICENSE NO. 14291 www.lakewoodfurnace.com FAX (216) 221-7856

January 17, 2023

Ohio Board of Building Standards

Att. Regina Hanshaw,

I have known Tom Melbar for over 40 years as a friend including 20 years as an employee and can testify that he is a quality person.

I had almost daily contact with him for 20 years while he was an employee here at the Lakewood Furnace Company. During that time he performed electrical work, HVAC installations, and plumbing.

He always handled himself in a professional manner both with other employees as well as our customers.

Every job he was involved in was done with the utmost quality and care. He represented our company well.

If there are further questions feel free to contact me at the Lakewood Furnace Company.

Thank You,

Joseph Miller

Joseph Miller, President/owner

PATRICK ELECTRIC LLC

COMMERCIAL INDUSTRIAL RESIDENTIAL
ELECTRICAL CONTRACTORS

Dear Ms. Regina Hanshaw, 1/28/23

The following is a letter of recommendation for Thomas Melbar. Since 1980, Tom has worked for Patrick Electric during three separate time periods.

First, as a field technician; second, as a field superintendent; and finally, as office manager, responsible for estimating purchasing and job site code compliance.

Patrick Electric has also had dealings with Tom as a business owner. Tom's workmanship, scheduling, and completion of projects have always been stellar. For these reasons, we have had him do more than a dozen jobs for our company.

As an inspector, Tom is knowledgeable, fair, and able to explain code when necessary.

I would personally recommend Tom for any position in the construction industry.

If you have any questions regarding Thomas Melbar, please give me a call at the number below.

Sincerely,

Thomas Patrick

Patrick Electric LLC P.O. Box 3027 Lorain, Ohio 44052 440-396-5781
e-mail patrickelec@gmail.com

File Attachments for Item:

P-9 Oeder, Charles - ESI

Certification ID: 5409

Current certifications- none, previously approved for ESI exams

Staff notes: OCILB contractor, meets criteria, recommend approval.

ESIAC Recommendations:

Committee Recommendation:

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

Oeder	Charles	
Last Name	*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				

Oeder	Charles	
Last Name	*First Name*	*BBS Certification ID*

SECTION 3: EMPLOYMENT/EDUCATION

Formal Education	Date Graduated
University of Toledo	2013
Related Vocational or Technical Training	**Years' Experience**
Terra State College - Industrial Electricity	
Contractor OH13566	27
U.S. Military construction experience (MOS or other designation):	**Years' Experience**
Place of Employment:	**Years' Employed**
Great Lakes Electric - Owner	27
EHOVE Career Center - High School Instructor	18

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)

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Ueder	Charles	
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)*
Total Experience on This Page (In Months):		

Oeder	Charles	
Last Name	*First Name*	*BBS Certification ID*

List Each Construction Project AND Specific Type of Work Performed	Name of Employer, Contact, Address, Telephone Number	Project Time: From_ To _ (MM/YY)
Owner - Great Lakes Electric OH13566	Great Lakes Electric, 12 N Main St, Milan Ohio 44846 419-499-4159	1996-Present
Worked in field on various projects from 250.00 to 1 million dollars as lead electrician		1996- Present
Worked on all jobs since 1996 as Project Manager from 250.00 - 2 million		1996- Present
Engineer many projects with P/E according to NEC requirements		2010 - Present
Approved to take test before COVID era. Application needs renewed.		
	Total Experience on This Page (In Months):	

Oeder	Charles	
Last Name	*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 6th of March in the year 2023 at Milan Ohio, County of Erie and State of Ohio.

Notary Public: Deborah K Oeder

Deborah K Oeder

SEAL

NOTARY PUBLIC STATE OF OHIO

DEBORAH K OEDER
Notary Public
State of Ohio
My Comm. Expires
December 20, 2027

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Ohio Department Commerce - OCILB OCILB - Ohio Construction Industry Licensing Board

Lookup Detail View

Name and Address

Name	Mail Address	Public Address
CHARLES J OEDER	[redacted]	[redacted]

Registration Information

Credential	License Type	Issue Date	Expiration Date	Status	Reason	Company
EL.13566	Electrical	07/01/2022	06/30/2023	ACTIVE	ACTIVE	GREAT LAKES ELECTRIC

Renewal Requirements

Formatted Credential	CE Requirements Completed	Estimated Amount Due
EL.13566	No	$0.00

Generated on: 3/16/2023 5:01:11 PM

File Attachments for Item:

P-10 Sharpe III, John - ESI, MI

Certification ID: 9065

Current certifications- none

Staff notes: Appears to meet requirements: Recommend approval for exams.

ESIAC Recommendations:

Committee Recommendation:

Sharpe III John

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				

Sharpe III John

SECTION 3: EMPLOYMENT/EDUCATION

Formal Education	Date Graduated
Saint Johns Highschool Bellaire Ohio	1979
Related Vocational or Technical Training	Years' Experience
Belmont Tec HVAC Program	2
Loc 141 Apprenticeship program	5
U.S. Military construction experience (MOS or other designation):	Years' Experience
Place of Employment:	Years' Employed
IBEW Loc 141 Wheeling Wva	24

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)

Sharpe III John

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

Applicants for Electrical Safety Inspector Only Must Complete This Item

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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).

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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)*
Total Experience on This Page (In Months):		

Sharpe III John

Last Name First Name BBS Certification ID

List Each Construction Project AND Specific Type of Work Performed	Name of Employer, Contact, Address, Telephone Number	Project Time: From_ To _ (MM/YY)
Cabellas store wheeling wva lighting /floor box forman general foreman at completion	Casteel electrical	2003-2004
underground pwr distribution highlands wheeling wva all underground for Aep	United Electric wheeling wva 304-232-1330	2005-2006
Second Phase Cabellas dist center / main foreman service/pwr dist. fire alarm etc	Lighthouse Elect Canonsburgh Pa 724-873-3500	2006-2007
Martins Ferry High/Middle school Main Foreman / electrical/ccv/hvac controls/fire alarm/ security ATT call center wheeling wva main foreman /electrical /ccvt/fire alarm	ErbElectric 500 hall st 740-633-5055 Reference Justin Klempa	2008-2009
West Liberty satelite center Cameron High middle school Oak Grove Gas plant adminstrivate bld and service garage John Marshall High/middle school remodel Wheeling Hospital long term care bld AEP Adm/service bld Manards store highlands North Wood Health center All the above jobs i was main foreman electrical / ccvt/fire alarm hvac controls / automation for erb electric Retired on August 24 2021 Currently Carry Active Ohio Fire Alarm Licence 54.09.1626 WestVirgina electrical licence J68090737880301 Started in trade 1998 5 year apprentiship 18 years as a journeyman electrican Apprentiship instructor for 12 years reference Mark Dunfee 304-242-3870	Erb Electric	
	Total Experience on This Page (In Months):	

Sharpe III	John	
Last Name	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 23rd of Feb in the year 2023 at Painesville, Lake, County of Lake and State of Ohio.

Notary Public: ____________________

MICHAEL T ANDERSON - NOTARY PUBLIC
COMM EXP. SEP 27, 2028
STATE OF OHIO

File Attachments for Item:

ER-1 Electric Vehicle Power Transfer Systems and the 2020 NEC Part 2 (Matthews Electrical Services)

All certifications (4 hours)

Staff Notes: Part 1 was approved in January.

ESIAC Recommendation:

Committee Recommendation:

BIOGRAPHY
Henry P. Matthews PE, CPE, CESCP, PVA

Henry has over 31 years of experience in the electrical design, construction, engineering and safety fields. He has a passion for teaching and mentoring.

Henry obtained his Bachelor of Science degree in Electrical Engineering from Penn State University in 1989.

He also earned a Master of Business Administration from Bowling Green State University in 2003.

In addition, Henry earned several certificates including:

- Plumbing and Electrician from Penn Foster Career School
- Welding from Owens Community College in Findlay, Ohio
- Residential Solar PV Systems from Solar Engineering International

Henry currently holds the following licenses, and memberships:

- Licensed Electrical Contractor in Ohio
- Licensed Training Agency in Ohio
- Licensed Professional Engineer in Ohio, Michigan, Kentucky, Indiana, Illinois, Wisconsin
- Certified Plant Engineer (CPE)
- Certified Building Operator (CBO)
- Certified Electrical Compliance Safety Professional (CESCP) by NFPA
- Solar PV Associate by the North American Board of Certified Energy Practitioners
- Electric Vehicle Infrastructure Training Program (EVITP) certification
- Senior Member of the Institute of Electrical and Electronic Engineers (IEEE)
- Member of the International Association of Electrical Inspectors (IAEI)
- Member of the National Fire Protection Association (NFPA)

Henry is currently employed as an Advanced Senior Engineer for Marathon Petroleum Company in Findlay, Ohio. During his 16 years at Marathon, Henry has worked as an Electrical Design Engineer, Project Engineer, Engineering Supervisor and currently as a Reliability Engineer.

Henry is also the owner of Matthews Electrical Services, a small, but full-service electrical contractor company.

Prior to this, he worked 13 years as an Electrical Engineer and a Plant Engineering Manager in at Cooper Standard Automotive, a major automotive parts supplier in Bowling Green, Ohio

Henry is the past co-chair of American Petroleum Institute Recommended Practice 545 Lightning Protection for Above Ground Storage Tanks.

He was also past president of the Fostoria Toastmaster club.

Electrical Vehicle Power Transfer Equipment and the NEC Part 2
Outline

Relevant NEC Chapters and Articles (Based on the 2020 NEC)
- Article 625 Electric Vehicle Power Transfer Systems
- Article 100 Key Definitions
- Article 250 Grounding and Bonding
- Chapter 3 Wiring Methods and Materials
- Chapter 9 Tables

Other Resources:
- NFPA 70E (2021) Electrical Safety in the Workplace
- NECA 413 Standard for Installing and Maintaining Electrical Vehicle Supply Equipment (EVSE)
- OSHA 1910 Subpart S Electrical Safety

Referenced Websites:
- www.NFPA.org
- NREL – National Renewable Energy Laboratories
- www.IAEI.org (International Association of Electrical Inspectors)
- www.mikeholt.com
- www.esfi.org Electrical Safety Foundation International)
- Multiple automobile and Class 2/DC Fast charger manufacturer websites

Course Content:
- Electrical Safety review with emphasis on DC systems
- NEC definitions
- Electric Vehicle Infrastructure
    - Non-residential installations
    - Fleet considerations
- ADA Considerations
- Installation requirements
- Example Installations

APPLICATION FOR CONTINUING EDUCATION APPROVAL
COURSE CONDITIONS AND GUIDELINES

The Ohio Board of Building Standards is committed to the ongoing education and professional development of board-certified personnel through the delivery of high-quality, accurate and engaging professional continuing education content. To this end, the Board reviews and approves Continuing Education Courses for building department personnel.

Board approval is granted for course instruction on current codes and standards, including the OBC, OMC, OPC, and RCO, and any other content areas directly related to the responsibilities of the certification for which credit is being requested.

Promotion: Any person or organization promoting an approved course is required to make full and accurate disclosure regarding course title, course approval number, number of credit hours, categories for which the BBS has approved the class, and fees in promotion materials and advertising. ***The Board does not grant retroactive approval. It is recommended that courses be submitted for approval well in advance of any scheduling of classes and advertising***. Advertising may not falsely state BBS approval before approval is granted. Course providers may state that BBS approval is pending.

Application Submission: All Applications and associated materials shall be submitted by email in .pdf format. Instructions for completing the application are attached.

Certificate of Completion: Course providers shall provide participants a certificate of completion containing the following information:

- Name of participant
- Title of approved courses
- BBS approval #
- BBS approved certifications
- Date of the continuing education program
- Number of approved credit hours awarded, and
- Signature of authorized sponsor or instructor.

Any person or organization administering an approved course shall return a completed BBS Course Attendance form by email.

Participants: Participants must attend the complete course as presented by the instructor to receive credit hours approved by the Board. The organization or instructor of online courses shall plan and execute methods to verify the individual's attendance and completion of the course. No partial credit will be given to any participant who failed to complete the entire course as approved.

Board approval: All courses are approved for the calendar year in which application is made. Courses may be renewed so long as the referenced code is in effect, and the CEUs, certification and content remain unchanged. When the referenced code is updated, courses must be updated, and new approvals obtained.

Facility/training area: BBS Course may be delivered in person or online, or both, at the sponsor's option.
Course facilities shall include the following:

In Person Classes:
- Sufficient seating capacity
- ADA accessible facilities
- Appropriate Audio/Visual devices for delivery
- Writing surfaces for participants

Online Classes:
- Web-accessible
- ADA accessible delivery
- Tech support available
- Live and recorded courses permitted

In-person facilities shall comfortably and safely seat at least the number of attendees present in the room and shall be climate controlled, non-smoking, and sound controlled so that outside noise will not interfere with the training.

Ohio | Department of Commerce

Mike DeWine, Governor
Jon Husted, Lt. Governor

Sheryl Maxfield, Director

Board of Building Standards

Application for Continuing Education Course Approval

Provider Information:

Name: Henry P. Matthews

Organization: Matthews Electrical Services

Address: 1203 McKinley Place; Fostoria, Ohio 4830

E-mail: hpmatthews@matthewselectrical.net Telephone: 419-575-3488

Website: www.matthewselectrical.net

Conference Sponsor (if applicable)________ Conference Email:________

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

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

New Course Information:

Course title: Electric Vehicle Power Transfer Systems and the NEC Part 2

Course instructor: Henry P. Matthews

Course description: This course will cover article 625 in the NEC for electric vehicle power transfer systems. This course will follow up on Electric Vehicle Power Transfer Systems and the NEC Part 1 and will focus on code-compliant installations. Examples of a single phase Level 2 charger installation and a three-phase level 2 charger will be presented and explained.

Instructional hours per session: 4 Number of Sessions: at least one per quarter

Course Date(s) and Location: , 5-27-2023 via Zoom. Registration at www.matthewselectrical.net

Special Content:

Code Administration:______ Conference Course: ________

Existing Buildings: ______ Conference Name: ________

Electrical Instruction: ______ Conference location:________

Plumbing Instruction:______

Course to be offered online? ✓ **On Demand**_____ **Webinar** ✓

Course Website: www.matthewselectrical.net

Detail online course participation confirmation method (*i.e. test, quizlets, participant activity confirmation*):
Surveys, polls, and roll call after each break will be conducted.

Course applicable for the following certifications

Residential Certifications Only: ✓ Commercial Certifications: ✓

Administrative Course, All Certifications: _______

Application materials included:

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

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

Instructions for new Continuing Education Approval form

Provider Information

1. Please include all contact information.
2. If course is not part of a conference, leave conference sponsor and email blank.

Course Renewal

1. Indicate if the course is being submitted for renewal. Include prior approval letter and write in prior course number.
2. Certification approval for courses has now changed: all existing courses being renewed will be approved within the new classification system.
    a. Courses previously approved for only residential certifications will be approved for all residential certifications.
    b. Courses previously approved for at least on commercial certification will now be approved for all commercial certifications and all residential certifications.
    c. Courses on required instruction topics, Ohio Ethics, Code Administration and Existing Buildings, will be noted as Administrative Courses and be approved for all certifications.
3. Courses being renewed should skip the New Course information section and are not required to submit outline, agenda, slides or other instructional materials for review. Skip to Special Content, and mark any item that applies to the course.

New Course Information

1. Enter course title, name of instructor, and a brief description of the course content. Learning objectives may be substituted for course description, if desired.
2. Number of instructional hours per session is the length of instructional time.
3. Number of sessions: can be 1 or the number of sessions planned.
4. Course date(s) and location: not necessary at this time, enter if known.

Special Content

1. Indicate if the course will meet instructional time in Code Administration or Existing Buildings.
2. Indicate if the course is a plumbing or electrical course, for ESIAC review and trainee course tracking.
3. If the course is associated with a conference, indicate the conference name and location, as this will allow BBS to coordinate approvals with the conference provider.
4. If the course will offered online, specify whether it will be on demand or offered as a virtual webinar, or both. Include website where the course will be provided.

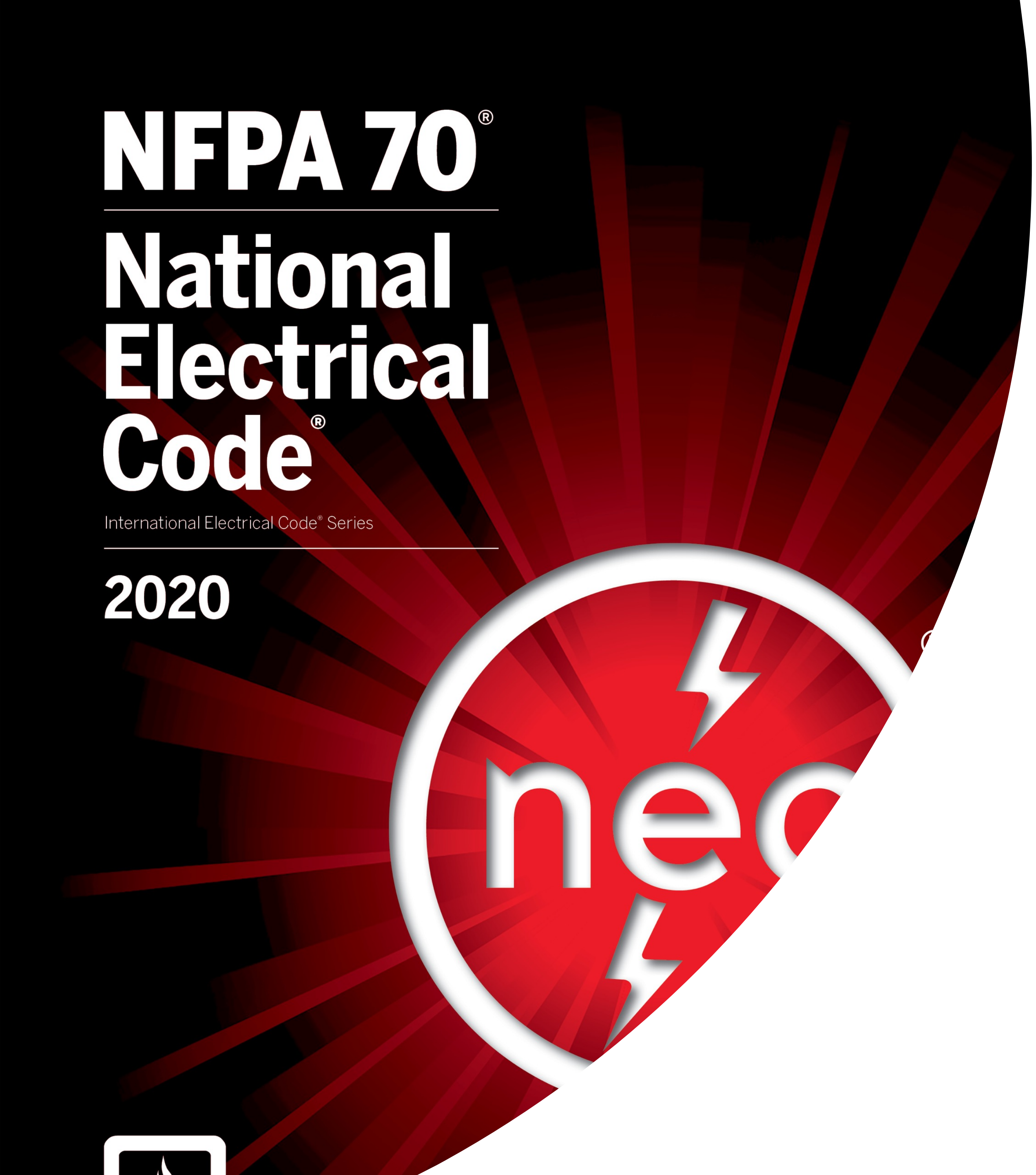
Course applicable for the following certifications

This section represents a major change from previous BBS course approval forms.

1. If the course is only for residential certifications, check 'Residential Certifications Only'. The course, if approved, will be approved for all residential certifications.
2. If the course is appropriate for any commercial certifications, check Commercial Certifications. The course, if approved, will be approved for all commercial certification **AND** all residential certifications.
3. If the course is intended to meet required instruction in Code Administration (Chapter 1) or Existing Buildings (commercial or residential) check 'Administrative Course, All Certifications'.

Application Materials Included

This is a checklist for the course submitter's use, to be sure all materials necessary for review are included with the application. All materials should be submitted in .pdf format, along with the application, via email to Michael.Lane@com.ohio.gov or BBS@com.ohio.gov



Electric Vehicle Power Transfer Systems and the NEC Part 2

OCILB Course # 4871435

The 2020 NEC has not been adopted in Ohio. PRESENTED FOR INFORMATIONAL PURPOSES ONLY

Notice!

This course is based on the 2020 NEC.

The 2020 NEC has not been adopted in Ohio

Presented for
INFORMATIONAL PURPOSES ONLY.

Webinar Rules

- Attendee must be present the entire time (except breaks)
- Mute microphone at all times
  - Prevents distraction during webinar
  - Instructor may activate participant microphone if verbal response is needed

Webinar Rules (Continued)

- 5 minute breaks every hour
  - Return promptly after breaks
  - The instructor will check attendance after each break
- Emergencies
- Contingency Plans: Ohio Weather
- Unexpected interruption
  - Re-joining webinar
  - Problems:
    - send me a text message: 419-575-3488
    - Or email: hpmatthews66@att.net

Webinar Completion

- Certificate of completion will be sent via email to all attendees
- 4 hours of Code credits will be submitted to the OCILB and OBBS state boards within 48 hours of class
- Feedback is encouraged to improve future webinars!
- Send other inquires, feedback and questions to: hpmatthews@matthewselectrical.net
- 419-575-3488 (cell)

WELCOME!

- Goals
  - Promote learning
  - Make session engaging
    - Discussion
    - Videos
    - Case Studies
    - Polls
  - Make 4 hours as productive as possible!

Ohio Department of Commerce
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Continuing Education Class Search

Note: Click on the provider name to show any available details.

Course Number	Course Name	Subject	Hours	Provider	Location	Date	Time	Phone	Address
4871435	ELECTRIC VEHICLE POWER TRANSFER SYSTEMS AND THE NEC PART 2	CODE	4.00	MATTHEWS ELECTRICAL SERVICES	www.matthewselectrical.net www.zoom.com 1203 McKinley Place Fostoria, OH 44830	01/14/2023	07:00	419-575-3488	1203 McKinley Pl Fostoria, OH 44830-4714
4871424	SOLAR PHOTOVOLTAICS AND THE NEC PART 1	CODE	4.00	MATTHEWS ELECTRICAL SERVICES	www.matthewselectrical.net www.zoom.com 1203 McKinley Place Fostoria, OH 44830	01/21/2023	07:00	419-575-3488	1203 McKinley Pl Fostoria, OH 44830-4714
4871429	SOLAR PHOTOVOLTAICS AND THE NEC PART 2 WEBINAR	CODE	4.00	MATTHEWS ELECTRICAL SERVICES	www.matthewselectrical.net www.zoom.com 1203 McKinley Place Fostoria, OH 44830	01/28/2023	07:00	419-575-3488	1203 McKinley Pl Fostoria, OH 44830-4714

CERTIFICATE OF COMPLETION

THIS CERTIFIES THAT

JOE STUDENT

OCILB License no: 12345 (Electrical, Plumbing)

HAS SUCCESSFULLY COMPLETED THE TRAINING REQUIREMENTS FOR

Electrical Vehicle Power Transfer Systems Part 2

OCILB COURSE NO: 4871435

4 CODE CREDIT HOURS

January 14, 2023

DATE

MATTHEWS ELECTRICAL SERVICES

Agency #48714

HENRY P. MATTHEWS PE, CESCP

INSTRUCTOR

The Electric Vehicle Infrastructure Training Program

Presents this

Certificate of Completion

#4034465

of the 20 hour EVITP Installer Training Course

to

Henry Matthews

Date of Certification, September 21, 2022

Valid Through, September, 2025

Jennifer Mefford, EVITP Chair

Bernie Kotlier, EVITP Chair

Your Instructor: Henry Matthews

- Advanced Senior Engineer (Current): (16 yrs)
- Plant Engineering Manager: Cooper Standard Automotive (13 yrs)
- Electrical Designer: Toledo Engineering Company (4 yrs)
- BS Electrical Engineering – Penn State University
- MBA – Bowling Green State University
- Registered Professional Engineer – OH, IN, KY, WI, MI, IL,WV
- Certified Professional Engineer – CPE
- Certified Electrical Safety Compliance Professional (CESCP) by NFPA
- Licensed Electrical Contractor – OH
- Registered Training Agency – OCILB OH #48714
- Registered Training Agency – Ohio Board of Building Standards (BBS)
- Senior Member of IEEE
- Member of NFPA – Builders and Architects division
- Member of International Association of Electrical Inspectors (IAEI)
- Member of Association of Facility Engineers (AFE)
- Co-chair API RP 545 – Lightning Protection for Above Ground Storage Tanks
- Over 29 years in the electrical design, construction and standards industry

Mike DeWine
Governor

Sheryl Maxfield
Director

Ohio Construction Industry Licensing Board
Approved Training Agency

MATTHEWS ELECTRICAL SERVICES

Training Agency License: **48714**

Expiration Date: **10/17/2023**

Carol Ross

Carol A. Ross
Board Secretary

William Koester

William Koester
Administrative Chairman

Mike DeWine
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OHIO CONSTRUCTION INDUSTRY LICENSING BOARD

Electrical

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HENRY P MATTHEWS

MATTHEWS ELECTRIC SERVICES

OWNER

Ohio License# **46972**

Expiration Date: **December 17, 2023**

STATE OF OHIO

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Carol Ross

Carol A. Ross
Board Secretary

William Koester

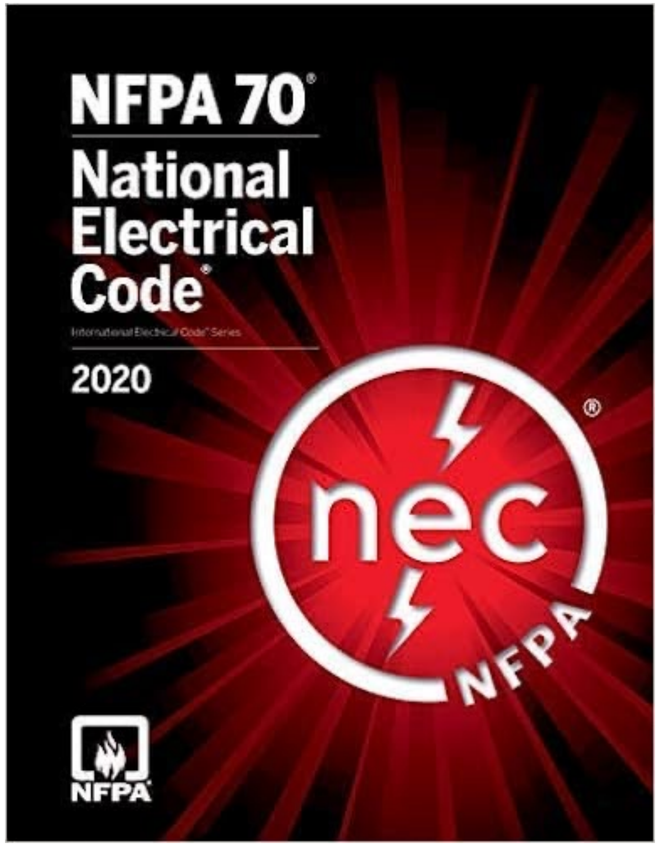
William Koester
Administrative Chairperson

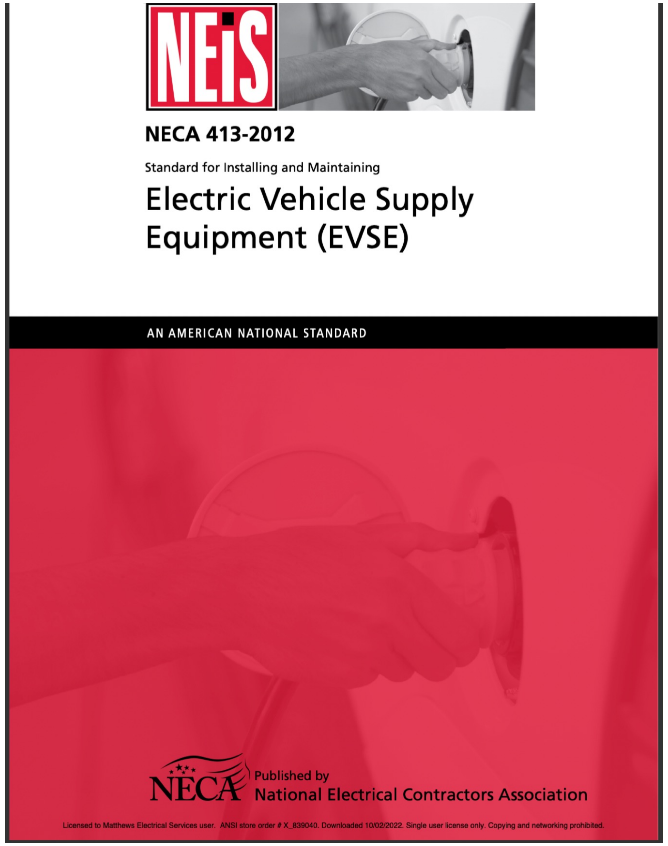
Electric Vehicle Power Transfer Equipment and the NEC Part 2

Agenda

- Part 1 review
- EV Current State
- Article 705: Interconnected Electrical Power Sources
- Residential Installation Example
- Commercial Examples:
  - Three-phase system power, single phase charger application
  - Three-phase system power, three phase charger app

Resources


NFPA 70®
National Electrical Code®
International Electrical Code® Series
2020
nec
NFPA
NFPA


NEiS
NECA 413-2012
Standard for Installing and Maintaining
Electric Vehicle Supply Equipment (EVSE)
AN AMERICAN NATIONAL STANDARD
NECA
Published by
National Electrical Contractors Association
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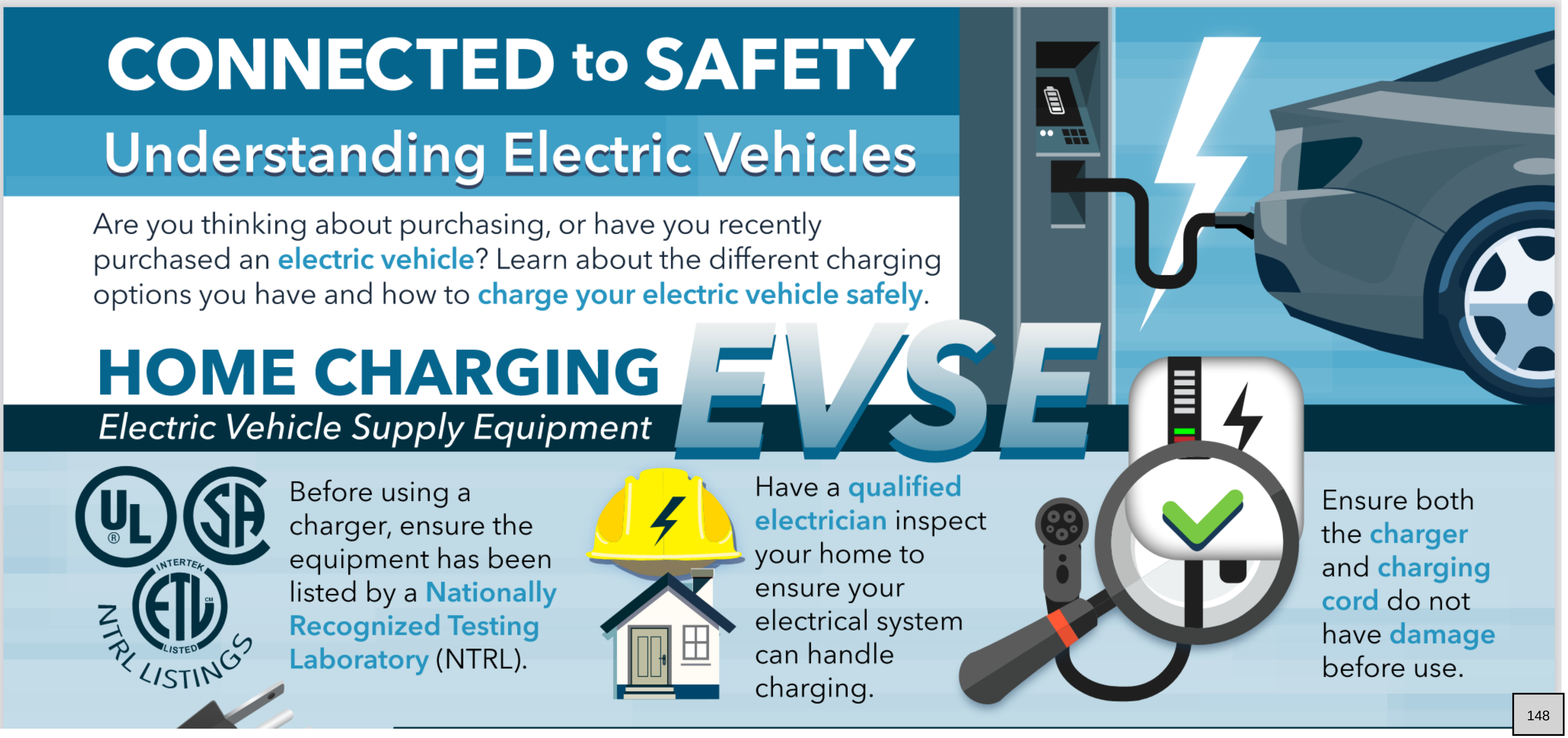
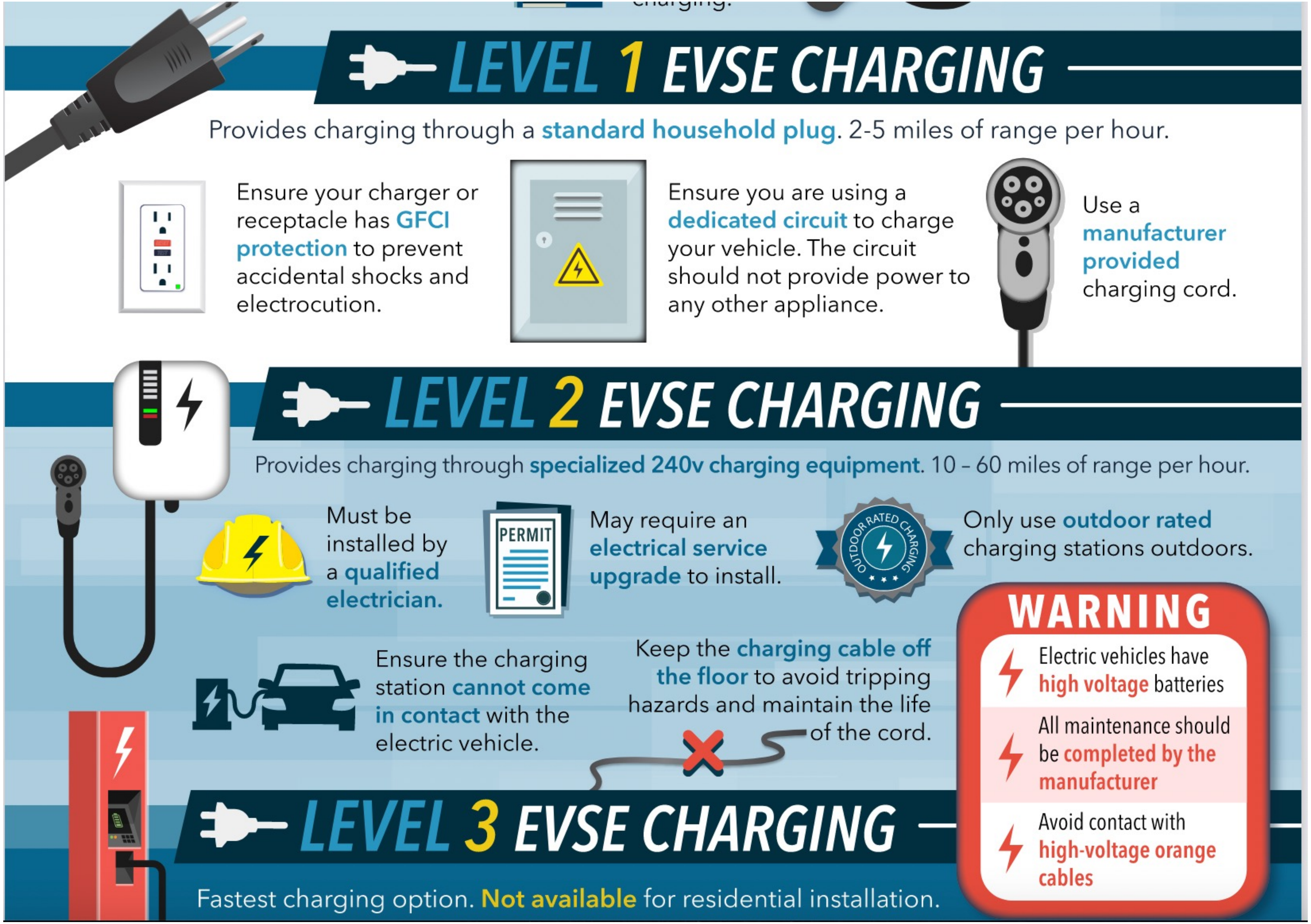
Websites

- www.NFPA.org
- www.evassociation.org   Electric Vehicle Charging Association
- www.chargedevs.com. Charged Electric Vehicles Magazine
- www.IAEI.org (International Association of Electrical Inspectors)
- www.mikeholt.com
- www.esfi.org Electrical Safety Foundation International)
- https://www.nrel.gov/ National Renewable Energy Laboratories
- Multiple automobile and Class 2/DC Fast charger manufacturer websites

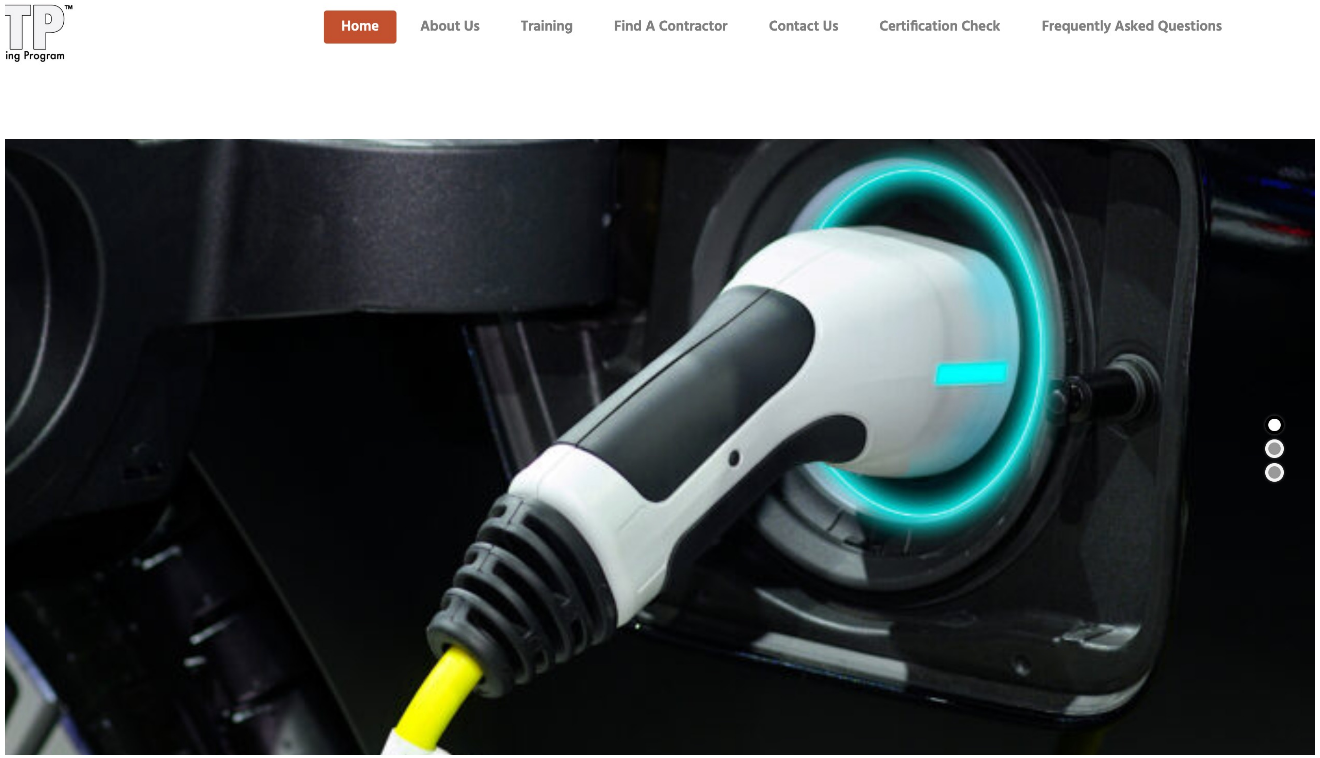
Always Lead with Safety!





Courtesy ESFI.org

Electric Vehicle Infrastructure Training Program (EVITP)



- https://evitp.org/

2.2. Electric Vehicle Adoption in Ohio

Figure 3 show the concentration of EVs registered in Ohio. Logically, the highest concentrations of EVs are in the largest metropolitan areas of Cleveland, Columbus and Cincinnati – followed by Akron, Dayton, Toledo and Youngstown. Among these, the greatest acceleration has occurred in the Columbus region. This is due primarily to major consumer education campaigns through Smart Columbus and assisted by some rebates for government fleet purchases. Growth in other metro areas have also been assisted by "grassroots" education campaigns.

Over 40% of plug-in vehicles registered in Ohio are Tesla vehicles (see **Table 1**), all of which are fully battery electric (BEV). Thus, about 75% of the BEVs registered in Ohio are Teslas. Ohio has seen steady growth in electric vehicle sales and registrations. Consistent with national trends, Ohio EV sales have accelerated with the introduction of mid-market priced BEVs with battery pack ranges of over 200 miles.

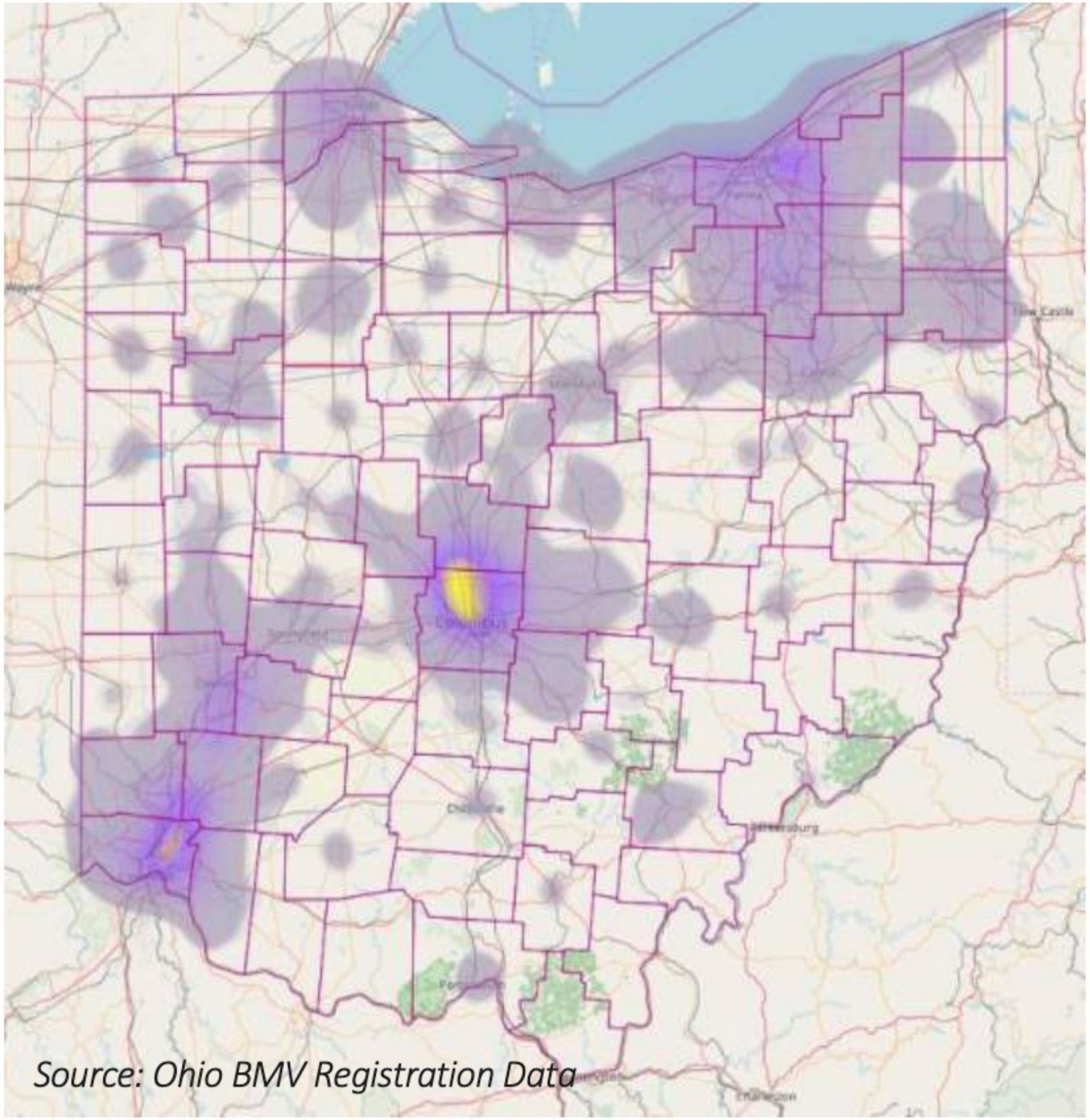


Figure 3: Ohio Concentration of Plug-In Vehicles

Review

Types of Electric Vehicles

Hybrid Electric Vehicles (HEV)

Plug-In Hybrid (PHEV)

Plug-In Electric Vehicle (PEV)

Battery Electric Vehicle (BEV)

Relevant NEC Chapters and Articles (Based on the 2020 NEC)

- **Article 625 Electric Vehicle Power Transfer Systems**
- Article 100 Key Definitions
- Article 110 Requirements for Electrical Installations
- Article 210 Branch Feeders - including GFCI requirements
- Article 215 Feeders
- Article 220 Branch-circuit, Feeder and Service Load Calculations
- Article 230 Services

Relevant NEC Chapters and Articles (Based on the 2020 NEC)

- Article 240 Overcurrent Protection
- Article 242 Overvoltage Protection
- Article 250 Grounding and Bonding
- Chapter 3 Wiring Methods and Materials
- Article 685 Integrated Electrical Systems
- Article 690 Solar Photovoltaic Systems

Relevant NEC Chapters and Articles (Based on the 2020 NEC)

- Article 702 Optional Standby Systems
- **Article 705 Interconnected Electric Power Production**
- Article 706 Energy Storage Systems
- Chapter 9 Tables

Other Resources

- NFPA 70E (2021) Electrical Safety in the Workplace
- NECA 413 Standard for Installing and Maintaining Electrical Vehicle Supply Equipment (EVSE)
- OSHA 1910 Subpart S Electrical Safety

UL and Other Standards

- **UL 2594** Electric Vehicle Supply Equipment
- **UL 2231** Personal Protection Device (i.e., CCID Hardware)
- **UL 1998** Standard for Safety-Related Software
- **UL 991** Standard for tests for Safety-Related Controls Employing Solid-State Devices
- **SAE J1772** Electric Vehicle Conductive Charge Coupler

NEC 705

- IEEE Std 2030.7-2017, *IEEE Standard for the Specification of Microgrid Controllers*,
- IEEE Std 2030.8-2018, *IEEE Standard for the Testing of Microgrid Controllers*, provide information on microgrid controllers.
- IEEE Std 1547-2018, *IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces*.

Residential Installations

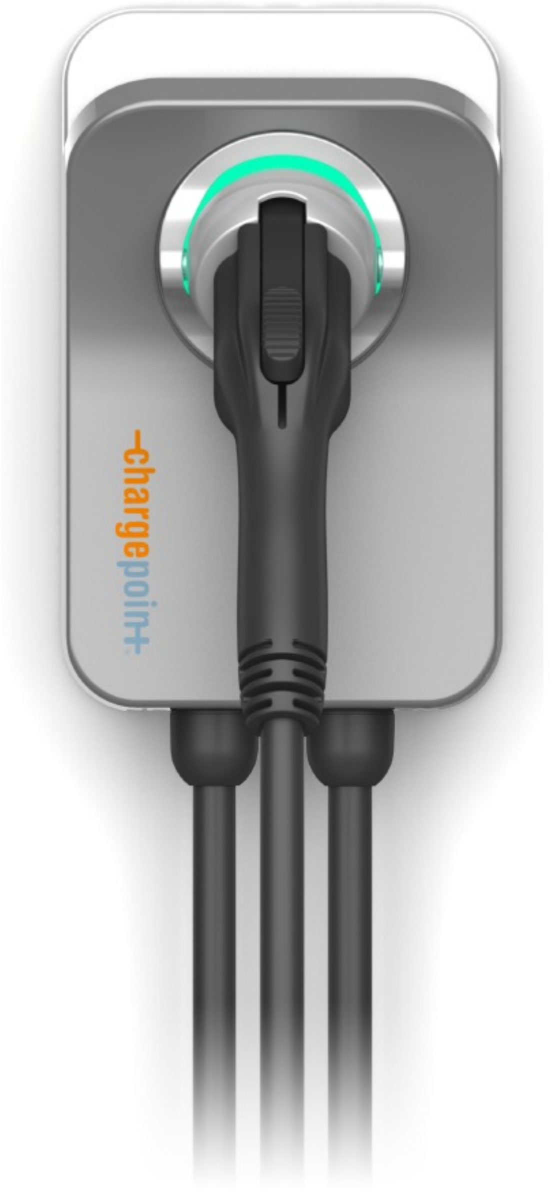
- Verify that equipment has proper listings: UL, ETL, CSA, TUV e.g.
  - Note: CE, RoHS, ISO 9000 etc. are not acceptable in the US!
- Read all manufacturer instructions!
- Follow all grounding and bonding requirements from manufacturer and the NEC
- Do not install in a hazardous location unless the equipment is rated for the location (Class I, Division 2, Class II, Division 2 for example)
  - See NEC chapter 5
- Inspect equipment for damage prior to installation

Residential Installations

- Use recommended wire type and material (90 deg C, copper) for example
- Make sure charger will be operating within its temperature range
  - Verify in extreme hot and cold locations
- Determine whether charger will be installed indoors or outdoors
  - Verify equipment is rated for outdoor, wet or damp locations if installed outdoors

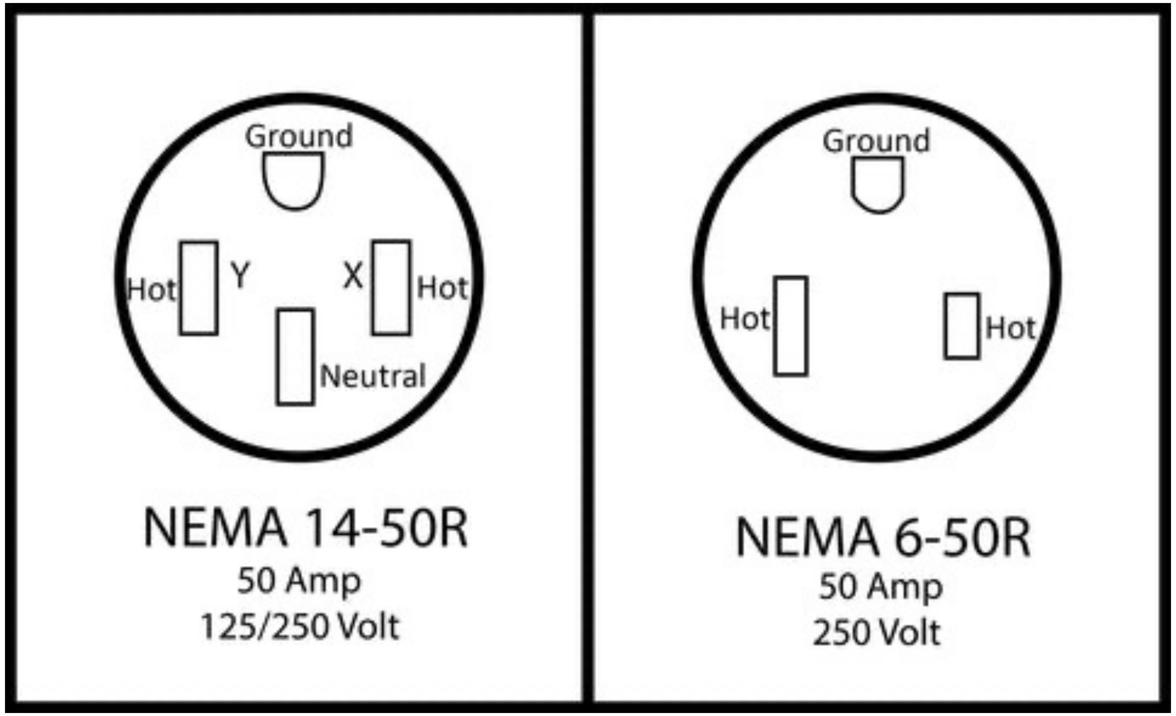
Example:

ChargePoint HomeFlex, 16A-50A Flexible Amperage Charger



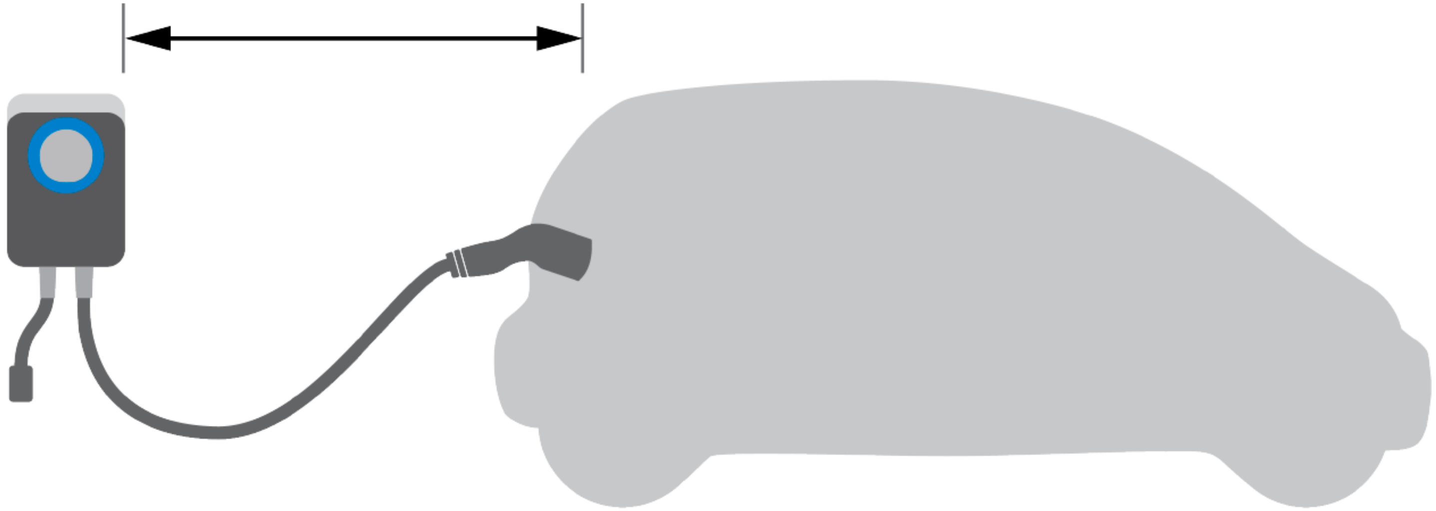
Options

- Use one NEMA 14-50 or NEMA 6-50 Outlet
- Fastened in place equipment shall be connected to the premises wiring by one or more of the following methods per 625.43(B) Fastened In-Place Equipment



Installation

- Choose an installation location that allows the charging cable to reach the car’s charging port while still providing slack
- Ensure a stud is available for mounting the charger
- Ensure a reliable WiFi signal is available

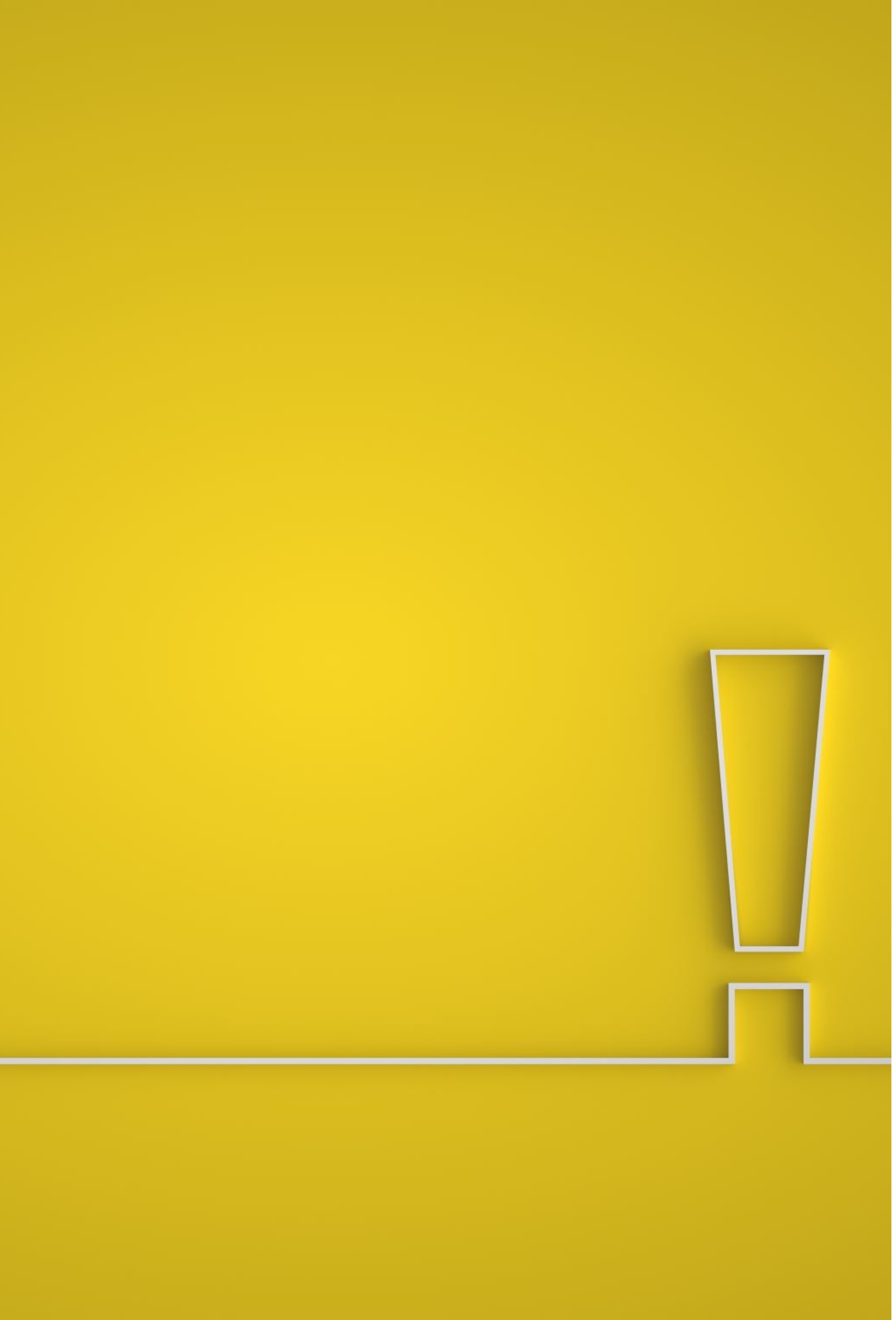


Outdoor Installation Option

- Requires outdoor –rated weather-resistant electrical outlet per 625.56
- Or hardwired installation

A *plug-connected charging station* must be installed close to the outlet. The image above shows how a *plug-in HCS model* could be installed outdoors. Note the weather-proof outlet covering.

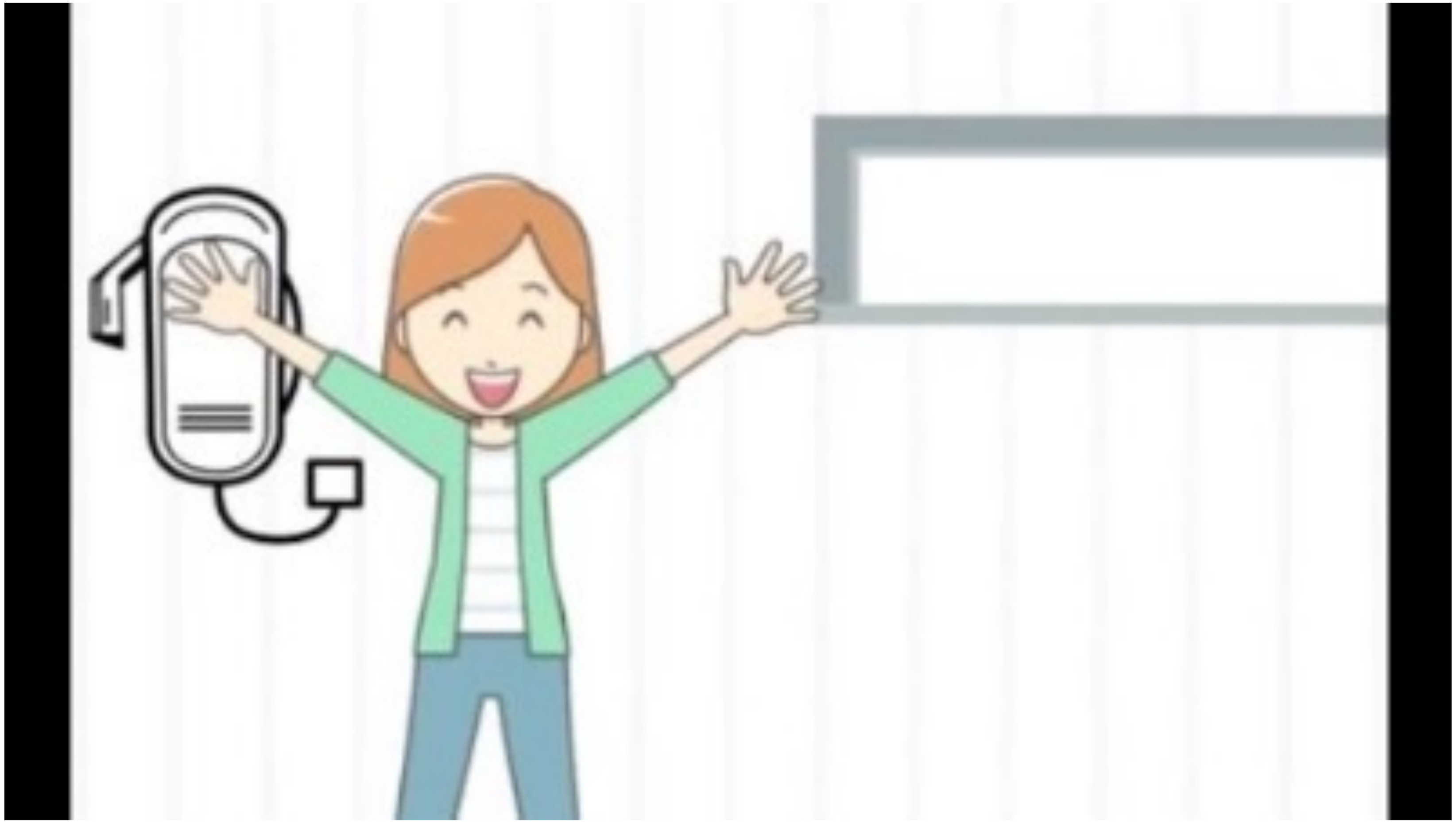
A *hardwired charging station* can be installed indoors or outdoors, but is always recommended for any given outdoor installations. Notice the conduit coming from the bottom of the hardwired HCS model and the ridged cord.



625.56 Receptacle Enclosures

- Receptacles for EV charging in a wet location shall be installed in a weatherproof enclosure
- Outlet box hood for the WP enclosure shall be listed and identified for Extra Duty
- If the the enclosure or assembly does not include a hood, it is not required to be marked as Extra Duty

Hardwire or Plug-In Installation?



Surge Protection

- In areas with frequent thunderstorms, add surge protection at the service panel for all circuits.

- Reference NEC Article 242
  - Note: not a NEC 2017 requirement. This is a 2020 NEC requirement

Determine Required Charging Amps

- Check electrical panel available space
- Check electrical service available capacity
- Important! Chargers are considered a Continuous load
- Multiply rated amps x 125% (1.25) per NEC 625.41

625.41 Overcurrent Protection (Circuit Breakers or Fuses)

- Overcurrent protection for EVSE and WPTE equipment shall be sized for continuous duty (125%)
- Shall have a rating of not less than 125% of the maximum load of the equipment.
- Use nameplate data to determine maximum rating
- Where noncontinuous loads are supplied from the same feeder, the overcurrent device shall have a rating of not less than the sum of the noncontinuous loads plus 125 percent of the continuous loads.

Determine Required Charging Amps

- Charge controller can be installed at a variety of amperages
- Determine if homeowner prefers plug-in or hard-wired installation

CAUTION: Home Flex is a continuous load device. The circuit must be rated for 125% of the maximum load.

Circuit Rating	Max Load	Estimated Range per Hour	Plug-In	Hardwire
50 A	40 A	30 miles/48 km	yes	yes
40 A	32 A	25 miles/40 km	yes	yes
30 A	24 A	18 miles/29 km	no	yes
20 A	16 A	12 miles/19 km	no	yes

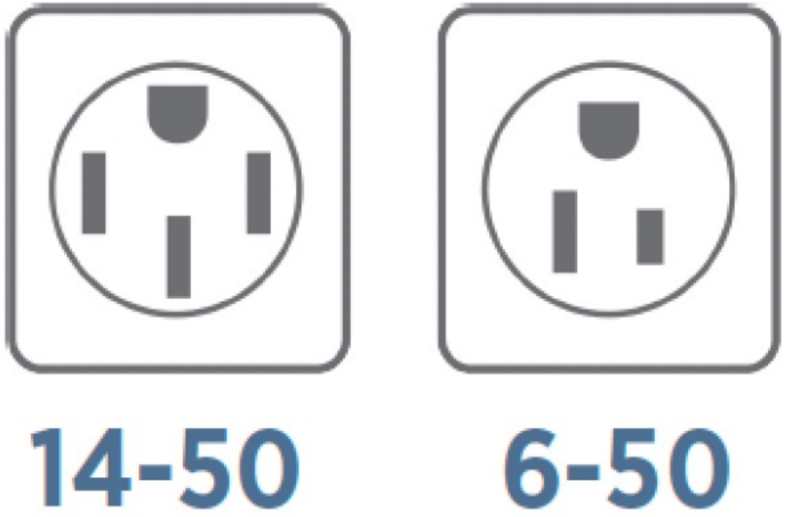
Higher Charging Amps

- This unit is capable of charging at higher amps
- Check electrical service to determine if adequate supply is available

Circuit Rating	Max Load	Estimated Range per Hour	Plug-in	Hardwire
80 A	50 A	37 miles/60 km	no	yes
70 A	50 A	37 miles/60 km	no	yes
60 A	48 A	36 miles/58 km	no	yes

Determine Appropriate Outlet and NEMA Receptacle Size

For single phase 240V application
- Hot (L1)
- Hot (L2)
- Neutral
- Ground



For single phase 120V application
- Hot
- Neutral
- Ground

Required for this installation

Electrical Service

- Ensure the panel can accept a 2-pole, 240-volt circuit breaker
- Ensure this will be a dedicated circuit per 625.40
  - *Each outlet installed for the purpose of charging electric vehicles shall be supplied by an individual branch circuit. Each circuit shall have no other outlets.*

625.54 Ground-Fault Circuit-Interrupter Protection for Personnel

- Portable and fastened-in-place EVSE that is permitted to be cord-and plug-connected must be supplied through a GFCI-protected receptacle.
  - *Henry's take: As far as I know, I have not seen any NEMA 14-50 GFCI receptacles, therefore, this must be a GFCI breaker at the panel (2-pole, 240V)*
  - *Amperage to be determined later*
- What about hard-wired installations?

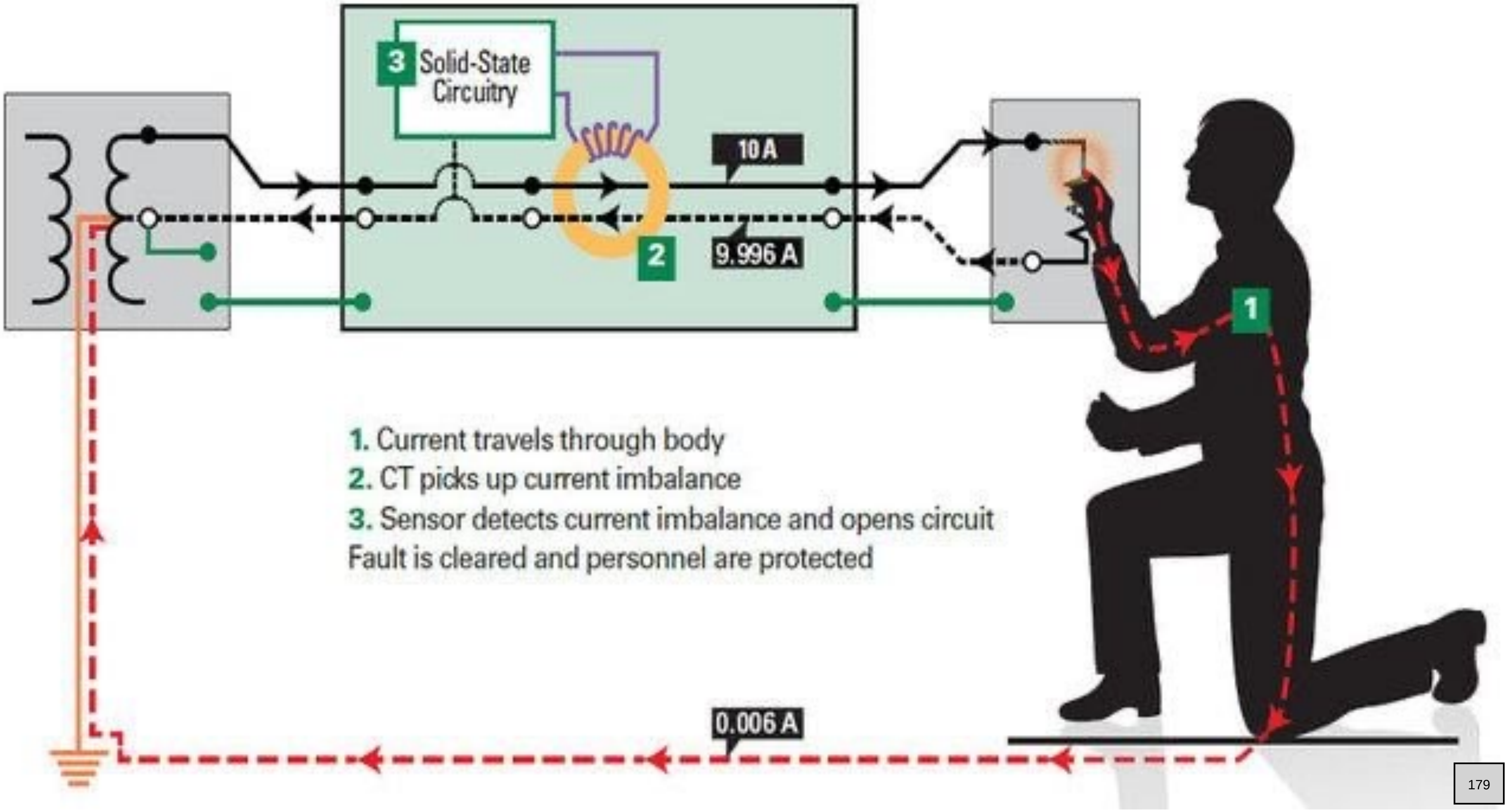
625.54 Ground-Fault Circuit-Interrupter Protection for Personnel

- The outlet supplying direct-connected EVSE is not required to be GFCI protected unless specified in the manufacturer's instructions.

- *Henry's note: Many manufactures have built-in GFCI or shock protection*

Remember

- Per the NEC, GFCI's are required for
  - Garages *per 210.8(A)(2)*
  - Outdoor installations *per 210.8(A)(3)*
  - NEW for 2020 NEC: installations rated 150 VAC to ground or less. This includes 208V (120 volts to ground) and 240 V (120 volts to ground) installations *per 210.8(A)*


3 Solid-State Circuitry
10 A
2
9.996 A
1
1. Current travels through body
2. CT picks up current imbalance
3. Sensor detects current imbalance and opens circuit
Fault is cleared and personnel are protected
0.006 A

From Clipper Creek…

- With a hardwired charging station **you generally do not need to have a GFCI circuit breaker in place** whereas you would be required to have this for any 240V outlet used for an electric vehicle charging station per National Electric Code requirements.

From Clipper Creek…

- Using a GFCI breaker to supply a charging station can result in nuisance tripping of the breaker during charging. The trip threshold for a standard U.S. GFCI breaker is 5mA which is relatively low for electric vehicle charging. For comparison, charging stations have 20mA GFCI protection built it. At the 5mA trip threshold you may experience nuisance tripping of the circuit breaker during charging due to noise on the line generated by the vehicle.

Per the 2020 NEC…

625.54 Ground-Fault Circuit-Interrupter Protection for Personnel.

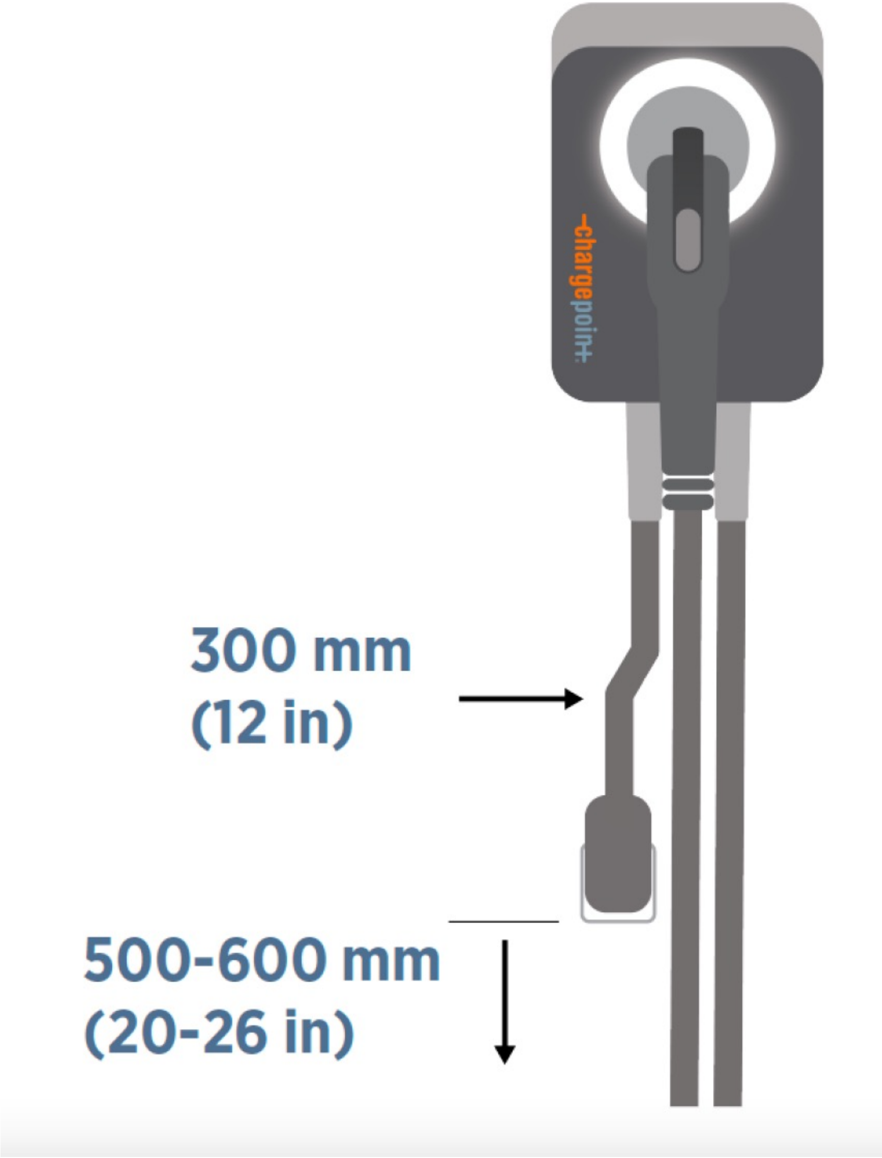
In addition to the requirements in **210.8**, all receptacles installed for the connection of electric vehicle charging shall have ground-fault circuit-interrupter protection for personnel.

ENHANCED CONTENT Collapse

Portable and fastened-in-place EVSE that is permitted to be cord-and plug-connected must be supplied through a GFCI-protected receptacle. This includes all the single- and three-phase receptacle configurations specified in **625.44**(A) and (B). The outlet supplying direct-connected EVSE is not required to be GFCI protected unless specified in the manufacturer's instructions.

Mounting

- For plug-in applications, the outlet should be located 20-26 inches from the ground
- Note: The input cable is 12 inches long per the NEC



625.50 Location

- Minimum mounting height for fixed or fastened-in-place EVSE coupling connectors (cabling and connectors)
- Not less than 18 inches above the floor for indoor locations
- Not less than 24 inches above the grade for outdoor locations

Details

- 240/120 Volt, 200-amp existing service
- 100 amps of existing load
- Several spaces in panel available
- Decide to use 40 amp charging (40 rated amps)
- Uses 50-amp circuit per instructions
- Installing inside of the garage
- Plug-in installation*
- *GFCI protection required
- NEMA 14-50 receptacle
- Using NM (Romex) cable, no conduit

Example Calculations: Residential Single Phase

- Can the existing panel handle the new load?
- What size overcurrent protection is required?
- What size wire is required for feed the charger?
- Is voltage drop acceptable?

Example Calculations: Residential Single Phase

- Charger rated 240 VAC, 40 amps, 9600 watts
- Since EVSE (chargers) are considered a continuous load:
  - 40 x 1.25 = 50 Amps
- Existing service has 100 amps of load existing (max demand)
  - 100 + 50 = 150 Amps
  - Yes, the 200 amp panel can handle the additional EVSE load

Calculate Wire Size

- Since EVSE is a continuous load: 40A x 1.25 = 50 amps
- Size wire size for 50A

334.80 Ampacity.

The ampacity of Types NM and NMC cable shall be determined in accordance with **310.14**. The ampacity shall not exceed that of a 60°C (140°F) rated conductor. The 90°C (194°F) rating shall be permitted to be used for ampacity adjustment and correction calculations, provided the final calculated ampacity does not exceed that of a 60°C (140°F) rated conductor. The ampacity of Types NM and NMC cable installed in cable trays shall be determined in accordance with **392.80(A)**.

Final Design

- 60 amp, 2-pole, 208V CB (non-GFCI)
- Hardwired (no receptacle or plug)
- (2) #2 THWN-2 and (1) #4 THWN-2 EGC in ¾” RMC

Three Phase Example

- What is the minimum size 120/208 V, three –phase OCPD and THWN-2 CU feeder required to supply 6 CS-40 chargers?

- Assume all equipment is rated 75 deg C

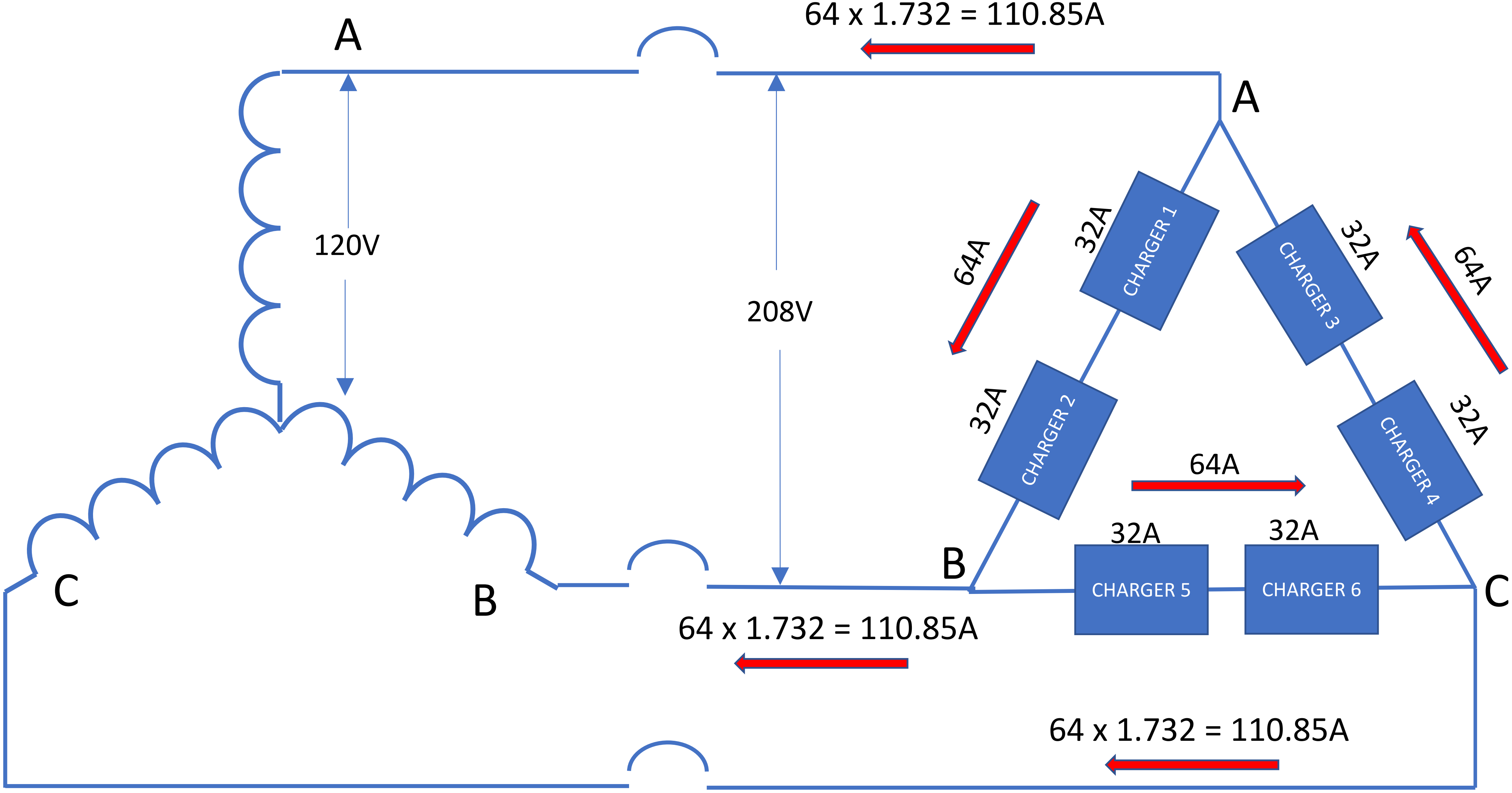
- Assume load is balanced

- For 6 chargers, there will be 2 chargers on each phase to balance the load

Example

- One charger draws 32 A.
- Power for one charger = 32 x 208 = 6656 VA (Watts)
- For 6 chargers, total power = 6656 x 6 = 39,936 VA (Watts)
- 3-phase power equation: P = 1.73 x V x I
- I = P/(1.73 x V) = 39,936/(1.732 x 208) = 110.85 A
- Since loads are balanced, there will be 110.85 amps on each phase
- Since chargers are continuous loads, multiply current by 125% for OCPD and wire size calculations

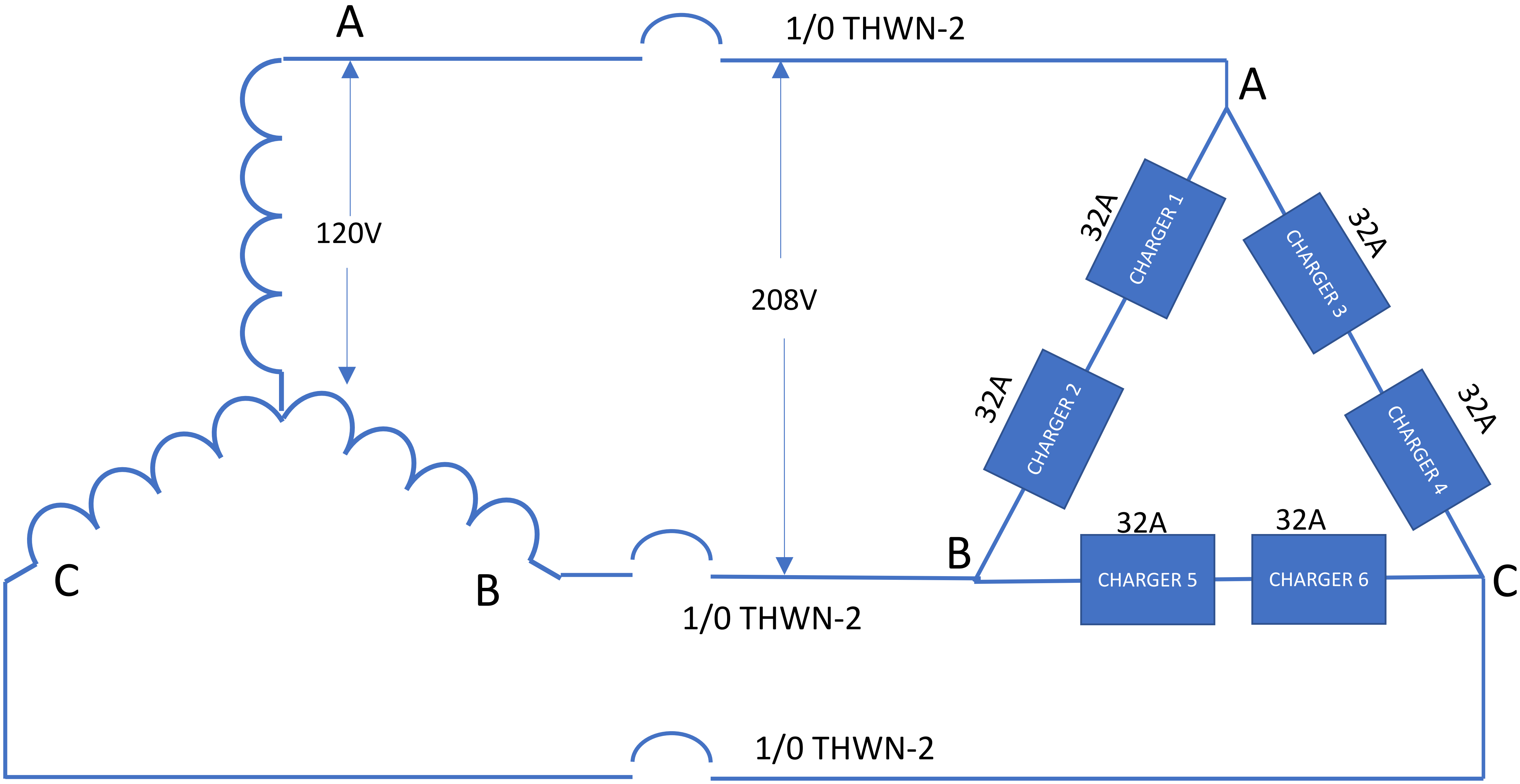
400A Service



Determine Wire Size

- Multiply line currents by 125%
- 110.85 x 1.25 = 138.57 A
- 1/0 THWN-2 wire is good for 150 A @ 75 deg. C

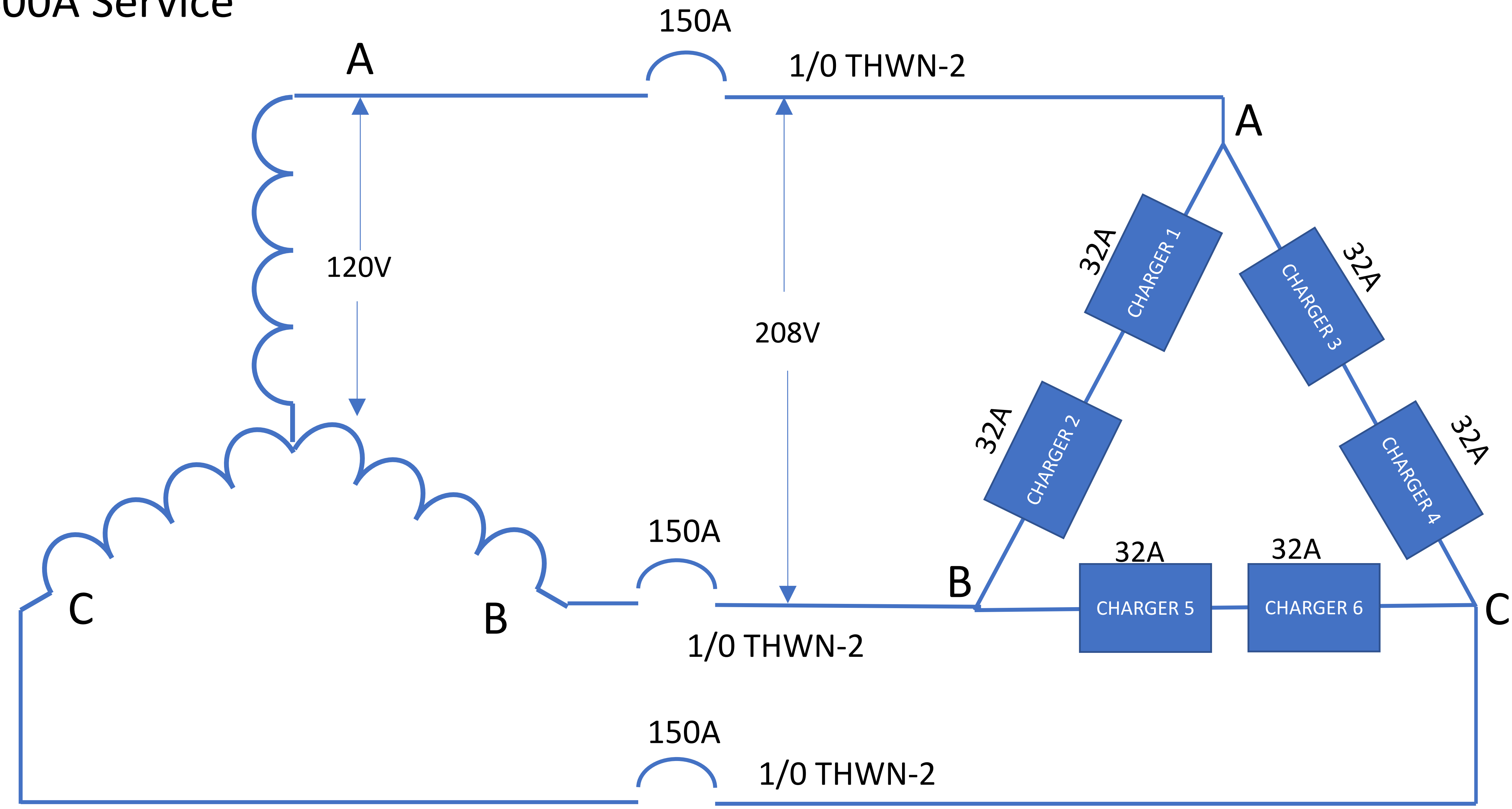
400A Service



Determine Overcurrent Protection Size

- Multiply line currents by 125%
- 110.85 x 1.25 = 138.57 A
- There is no standard CB for 138.57 A, so OK to use next size up
- 150A CB

400A Service



Can 150A CB Protect 1/0 Wire?

- 1/0 THWN-2 wire at 75 deg C is good for 150A
- Yes, 150A circuit breaker can protect 1/0 wire

Other Adjustment Factors to Consider

- Number of wires in conduit
- Ambient temperature
- Voltage Drop

Follow up question…

- If this 400 A service already had 200A of load on it, can it accept the new charger loads?
- New load is 32A/charger x 6 chargers = 192 amps
- Since chargers are considered a continuous load, have to add 125%
- 192 x 1.25 = 240A
- 200 amps of existing load + 240 amps of new load = 440 amps
- No! The service cannot accept the new load!
- Would need to:
  - install a larger service
  - Decrease existing load
  - Or select lower wattage chargers!

Other Considerations for Commercial Installations

- Placement of chargers: Charging for one car or two
- Protection of chargers: bollards, concrete curbs etc.
- Access to chargers
- Protection of cables
- Theft of cables
- Physically Impaired driver access: ADA compliance
- Lighting of areas
- Water Drainage

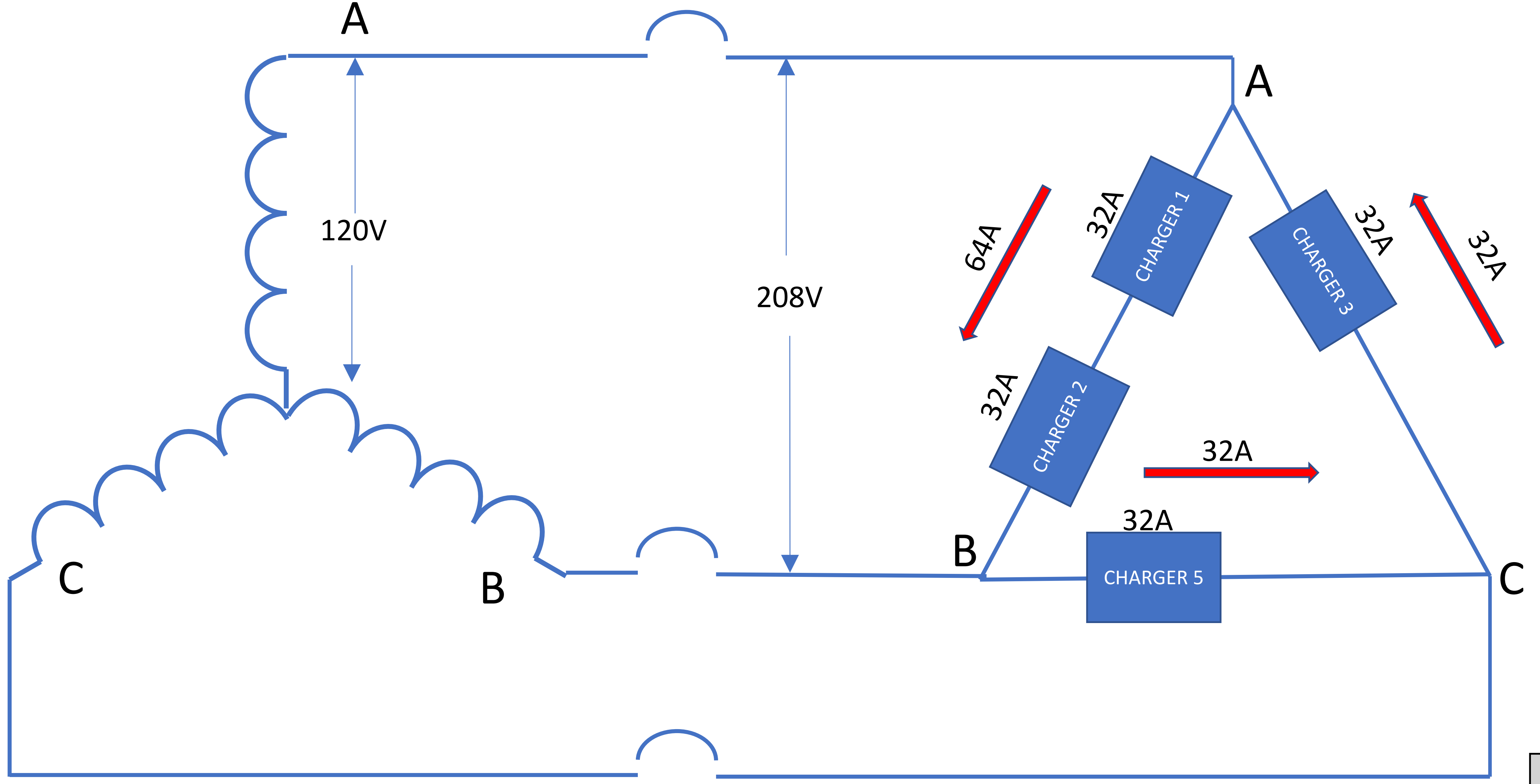
Warning! Uglier Math Ahead!

Challenges

- Unbalanced loads
- Long feeder distance to charger - voltage drop
- Hardwire installations
- If using parallel feeds: avoiding inductive heating
- Must consider neutral current due to line imbalance (if using neutral)
- Circuit Breaker selection

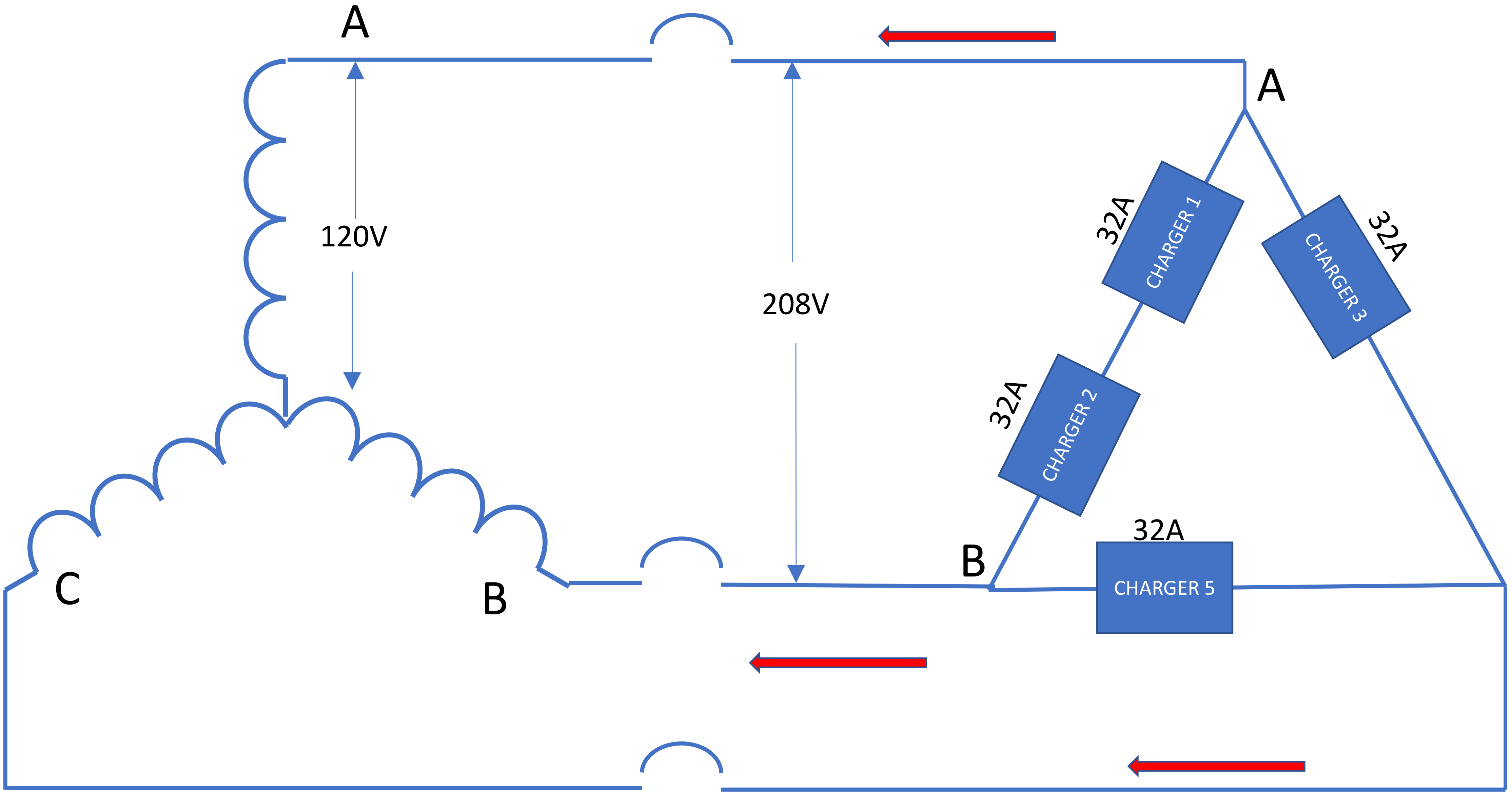
400A Service

Determine Phase Currents



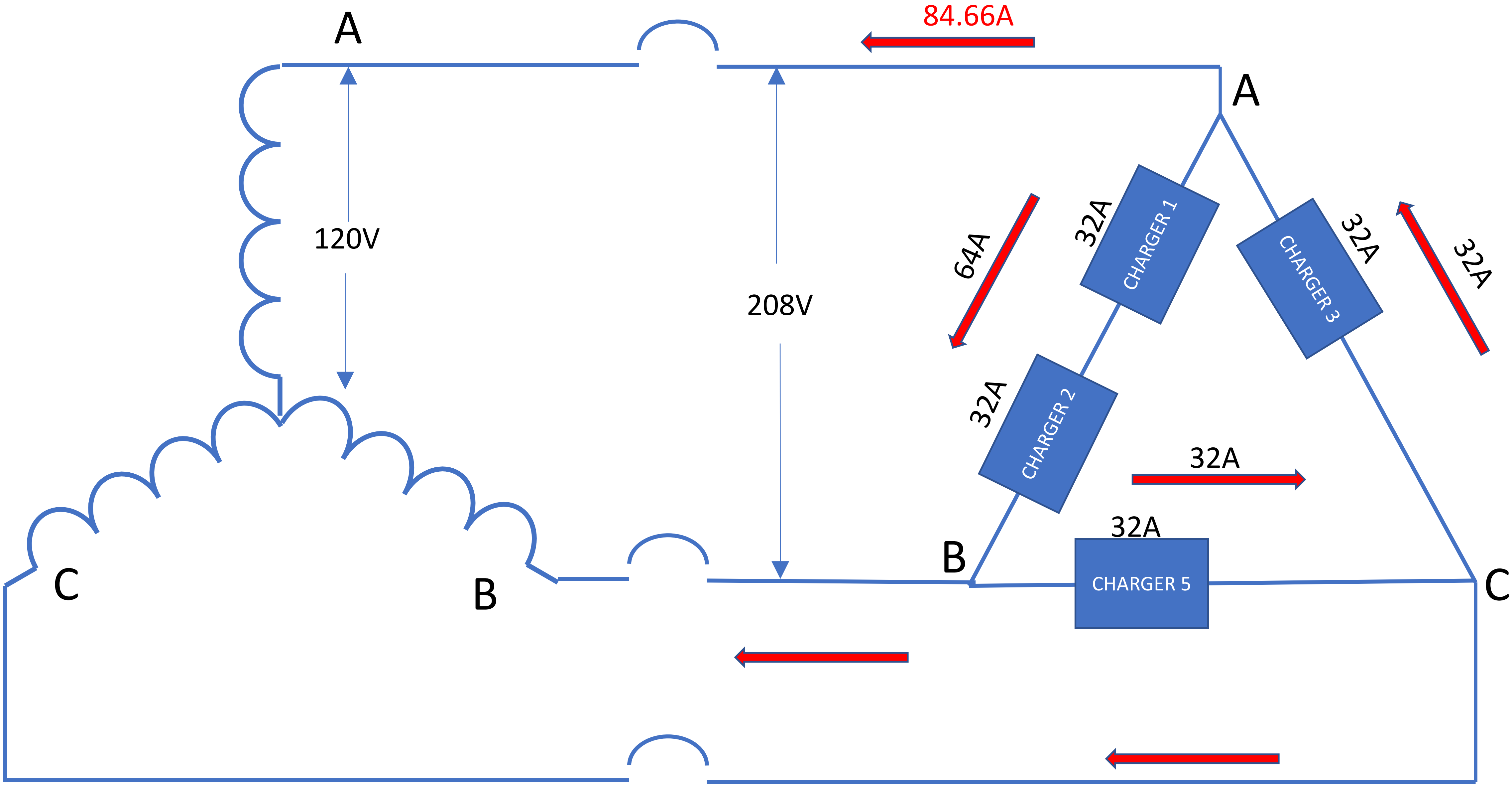
400A Service

Determine Line Currents



400A Service

Determine Line Currents



CONGRATULATIONS!

Next Steps

A Certificate of Completion will be emailed to those who successfully completed course

4 hours of Code Class Hours will be reported to the OCILB for Code Continuing Education Credits

Contact instructor at hpmatthews@matthewselectrical.net for any questions or comments

Make sure you completely sign out of webinar after the next slide!


THANK YOU

File Attachments for Item:

ER-2 One- and Two-Family Dwelling (2017 NEC) (IAEI Central)

All certifications (five 2-hour sessions)

Staff Notes: The five sessions include one session already presented February 9, for which retroactive approval is sought. The Committee can ignore the session listed for the year 2024. It will be submitted at the proper time.

ESIAC Recommendation:

Committee Recommendation:

APPLICATION FOR CONTINUING EDUCATION APPROVAL
COURSE CONDITIONS AND GUIDELINES

The Ohio Board of Building Standards is committed to the ongoing education and professional development of board-certified personnel through the delivery of high-quality, accurate and engaging professional continuing education content. To this end, the Board reviews and approves Continuing Education Courses for building department personnel.

Board approval is granted for course instruction on current codes and standards, including the OBC, OMC, OPC, and RCO, and any other content areas directly related to the responsibilities of the certification for which credit is being requested.

Promotion: Any person or organization promoting an approved course is required to make full and accurate disclosure regarding course title, course approval number, number of credit hours, categories for which the BBS has approved the class, and fees in promotion materials and advertising. ***The Board does not grant retroactive approval. It is recommended that courses be submitted for approval well in advance of any scheduling of classes and advertising***. Advertising may not falsely state BBS approval before approval is granted. Course providers may state that BBS approval is pending.

Application Submission: All Applications and associated materials shall be submitted by email in .pdf format. Instructions for completing the application are attached.

Certificate of Completion: Course providers shall provide participants a certificate of completion containing the following information:

- Name of participant
- Title of approved courses
- BBS approval #
- BBS approved certifications
- Date of the continuing education program
- Number of approved credit hours awarded, and
- Signature of authorized sponsor or instructor.

Any person or organization administering an approved course shall return a completed BBS Course Attendance form by email.

Participants: Participants must attend the complete course as presented by the instructor to receive credit hours approved by the Board. The organization or instructor of online courses shall plan and execute methods to verify the individual's attendance and completion of the course. No partial credit will be given to any participant who failed to complete the entire course as approved.

Board approval: All courses are approved for the calendar year in which application is made. Courses may be renewed so long as the referenced code is in effect, and the CEUs, certification and content remain unchanged. When the referenced code is updated, courses must be updated, and new approvals obtained.

Facility/training area: BBS Course may be delivered in person or online, or both, at the sponsor's option.
Course facilities shall include the following:

In Person Classes:
Sufficient seating capacity
ADA accessible facilities
Appropriate Audio/Visual devices for delivery
Writing surfaces for participants

Online Classes:
Web-accessible
ADA accessible delivery
Tech support available
Live and recorded courses permitted

In-person facilities shall comfortably and safely seat at least the number of attendees present in the room and shall be climate controlled, non-smoking, and sound controlled so that outside noise will not interfere with the training.

Ohio | Department of Commerce

Mike DeWine, Governor
Jon Husted, Lt. Governor

Sheryl Maxfield, Director

Board of Building Standards

Application for Continuing Education Course Approval

Provider Information:

Name: International Association of Electrical Inspectors (IAEI) Central Ohio division

Organization: International Association of Electrical Inspectors (IAEI) Central Ohio division

Address: 1081 Lewis Center Road Lewis Center, OH 43035

E-mail: lettherebelight110@yahoo.com Telephone: 937-763-6361

Website: ____

Conference Sponsor (if applicable)____ Conference Email: ____

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

Renewals will only be granted for identical content and certifications, within the current code cycle.

Attach a copy of prior course approval letter for confirmation. No further information is required.

New Course Information:

Course title: 1 & 2 Family Dwelling (2017 NEC), Soares Grounding and bonding (2017 NEC).

Course instructor: Eric M. Klintworth PE; Matthew Ross; Chad Roberts

Course description: These classes will cover the 2017 NEC; via PowerPoint slides created by t
of Electrical Inspectors (IAEI)

Instructional hours per session: 2 hours ea. Number of Sessions: 10; 13 if able to backd

Course Date(s) and Location: 1/12, 2/9, 3/9, 4/13, 5/11, 6/8, 9/14, 10/12, 11/9, & 12/14/2023; 1/11
1081 Lewis Center Road Lewis Center, OH 43035

Special Content:

Code Administration: ☐
Existing Buildings: ☐
Electrical Instruction: ☑
Plumbing Instruction: ☑

Conference Course: ____
Conference Name: ____
Conference location: ____

Course to be offered online? ☐ **On Demand** ☐ **Webinar** ☐

Course Website: ____

Detail online course participation confirmation method (*i.e. test, quizlets, participant activity confirmation*):

____

Course applicable for the following certifications

Residential Certifications Only: ☐ Commercial Certifications: ☐

Administrative Course, All Certifications: ☐

Application materials included:

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

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

Instructions for new Continuing Education Approval form

Provider Information

1. Please include all contact information.
2. If course is not part of a conference, leave conference sponsor and email blank.

Course Renewal

1. Indicate if the course is being submitted for renewal. Include prior approval letter and write in prior course number.
2. Certification approval for courses has now changed: all existing courses being renewed will be approved within the new classification system.
   a. Courses previously approved for only residential certifications will be approved for all residential certifications.
   b. Courses previously approved for at least on commercial certification will now be approved for all commercial certifications and all residential certifications.
   c. Courses on required instruction topics, Ohio Ethics, Code Administration and Existing Buildings, will be noted as Administrative Courses and be approved for all certifications.
3. Courses being renewed should skip the New Course information section and are not required to submit outline, agenda, slides or other instructional materials for review. Skip to Special Content, and mark any item that applies to the course.

New Course Information

1. Enter course title, name of instructor, and a brief description of the course content. Learning objectives may be substituted for course description, if desired.
2. Number of instructional hours per session is the length of instructional time.
3. Number of sessions: can be 1 or the number of sessions planned.
4. Course date(s) and location: not necessary at this time, enter if known.

Special Content

1. Indicate if the course will meet instructional time in Code Administration or Existing Buildings.
2. Indicate if the course is a plumbing or electrical course, for ESIAC review and trainee course tracking.
3. If the course is associated with a conference, indicate the conference name and location, as this will allow BBS to coordinate approvals with the conference provider.
4. If the course will be offered online, specify whether it will be on demand or offered as a virtual webinar, or both. Include website where the course will be provided.

Course applicable for the following certifications

This section represents a major change from previous BBS course approval forms.

1. If the course is only for residential certifications, check 'Residential Certifications Only'. The course, if approved, will be approved for all residential certifications.
2. If the course is appropriate for any commercial certifications, check Commercial Certifications. The course, if approved, will be approved for all commercial certification **AND** all residential certifications.
3. If the course is intended to meet required instruction in Code Administration (Chapter 1) or Existing Buildings (commercial or residential) check 'Administrative Course, All Certifications'.

Application Materials Included

This is a checklist for the course submitter's use, to be sure all materials necessary for review are included with the application. All materials should be submitted in .pdf format, along with the application, via email to Michael.Lane@com.ohio.gov or BBS@com.ohio.gov

IAEI Central Ohio Division 2023-2024 syllabus

1. January 12, 2023
    1. Soares 2017 NEC Part 1 (Final) 2--Chapter 4 Grounding Electrical Services. Instructor, Matthew Ross.
2. February 9, 2023
    1. 1 & 2 Family (2017 NEC) (Vol I) Chapter 3. Instructor, Eric Klintworth.
3. March 9, 2023
    1. Soares 2017 NEC Part 1 (Final) 2--Chapter 5 Main bonding Jumpers and Services. Instructor, Matthew Ross.

The above classes have already been taught if it is possible to backdate to get credit for these classes, that would be great. If not, I understand. We have an attendance roster for verification.

4. April 13, 2023
    1. Soares 2017 NEC Part 1 (Final) 2--Chapter 6 Grounding Electrode Systems. Instructor, Matthew Ross.
5. May 11, 2023
    1. 1 & 2 Family (2017 NEC) (Vol II) Chapter 4. Instructor, Eric Klintworth.
6. June 8, 2023
    1. 1 & 2 Family (2017 NEC) (Vol II) Chapter 5. Instructor, Eric Klintworth.
7. September 14, 2023
    1. Soares 2017 NEC Part 1 (Final) 2--Chapter 7 Grounding Electorde Conductors. Instructor, Matthew Ross.
8. October 12, 2023
    1. 1 & 2 Family (2017 NEC) (Vol II) Chapter 6. Instructor, Eric Klintworth.
9. November 9, 2023
    1. Soares 2017 NEC Part 1 (Final) 2--Chapter 8 Bonding Enclosures and Equipment. Instructor, Matthew Ross.
10. December 14, 2023
    1. 1 & 2 Family (2017 NEC) (Vol II) Chapter 7. Instructor, Eric Klintworth.
11. January 11, 2024
    1. Soares 2017 NEC Part 1 (Final) 2--Chapter 9 Equipment Grounding Conductors. Instructor, Matthew Ross.
12. February 8, 2024
    1. 1 & 2 Family (2017 NEC) (Vol II) Chapter 8. Instructor, Eric Klintworth.
13. March 14, 2024
    1. Soares 2017 NEC Part 1 (Final) 2--Chapter 10 Enclosure and Equipment Grounding. Instructor, Matthew Ross.

Eric M Klintworth, PE

638 Rockbridge Road, Westerville, Ohio 43081
klintworth@earthlink.net
Cell: 614–499–7056

Senior Electrical Engineer

A seasoned electrical engineer with in-depth experience in industrial control & automation, instrumentation, PLC, HMI, SCADA, and power distribution. Extensive hands-on startup, troubleshooting, and system level experience.

Core Competencies:

Industrial Control & Automation ▪ Instrumentation ▪ PLC ▪ HMI ▪ SCADA
Low & Medium Voltage Power ▪ Hazardous Locations ▪ Machine Safety
Field Startup & Commissioning ▪ Advanced Troubleshooting ▪ Expert Witness
VFD ▪ Servo Drives ▪ HVAC Controls ▪ Networking ▪ NEC ▪ UL 508a ▪ Lighting

Professional Experience

Hyperion Materials & Technologies/Diamond Innovations/Sandvik
Worthington, Ohio, 2014–present

Manufacturer of synthetic diamond and cubic boron nitride for industrial applications

Senior Electrical Controls Engineer, R&D

- Developed specialized control schemes and measurement techniques for high temperature, high pressure, pressing to facilitate new product development.
- Created Microsoft SQL Server database tables to automatically record process data from PLCs via Cimplicity.
- Customized imported hydraulic presses to meet specialized in-house needs via hardware, PLC, and HMI program additions.
- Led upgrade of cubic press controls and hydraulics to achieve unique multi-axis pressure control.

Consultant to Bricker & Eckler Attorneys, Columbus, Ohio, 2002–present

Troubleshooter and Technical Expert (occasional)

- Sort out performance issues with water and wastewater construction projects.
- Determine root causes and most economical remedies, working with owners, engineers, and contactors.
- Advise attorneys on technical matters.
- Prepare reports and serve as expert witness as needed.

Continued…

Eric M Klintworth, PE

Star Dynamics Corporation, Hilliard, Ohio, 2008–2014

Builder of advanced multi-target tracking radars and radar cross-section measurement systems

Staff Electrical Engineer

- Led design of AC and DC power distribution for mobile tracking radar system.
- Designed and programmed PLC-based radar system operator's console.
- Integrated digital motion controller with industrial servo drives for five-axis antenna characterization system.

LATA/Sharp and Associates, Westerville, Ohio, 1996–2008

Engineers and system integrators for environmental remediation, water, and wastewater systems

Senior Electrical Engineer

- Wrote and commissioned all PLC programs for radio-connected multi-site groundwater remediation system in Lansing, Michigan. Prepared and stamped electrical drawings for three system expansions.
- Replaced entire control and SCADA system at 3 Mgal/day municipal water treatment plant, Wadsworth, Ohio.
- Test/startup engineer and electrical SME at greenfield US Department of Energy DUF6 nuclear facility, Piketon, Ohio.
- Designed, programmed, and retrofitted PLC-based 21-site rural water distribution SCADA system, Erie County, Ohio.

Worthington Foods, Inc., Worthington, Ohio, 1993–1994

Producer of Morningstar Farms brand frozen and packaged vegetarian foods, now Kellogg's

Electrical Project Engineer

- Ferreted out and resolved complex power and control system deficiencies throughout the newly built Zanesville food plant.

Ormet Primary Aluminum Corporation, Hannibal, Ohio, 1987–1993

256 acre aluminum reduction plant producing 1.5M lb/day of sows and premium extrusion billets

Electrical Project Engineer

- Oversaw specification, procurement, and retrofitting of 13.8kV substations.
- Conceived and oversaw implementation of aluminum billet casting control system.

Education, Licensure, Professional Memberships

- BS in Electrical Engineering with Management Option, Ohio Northern University
- Registered Professional Engineer in Ohio, Michigan, Colorado, Arizona, & New Mexico
- Licensed Electrical Contractor in Ohio
- NFPA 70E Qualified Person
- IEEE Senior Member

Calculating the Load for a Two-Family Dwelling

- Trade practice is to supply the service equipment for a two-family dwelling through a common mast or through a common service lateral
- Where this is done, a duplex meter base is commonly installed
- A calculation must be performed to determine the minimum size of service-entrance or service-lateral conductors required to supply the common loads

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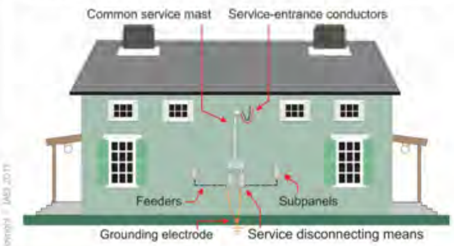
Calculation Methods of Two-Family Dwellings

- Standard calculation of both feeders and service-entrance or service-lateral conductors
- Optional calculation of feeders to individual dwelling units and standard calculation of service-entrance or service-lateral conductors
- Optional calculation under *NEC* 220.83
  - Two calculations are performed
  - Standard calculation under Article 220 Part III for two units, then for three units under Section 220.82
- Smaller of the two calculated loads can be used
- Applies only to service-entrance or service-lateral conductors

137

Service-Entrance Conductors - Two-Family Dwellings

For two-family dwellings with duplex meter base installations, a calculation must be performed to determine the minimum size of the overhead or underground service-entrance conductors required to supply the common loads



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Standard Load Calculation for Dwelling Unit

See **IAEI's One- and Two-Family Dwelling Electrical Systems** textbook (Volume I, Chapter 2) for complete details of load calculations and sample load calculation work sheets

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Volume I
Chapter Three
Cabinets and Meter Socket Enclosures

141

Article 100: Definitions

- **Cabinet:** "An enclosure that is designed for either surface or flush mounting and is provided with a frame, mat, or trim in which a swinging door or doors are or can be hung."
- **Panelboard:** "A single panel or group of panel units designed for assembly in the form of a single panel, including buses and automatic overcurrent devices, and equipped with or without switches for the control of light, heat, or power circuits; designed to be placed in a cabinet or cutout box placed in or against a wall, partition, or other support; and accessible only from the front."

142

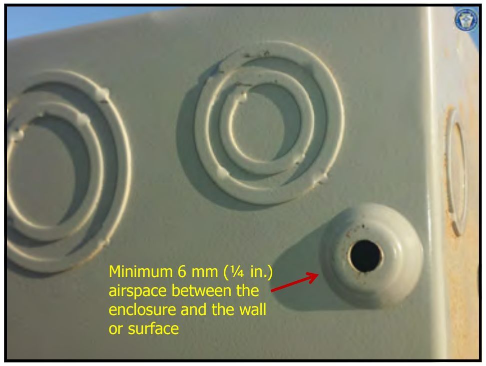
Article 100: Definitions

143

312.2 Cabinets in Damp and Wet Locations

- Must be designed to prevent moisture or water from entering or accumulating within the cabinet or cutout box
- Shall be mounted so there is at least 6 mm (¼ in.) airspace between the enclosure and the wall or surface
- Enclosures installed in wet locations shall be weatherproof
- For enclosures in wet locations, raceways or cables entering above uninsulated live parts must use fittings listed for wet locations

144



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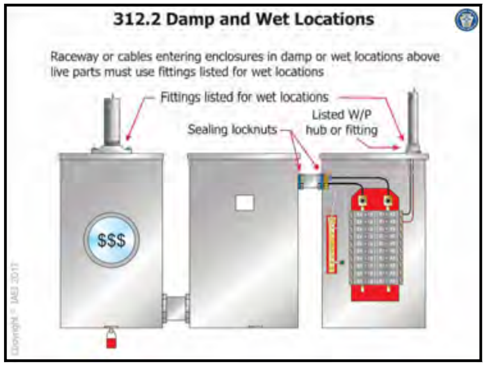

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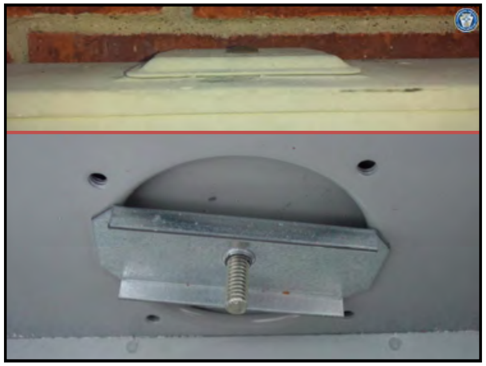
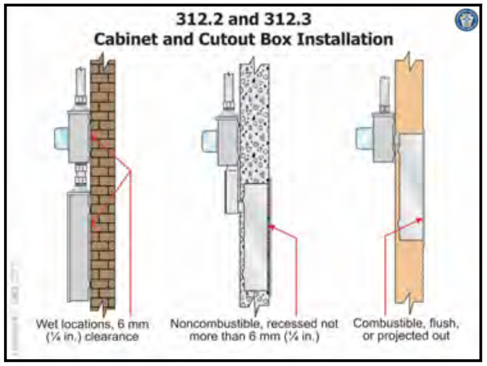


147

Position in Walls and Repairs

- Cabinets installed in walls of concrete, tile, or other noncombustible material must have their front edge recessed not more than 6 mm (¼ in.) from the finished surface
- Where installed in wooden walls or other combustible material, cabinets must be flush with the finished surface or project out from the surface *[NEC 312.3]*
- Finished surfaces such as plaster, drywall or plasterboard that are broken out or incomplete have to be repaired
- The maximum permitted gap around or surrounding the cabinet and the finish surface is 3 mm (⅛ in.) for cabinets that have a flush-type cover *[NEC 312.4]*

148



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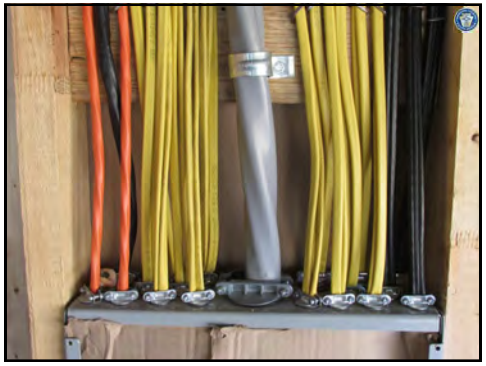
312.5 Cables Entering Cabinets and Cutout Boxes

- Cables and conductors shall be protected from abrasion
- Openings in enclosures shall be adequately closed
- Concealed knob-and-tube or open wiring shall enter through insulating bushings or, in dry locations, through flexible tubing extending from the last insulating support and firmly secured to the enclosure
- Where cables are used, each cable shall be individually secured to the cabinet, cutout box, or meter socket enclosure *(see exception)*

150



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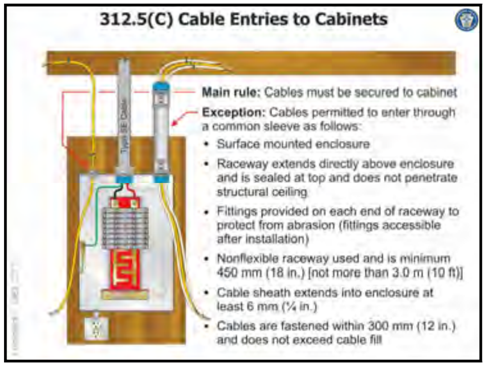
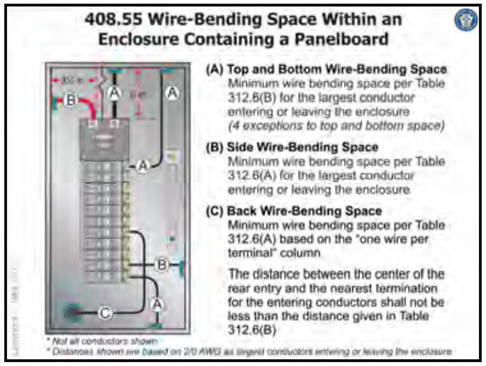


152

Wire Bending Space at Terminals

- Conductors at terminals or conductors entering or leaving enclosures must be installed so that **adequate wire bending space** at each terminal is provided
- Allows connections to be made to terminals without damaging the terminal or conductor insulation
- Larger the conductor, stiffer it is and more difficult to bend to make connections; thus, more wire-bending space is required
- *Code* requires cabinets to be provided with back wiring spaces, gutters, or wiring compartments
- Applies to cabinets that contain devices connected within the cabinet to more than eight conductors

153



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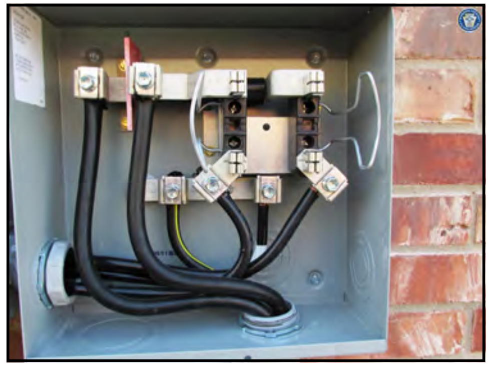

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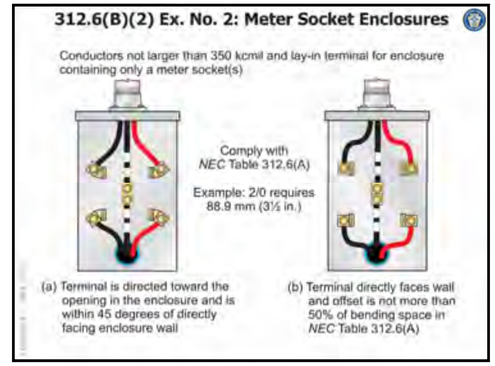

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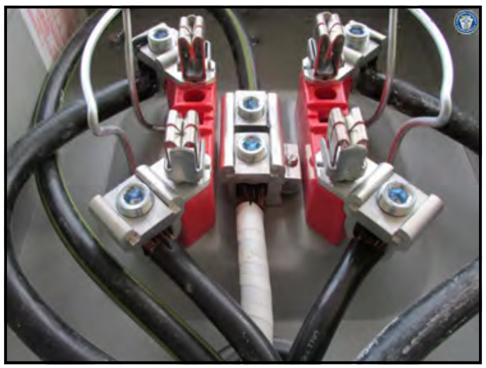

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Conductor Protection from Abrasion

- Insulated circuit conductors *(4 AWG or larger)* entering a raceway in a cabinet, pull box, junction box, or auxiliary gutter, required to be protected by an identified fitting providing a smoothly rounded insulating surface
- Fittings used for this purpose typically are an insulated conduit bushing *(Code permits alternatives such as a metal fitting with an insulated throat or a nonmetallic terminal adaptor)*
- Conduit bushings made wholly of insulating material are not permitted to be used to secure a raceway to an enclosure
- Listed metal locknut would need to be used in conjunction with an insulating bushing
- See *NEC* 312.6(C), 300.4(G)

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159

160

Wire Space in Enclosures

- Cabinets and meter socket enclosures are required to have **sufficient space** to accommodate all installed conductors
- Cabinet enclosures for switches or overcurrent devices are generally **not permitted to be used as junction boxes**, auxiliary gutters, or raceways for conductors feeding through or tapping off to other switches or overcurrent devices ***(unless adequate space is provided)***
- Conductors not permitted to fill the wiring space at any cross section to more than **40%** of the cross-sectional area of the gutter space in the enclosure
- Where conductors are **spliced** in these switch or overcurrent device enclosures, the conductors, splices, and taps cannot fill the wiring space at any cross section to more than **75%** of the cross-sectional area of the space

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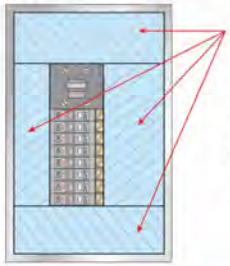
Wire Space in Enclosures *(cont.)*

- Where **feed-through conductors** are present, a **warning label** complying with NEC 110.21(B) is required to be applied to the enclosure identifing the closest disconnecting means for these feed-through conductors
- See *NEC* 312.8

162

312.8 Enclosures for Overcurrent Devices

The wiring space of enclosures for switches or overcurrent devices is permitted to contain feed-through, splices, or tapped conductors where all of the following conditions are met:



Conductors cannot fill wiring space to more than 40%

Where splices or taps are made they cannot take up more than 75% at any cross section

Warning label complying with 110.21(B) applied to enclosure that identifies the closest disconnecting means for any feed-through conductors

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Mounting and Location of Switches and Overcurrent Devices

- Switches and circuit breakers of the externally operable type must be mounted in an enclosure listed for the intended use *[404.3(A)]*
- Minimum wire bending space at terminals and minimum gutter space must be provided in switch enclosures *[312.6]*
- Where installed in any damp or wet location or outside a building, a switch or circuit breaker is required to be enclosed in a weatherproof enclosure or cabinet *[404.4(A)]*
- General-use and motor-circuit switches and circuit breakers, where mounted in an enclosure, must clearly indicate whether they are in the open "off" or closed "on" position *[404.7]*

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Mounting and Location of Switches and Overcurrent Devices *(cont.)*

- Where switch or circuit breaker handles are operated vertically rather than rotationally or horizontally, the "up" position of the handle must be in the "on" position *[404.7, 240.81]*
- All switches and circuit breakers that are used as switches must be located so they can be operated from a readily accessible location *[404.8(A)]*
- All switches and circuit breakers must be installed so the **center of the grip of their operating handles**, when in their highest position, will not be more than **2.0 m (6 ft 7 in.)** above the surface of the floor or other working platform [404.8(A), 240.24(A)]

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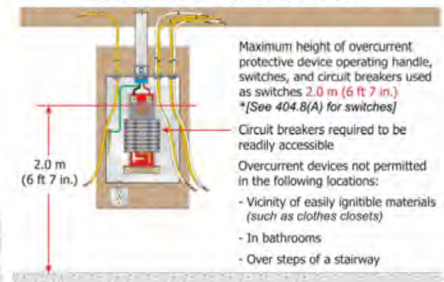
240.24 Accessibility and Location of Overcurrent Devices



Maximum height of overcurrent protective device operating handle, switches, and circuit breakers used as switches 2.0 m (6 ft 7 in.)
*[See 404.8(A) for switches]

Circuit breakers required to be readily accessible

Overcurrent devices not permitted in the following locations:
- Vicinity of easily ignitible materials *(such as clothes closets)*
- In bathrooms
- Over steps of a stairway

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408.4(A) Circuit Directory or Circuit Identification

All panelboard circuits and any circuit modifications are required to be legibly identified as to its clear, evident, and specific purpose or use

Circuit directory required to be located on the face or inside the panel doors

The circuit identification shall have an approved degree of detail to distinguish each circuit from all others

Spare positions containing unused overcurrent devices or switches required to be marked accordingly

Circuits shall not be identified in a manner that depends on transient conditions of occupancy

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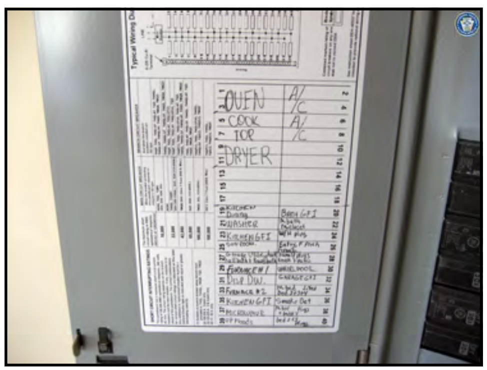

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408.3(A)(2) Barriers at Service Panelboards

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

Courtesy of Schneider Electric

Exception: *This requirement shall not apply to service panelboards with provisions for more than one service disconnect within a single enclosure as permitted in 408.36, Exceptions No. 1, 2, and 3*

171

Main Bonding Jumper

- Where a panelboard is used as service equipment it must be provided with a **main bonding jumper**
- Generally, the *main bonding jumper* is a bus, strap, or screw provided by the manufacturer, and under this condition, it can be installed without a sizing requirement in the field
- It is placed within the panelboard and is used for connecting the grounded (neutral) service conductor on its supply side to the metallic frame of the panelboard
- See *NEC* 250.28, 408.3(C)

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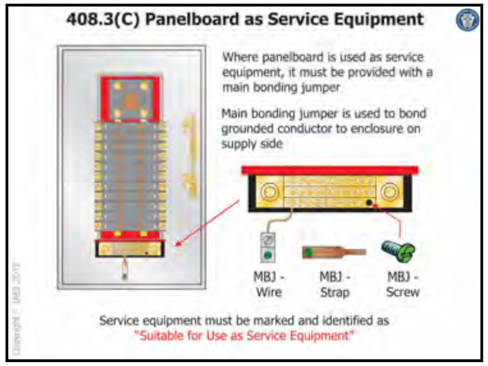

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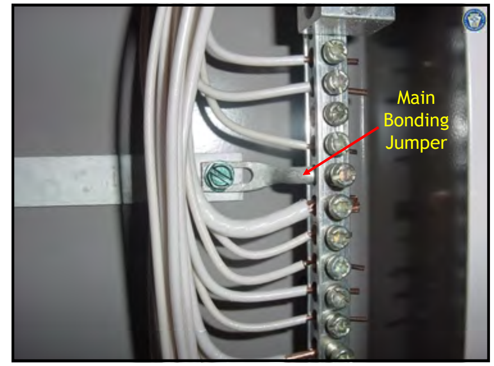

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408.36 Overcurrent Protection for Panelboards

- Generally, a panelboard is required to be protected by an overcurrent protective device having a rating not greater than that of the panelboard
- This overcurrent protective device to be located within or at any point on the supply side of the panelboard
  - **Ex. No. 1**: Individual protection not required for a panelboard used as service equipment with multiple disconnecting means *[up to six means of disconnect(230.71)]*
  - Panelboards protected in this manner shall not supply a second bus structure within the same panelboard

(cont. on next slide)

175

408.36 Overcurrent Protection for Panelboards *(cont.)*

- Generally, a panelboard is required to be protected by an overcurrent protective device having a rating not greater than that of the panelboard
- This overcurrent protective device to be located within or at any point on the supply side of the panelboard
  - **Ex. No. 2:** Individual protection not required for a panelboard protected by main on its supply side *(two main circuit breakers or two sets of fuses)*
  - A panelboard employing this exception shall not contain more than 42 overcurrent devices

(cont. on next slide)

176

408.36 Overcurrent Protection for Panelboards *(cont.)*

- Generally, a panelboard is required to be protected by an overcurrent protective device having a rating not greater than that of the panelboard
- This overcurrent protective device to be located within or at any point on the supply side of the panelboard
  - **Ex. No. 3**: For existing panelboards, individual protection not required for a panelboard used as service equipment for an individual residential occupancy

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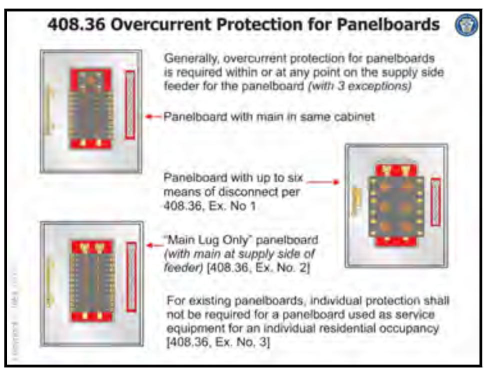

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408.36 Overcurrent Protection for Panelboards *(cont.)*

- Generally, panelboards are no longer limited to a maximum of 42 overcurrent devices per panelboard
  - *See 408.36, Ex. No. 2*
- Number of overcurrent devices per panelboard limited only by listing and manufacturer's specifications

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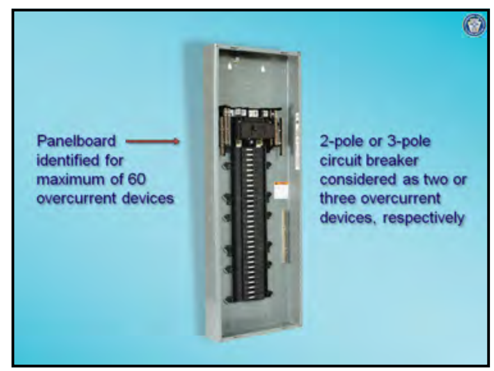

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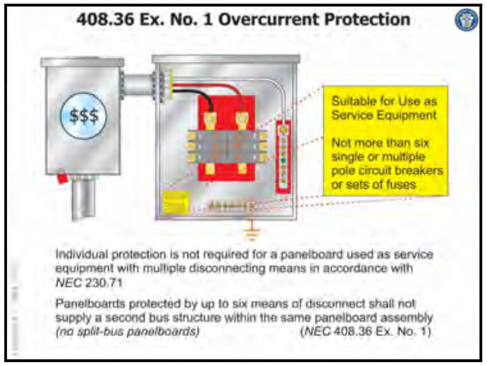

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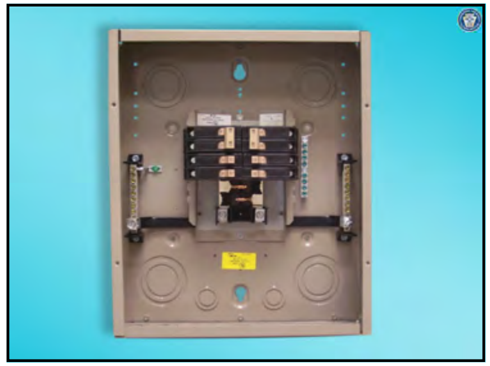

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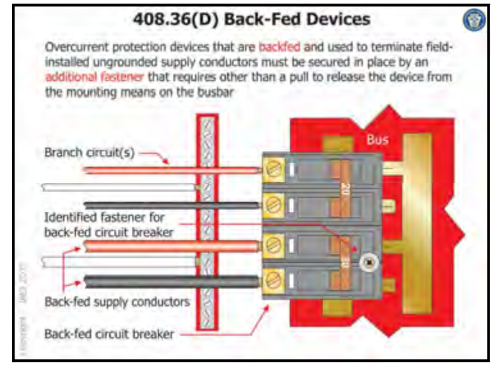

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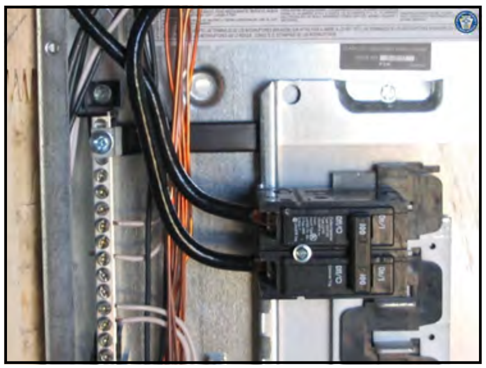

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Grounded Conductors in Panelboards

- Each grounded (neutral) conductor must terminate in an **individual terminal** that is not to be used to terminate another neutral conductor
- Exception will allow more than one grounded conductor to terminate under one termination point where parallel conductors are installed, as long as they terminate in a terminal identified for more than one conductor
- See *NEC* 110.14; 408.41

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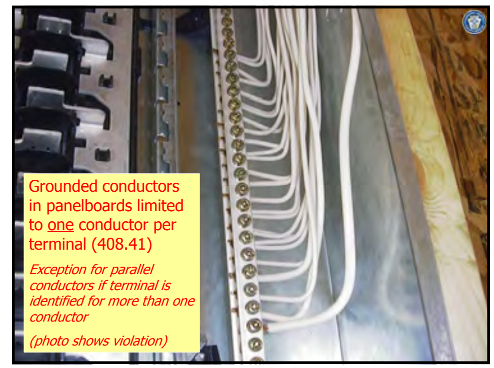

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408.40 Grounding of Panelboards

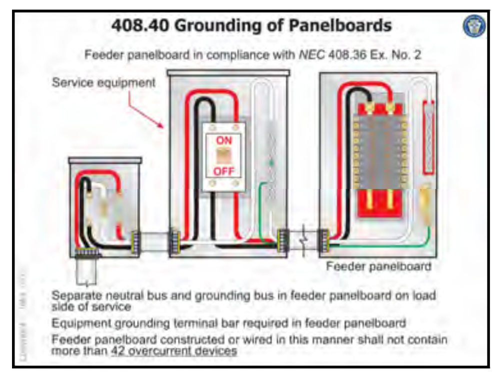
- Metal panelboard cabinets and panelboard frames must be:
  - In physical contact with each other
  - Connected to an equipment grounding conductor
- Where the panelboard is used with nonmetallic raceway or cable or where separate equipment grounding conductors are provided, a terminal bar for the equipment grounding conductors shall be secured inside the cabinet
- Terminal bar must be bonded to the cabinet and panelboard frame *(if of metal)* otherwise it shall be connected to the equipment grounding conductor that is run with the conductors feeding the panelboard
- *Exception for isolated equipment grounding conductor*

187

408.40 Grounding of Panelboards *(cont.)*

- Equipment grounding conductors are not be connected to a terminal bar provided for **grounded conductors** or **neutral conductors** unless…
- Terminal bar is:
  - **identified for the purpose**
  - located where interconnection between equipment grounding conductors and grounded circuit conductors is permitted or required by Article 250

188



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Appendices

Appendices

- Appendix A - Cross reference from 2017 *NEC* to 2018 IRC
- Appendix B - Residential Wiring Checklists *NEC* & IRC
- Appendix C – Comparison Chart of *NEC* and IRC Tables
- Appendix D - Answers to Chapter Lesson Questions

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One- and Two-Family Dwelling Electrical Systems – 2017 *NEC*

End of Volume I of IV

Training Presentation by:
International Association of Electrical Inspectors

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One- and Two-Family Dwelling Electrical Systems – 2017 *NEC*

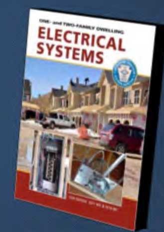
Volume II of IV

Training Presentation by:
International Association of Electrical Inspectors

1

One- and Two-Family Dwelling Electrical Systems – 2017 *NEC*

- Presentation based on IAEI's *One- and Two-Family Dwelling Electrical Systems* , 10th edition textbook
- This textbook is based on the requirements contained the **2017 *NEC*** and the **2018 *IRC***



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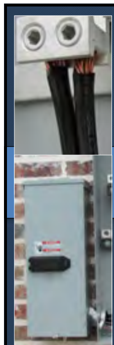

Volume II Chapter Four

Installation and Inspection of Services

4

5

General Requirements for Services

- A building or other structure is generally required to be served by only one service [*NEC* 230.2]
- Service conductors supplying a building or structure shall not pass through the interior of another building or structure [*NEC* 230.3]
- Conductors other than service conductors are not permitted in the same raceway or cable with the service conductors [*NEC* 230.7]
- Service raceways entering buildings from an underground distribution system required to be sealed with a material identified for the use [*NEC* 230.8]

6

Article 100: Definitions

- **Premises Wiring (System):** "Interior and exterior wiring, including power, lighting, control, and signal circuit wiring together with all their associated hardware, fittings, and wiring devices, both permanently and temporarily installed. This includes (a) wiring from the service point or power source to the outlets or (b) wiring from and including the power source to the outlets where there is no service point.
- Such wiring does not include wiring internal to appliances, luminaires, motors, controllers, motor control centers, and similar equipment."
  - **Informational Note:** Power sources include, but are not limited to, interconnected or stand-alone batteries, solar photovoltaic systems, other distributed generation systems, or generators.

7

Article 100: Definitions

- **Service:** "The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served."
- **Service Cable:** "Service conductors made up in the form of a cable."
- **Service Conductors:** "The conductors from the service point to the service disconnecting means."

8

Article 100: Definitions

- **Service Conductors, Overhead:** "The overhead conductors between the service point and the first point of connection to the service-entrance conductors at the building or other structure."
- **Service Conductors, Underground:** "The underground conductors between the service point and the first point of connection to the service-entrance conductors in a terminal box, meter, or other enclosure, inside or outside the building wall."
  - **Informational Note:** Where there is no terminal box, meter, or other enclosure, the point of connection is considered to be the point of entrance of the service conductors into the building.

9

Article 100: Definitions

- **Service Drop:** "The overhead conductors between the utility electric supply system and the service point."
- **Service-Entrance Conductors, Overhead System:** "The service conductors between the terminals of the service equipment and a point usually outside the building, clear of building walls, where joined by tap or splice to the service drop or overhead service conductors."

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Article 100: Definitions

- **Service-Entrance Conductors, Underground System:** "The service conductors between the terminals of the service equipment and the point of connection to the service lateral or underground service conductors.
  - **Informational Note:** Where service equipment is located outside the building walls, there may be no service-entrance conductors or they may be entirely outside the building.
- **Service Equipment:** "The necessary equipment, usually consisting of a circuit breaker(s) or switch(es) and fuse(s) and their accessories, connected to the load end of service conductors to a building or other structure, or an otherwise designated area, and intended to constitute the main control and cutoff of the supply."

11

Article 100: Definitions

- **Service Lateral:** "The underground conductors between the utility electric supply system and the service point."
- **Service Point:** "The point of connection between the facilities of the serving utility and the premises wiring."
  - **Informational Note:** The service point can be described as the point of demarcation between where the serving utility ends and the premises wiring begins. The serving utility generally specifies the location of the service point based on the conditions of service.

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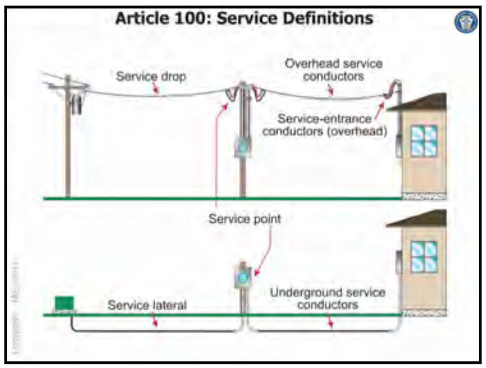

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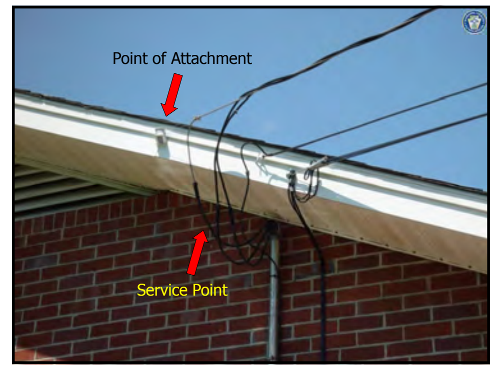

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Clearances on Buildings

- The *Code* requires **minimum clearances for service conductors installed as open conductors** *(such as duplex or triplex service drops or multiconductor cables)* that do not have an overall outer jacket from building openings and other items such as:
  - Porches
  - Balconies
  - Ladders
  - Stairs
- Does not restrict the installation of a multiconductor cable assembly that has an overall outer jacket, such as Type SE
- See *NEC* 230.9

16

Clearances on Buildings *(cont.)*

- Open service conductors *(including the drip loop)* cannot be installed any closer than **900 mm (3 ft)** from the sides or bottom of any window that is designed to be opened
- This **900 mm (3 ft)** clearance required from:
  - Doors
  - Porches
  - Balconies
  - Ladders
  - Stairs
  - Fire escapes
  - Other similar locations

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Clearances on Buildings *(cont.)*

- This **900 mm (3 ft)** clearance is intended to keep open service conductors at least **"reach distance"** from building openings or platforms
- Some forms of service conductors are **not required to maintain this 900 mm (3 ft)** such as:
  - Service conductors installed **above the top level of a window**
  - Service conductors in the form of service-entrance cable, Type SE or SER
  - Service conductors installed in a raceway

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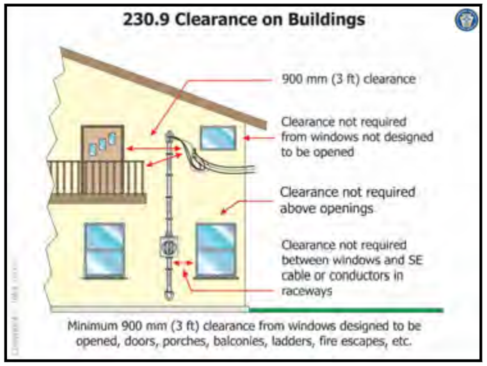

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Service Drop Clearances Above Roofs

- General rule for clearances requires service drops to have a minimum vertical clearance of not less than **2.5 m (8 ft)** where they pass over a roof
- This **2.5 m (8 ft)** vertical clearance must generally be maintained for a distance of **900 mm (3 ft)** in all directions from the edge of the roof
- Five exceptions to this general rule
- See *NEC* 230.24(A) and (B)

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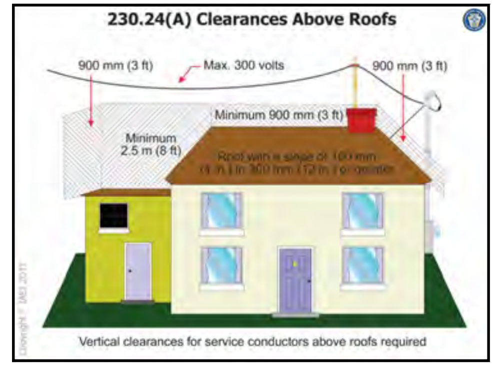

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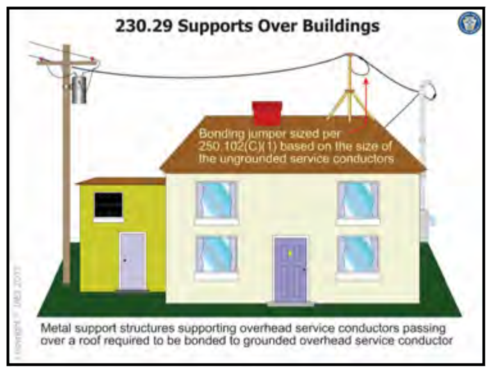

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Service Drop Clearances Above Roofs *(cont.)*

- Service drops to have a minimum vertical clearance of not less than **2.5 m (8 ft)** above roof *(with exceptions)*
  - Reduction of the service-drop clearance to **900 mm (3 ft)** when the voltage between the service-drop conductors is not over **300 volts** and the roof has a slope of **100 mm (4 in.)** in **300 mm (12 in.)** or greater
- See 230.24(A) Ex. No. 2

24

Service Drop Clearances Above Roofs *(cont.)*

- Service drops to have a minimum vertical clearance of not less than **2.5 m (8 ft)** above roof *(with exceptions)*
  - Reduction in clearance of the service-drop conductors to **450 mm (18 in.)** above the roof where:
    - Voltage between conductors does not exceed **300 volts**
    - Service drop passes over only the overhanging portion of the roof, and not more than **1.8 m (6 ft)** of service-drop conductor passes diagonally over the roof overhang
    - Service drop does not pass over an overhang that extends more than **1.2 m (4 ft)** horizontally from the structure
    - Secured to an electric service mast (through-the-roof) raceway or other approved support means
- See 230.24(A) Ex. No. 3

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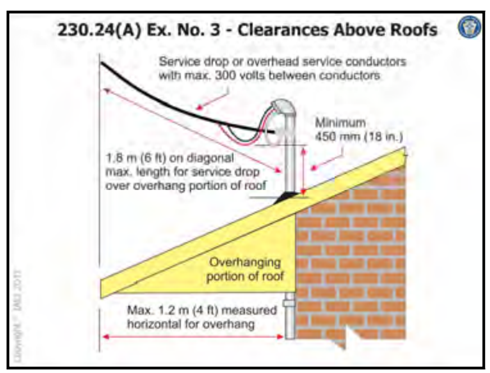

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230.24(B) Vertical Clearances Above Final Grade

- Vertical clearances for service drops and overhead service conductors passing above finished grade or ground level vary depending on the voltage involved and the condition
- Vertical clearance must be maintained at the minimum distances described in the Article 230
- *See next slide*

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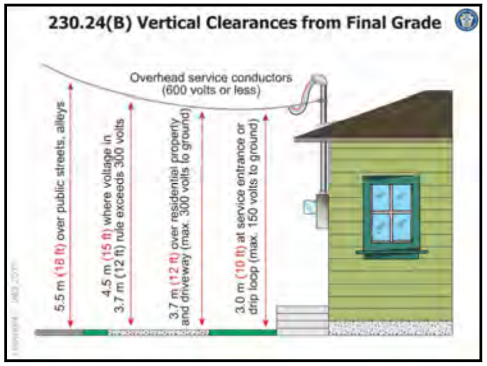

28

230.28 Service Mast as Support

- Service masts used as support of service drops must be **"of adequate strength"** to withstand safely the weight imposed by service drop *(or be supported by braces or guy wires)*
- The *Code* does not mandate minimum size of conduit permitted for a service mast or the use of additional support such as guy wires
- Interpretation of **"of adequate strength"** determined by AHJ
- Many serving utility companies provide a set of regulations that detail what is required for the service mast to which a service drop is to be attached
- By electric utility company regulations or local ordinances often require a **metric designator 53 (2 in.)** or larger steel galvanized **rigid metal conduit** to be used for an electric service mast

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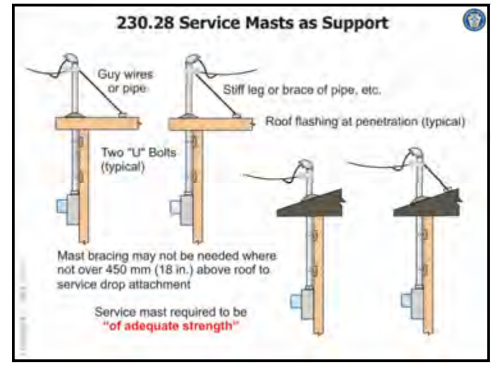

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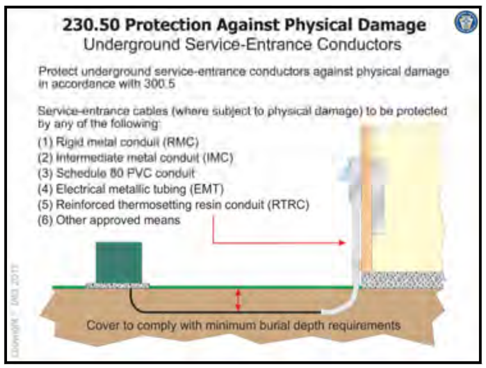

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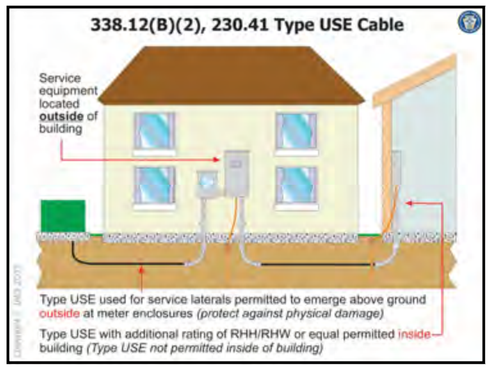

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Service-Entrance Cable Installation

- Type SE cable can be used for services and is often used in older, existing dwelling units *(See NEC Article 338)*
- Several **fittings** are made to facilitate the installation of Type SE cables for services including:
  - Weatherhead or service cap
  - Watertight connectors for connection at meter bases and service equipment
  - Service-cable sill plates
  - One-hole and two-hole straps
  - One-screw and two-screw connectors
- Additional information on service-entrance cable fittings can be found in the UL Product Spec (formally UL White Book) in **Category (TYZX)**

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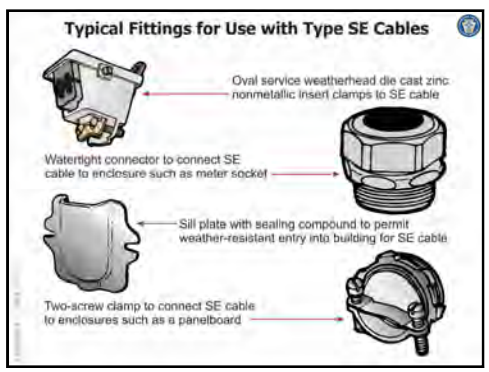

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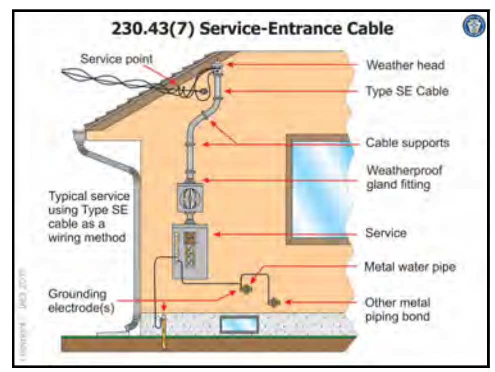

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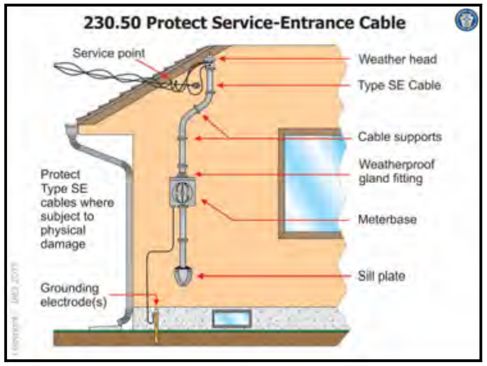

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230.43 Raceways Permitted for Service Entrance

- Rigid metal conduit (RMC)
- Intermediate metal conduit (IMC)
- Rigid polyvinyl chloride conduit (PVC)
- Electrical metallic tubing (EMT)
- Electrical nonmetallic tubing (ENT)
- Flexible metal conduit (FMC) *[1.8 m (6 ft) lengths]*
- Liquidtight flexible metal conduit (LFMC) *[1.8 m (6 ft) lengths]*
- Liquidtight flexible nonmetallic conduit (LFNC)
- High density polyethylene conduit (HDPE)
- Nonmetallic underground conduit with conductors (NUCC)
- Reinforced thermosetting resin conduit (RTRC)

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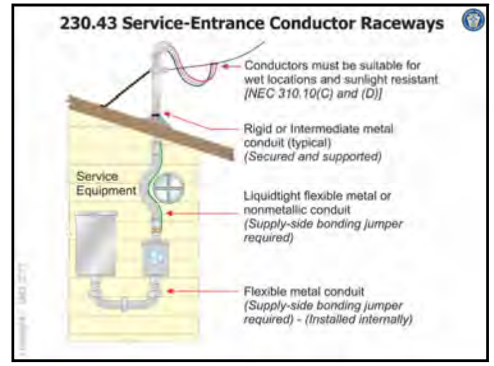

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Service Disconnecting Location

- All one- and two-family dwelling services required to provide a **means of disconnect** for all service-entrance conductors installed in a building or other structure
- Service disconnecting means must be installed in a **readily accessible location**
- Permitted to be located **outside** the building or **inside** the building
  - If located inside the building, the disconnecting means must be located ***"nearest the point of entrance"*** from where the service conductors enter the building
- See *NEC* 230.70(A)(1)

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Service Disconnecting Location *(cont.)*

- Service conductors considered **outside the building** under any of the following conditions where they are installed in:
  - Suitable raceway under not less than **50 mm (2 in.) of concrete beneath building**
  - Building, but the raceway or cable is **encased in not less than 50 mm (2 in.) of concrete** or brick
  - A vault *(not typical for dwelling units)*
  - Conduit under not less than **450 mm (18 in.) of earth** beneath the building
  - Rigid metal conduit **(RMC)** or intermediate metal conduit **(IMC)** routed **directly through an eave** *(not a wall)*
- See *NEC* 230.6

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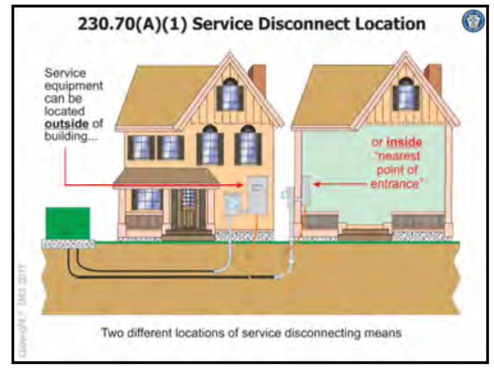

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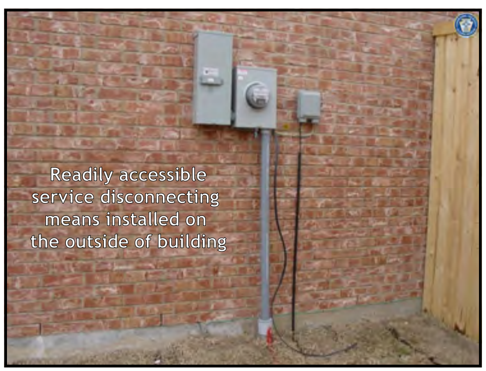

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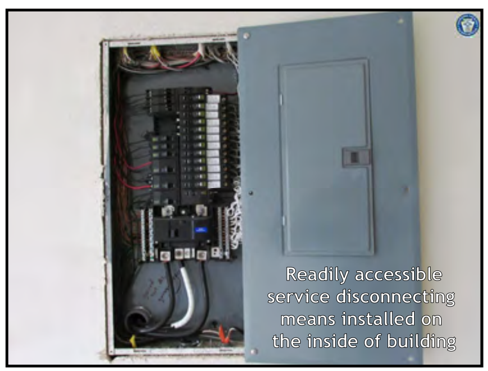

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Service Disconnecting Location *(cont.)*

- Overcurrent devices *(including service OCPD)* required to be installed in a **readily accessible location** to the occupant
- Overcurrent devices restricted from being located in the following locations:
  - In the vicinity of **easily ignitible material** (such as clothes closets)
  - Over **steps of a stairway**
  - In **bathrooms** of dwelling units *(exception for supplementary OCPD)*
- Service disconnecting means are **not permitted** to be installed in bathrooms [*NEC* 230.70(A)(2)]
- See *NEC* 240.24

45

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230.66 Marking of Service Disconnecting Means

- Service equipment required to be marked as being suitable for use as service equipment
- Marking provided by the manufacturer and is often a part of the information on the label affixed inside the cabinet
- Manufacturers markings will include:
  - SUITABLE FOR USE AS SERVICE EQUIPMENT
  - SUITABLE ONLY FOR USE AS SERVICE EQUIPMENT
  - SUITABLE FOR USE AS SERVICE EQUIPMENT – WHEN NOT MORE THAN SIX MAINS ARE INSTALLED
- All service equipment shall be listed or field labeled
- Also see 230.70(B)

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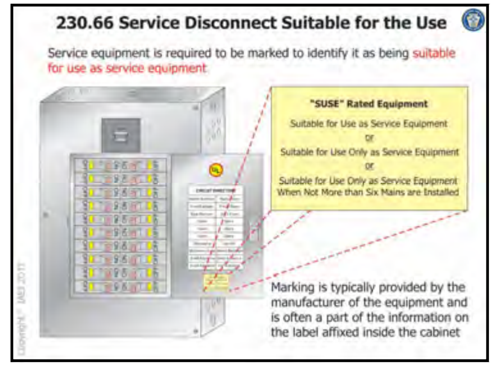

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230.70(B) Marking of Service Disconnecting Means

- Each service disconnect is also required to be permanently marked identifying it as a **"Service Disconnect"**
- This is in addition to the manufacturer's marking of service equipment required to be marked as being **suitable for use as service equipment** [230.66]

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Working Space – Space About Electrical Equipment

- Ample **working space** is required in the vicinity of service equipment so any repairs, operation, or servicing of equipment can be performed safely
- Minimum **750 mm (30 in.) wide** in front or the width of the equipment whichever is greater
- Minimum headroom required – **2.0 m (6½ ft)**
- Doors to swing a minimum of **90° angle**
- **Dedicated electrical space** required above and below the electrical equipment
- Dedicated electrical space applies to both **indoor and outdoor** installations

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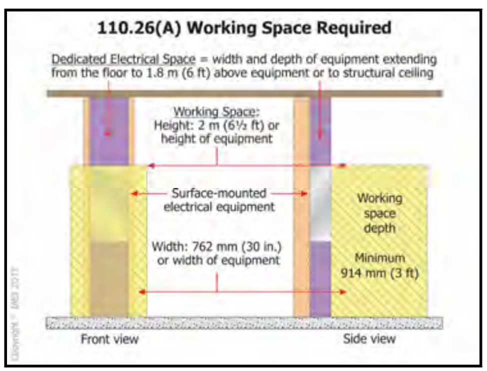

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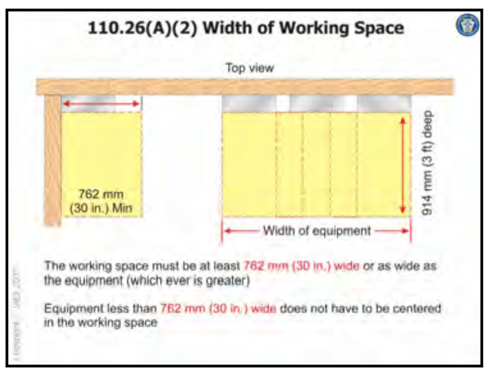

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Limited Access Working Space

- Working space is also required around electrical equipment located in spaces with **"limited access"** such as above suspended ceilings, attics, or crawl spaces
- Strict compliance with normal working space rules in attics and crawl spaces is often not feasible and, in some cases, not possible
- Prescriptive requirements for such limited access spaces has been addressed in the latest edition of the *Code* and sorely lacking previously
- Limited access working space provisions is an attempt to provide relief for both the installer and the enforcement community
- See *NEC* 110.26(A)(4)

55

56

Working Space – Illumination & Headroom

- **Illumination** shall be provided for all working spaces about service equipment and panelboards installed indoors
- Additional lighting outlets not required where the work space is illuminated by an **adjacent light source**
- Illumination source cannot be controlled by an **automatic means only** *(such as a motion sensor)*
- Minimum headroom required – **2.0 m (6½ ft)**
  - *Exception: In existing dwelling units, service equipment or panelboards not exceeding 200 amperes are permitted in spaces where the headroom is less than 2.0 m (6½ ft)*

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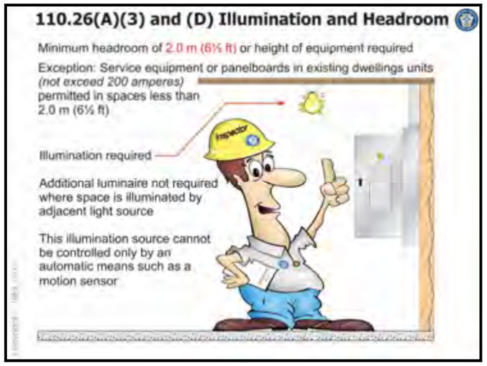

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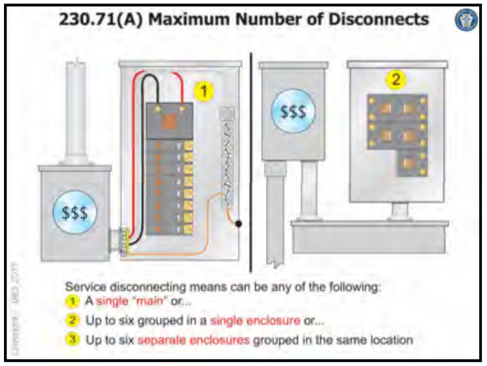
Requirements for Service Disconnects

- Service disconnect required for each service permitted by 230.2 or each set of service-entrance conductors permitted by 230.40 Ex. No. 1
- Shall consist of not more than **six switches or six circuit breakers** mounted in a single enclosure or separate enclosures
- The two to six service disconnects permitted by 230.71 are required to be **grouped together**
- Each service disconnect shall be marked to indicate the load served

59



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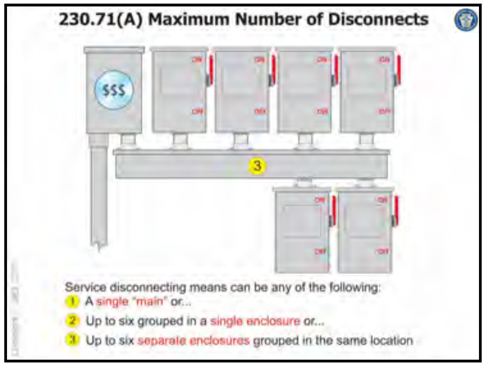
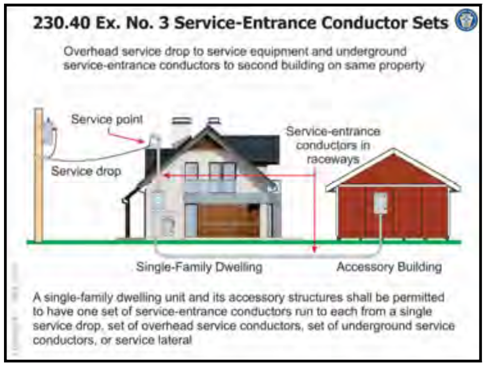


61

Services for Outbuildings

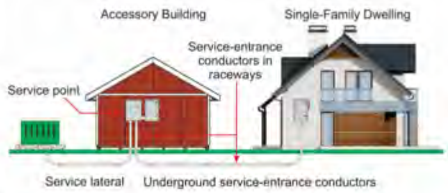
- Section 230.40 Ex. No. 3 permits a set of service-entrance conductors to be run from a **common location** *(such as a meter socket enclosure or wireway)* to another building
- Service drop or lateral can supply either building
- Service-entrance conductors must remain **outside the structures** per 230.3
- Service disconnect(s) located to comply with 230.70(A) *(outside or inside, nearest the point of entrance)*
- Connections to service-entrance conductors or service lateral to be made in an acceptable manner in an enclosure with adequate space

62



63

230.40 Ex. No. 3 Service-Entrance Conductor Sets



A single-family dwelling unit and its accessory structures shall be permitted to have one set of service-entrance conductors run to each from a single service drop, set of overhead service conductors, set of underground service conductors, or service lateral

64

Minimum Size of Service-Entrance Conductors

- Not less than the calculated load in accordance with Article 220 [230.42(A)]
- Minimum 100 amperes for one-family dwellings as required by the disconnect sizing requirements of 230.79
- Must be equal to or exceed the rating of the overcurrent device in series with service-entrance conductor [230.90(A)]

65

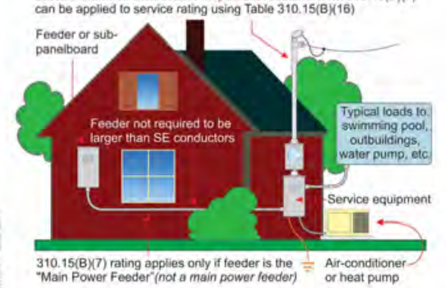
Sizing Service-Entrance Conductors for Dwelling Units

- *NEC* 310.15(B)(7) can be applied specifically to the service-entrance, service-lateral and the main power feeder conductor for dwelling units
- Applies to dwelling unit services of **120/240 volts**, 3-wire or **208Y/120 volts**, single-phase feeder conductors
- Permitted to have an ampacity not less than ***83 percent*** of the service or feeder rating based on standard ampacity ratings found at *NEC* 240.6(A)
- Permitted to be used for the feeder conductors that supply the entire load associated with the dwelling unit

66

310.15(B)(7) Permitted to be Used

Service-entrance conductors: 83 percent reduction from 310.15(B)(7) can be applied to service rating using Table 310.15(B)(16)



310.15(B)(7) rating applies only if feeder is the "Main Power Feeder" *(not a main power feeder)*

67

310.15(B)(7) Permitted to be Used

310.15(B)(7) - 120/240-Volt, 3-Wire, Single-Phase Dwelling Unit Service or Feeder or a 208Y/120-Volt, Single-Phase Dwelling Unit Feeder

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

68

Informational Annex Example D7 Sizing of Service Conductors for Dwelling(s) *[See 310.15(B)(7)]*

- **With No Required Adjustment or Correction Factors**
- Service conductors and the main power feeder for certain dwellings are permitted to be sized in accordance with 310.15(B)(7)
- If a 175-ampere service rating is selected, a service conductor is then sized as follows:
- 175 amperes × 0.83 = 145.25 amperes per 310.15(B)(7)
- If no other adjustments or corrections are required for the installation, then, in accordance with Table 310.15(B)(16), a 1/0 AWG Cu or a 3/0 AWG Al meets this rating at 75°C (167°F)

Reproduction of Example D7 of NEC Informational Annex D

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Informational Annex Example D7 Sizing of Service Conductors for Dwelling(s) *[See 310.15(B)(7)]*

- **With Required Temperature Correction Factor**
- Service conductors and the main power feeder for certain dwellings are permitted to be sized in accordance with 310.15(B)(7)
- If a 175-ampere service rating is selected, a service conductor is then sized as follows:
- 175 amperes × 0.83 = 145.25 amperes per 310.15(B)(7)
- Conductors to be installed in an ambient temperature of 40°C (104°F) *[See Table 310.15(B)(2)(a)]*
- Using XHHW-2 conductors requires a correction factor of 0.91 to find the minimum conductor ampacity and size: 145.25/.91 = 159.6 amperes
- In accordance with Table 310.15(B)(16), a 2/0 AWG Cu or a 4/0 AWG Al would be required

Reproduction of Example D7 of NEC Informational Annex D

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Informative Annex D - Example D7 Sizing of Service Conductors for Dwelling(s)

[Former Table 310.15(B)(7)]

If no temperature correction or ampacity adjustment factors are required, the following table includes conductor sizes calculated using the requirements in 310.15(B)(7). This table is based on 75°C terminations and without any adjustment or correction factors.

Service or Feeder Rating (Amperes)	Conductor (AWG or kcmil) Copper	Conductor (AWG or kcmil) 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

71

Overload Protection for Service-Entrance Conductors

- In most cases, each ungrounded (hot) service-entrance conductor must be protected from **overload** by an overcurrent device installed in series with the conductor that will operate during an overload
- Each ungrounded service conductor is required to have **overload protection**
- Service-entrance conductors are protected from overload at their **load end** rather than at their supply end
- See *NEC* 230.90

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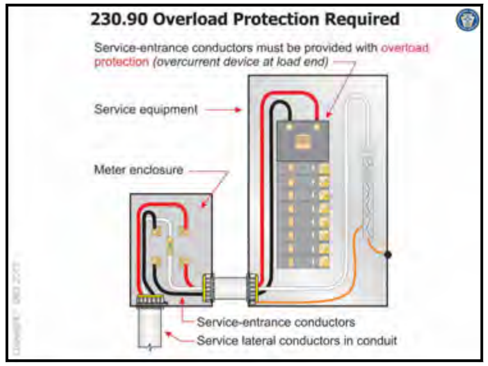
Overload Protection for Service-Entrance Conductors *(cont.)*

- An overload includes
  - Operation of equipment in excess of normal
  - Full-load rating
  - Conductor in excess of rated ampacity *(which, if it persists for a sufficient length of time, would cause damage or dangerous overheating)*
- A fault, such as a short circuit or ground fault, is not an overload

73



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Panelboards at Dwelling Units

- Two types of panelboards are commonly used in residential occupancies
  - **Main circuit breaker** or set of fuses installed at the factory by the manufacturer *(most commonly used at dwellings)*
  - **"Main Lug Only" (MLO)** panelboard (no main breaker)
- MLO panelboard has the ungrounded service or feeder conductors connected directly to the **main lugs on the load side** rather than to a circuit breaker or set of fuses
- MLO panelboard protected from overcurrent and overload on the **supply-side of the feeder** with two main circuit breakers or two sets of fuses having a combined rating not greater than that of the panelboard

76

77

408.36 Overcurrent Protection for Panelboards

- Generally, a panelboard is required to be protected by an overcurrent protective device having a rating not greater than that of the panelboard
- This overcurrent protective device to be located within or at any point on the supply side of the panelboard
  - **Ex. No. 1**: Individual protection not required for a panelboard used as service equipment with multiple disconnecting means *[up to six means of disconnect(230.71)]*
  - Panelboards protected in this manner shall not supply a second bus structure within the same panelboard

(cont. on next slide)

78

408.36 Overcurrent Protection for Panelboards *(cont.)*

- Generally, a panelboard is required to be protected by an overcurrent protective device having a rating not greater than that of the panelboard
- This overcurrent protective device to be located within or at any point on the supply side of the panelboard
  - **Ex. No. 2:** Individual protection not required for a panelboard protected by main on its supply side *(two main circuit breakers or two sets of fuses)*
  - A panelboard employing this exception shall not contain more than 42 overcurrent devices

(cont. on next slide)

79

408.36 Overcurrent Protection for Panelboards *(cont.)*

- Generally, a panelboard is required to be protected by an overcurrent protective device having a rating not greater than that of the panelboard
- This overcurrent protective device to be located within or at any point on the supply side of the panelboard
  - **Ex. No. 3**: For existing panelboards, individual protection not required for a panelboard used as service equipment for an individual residential occupancy

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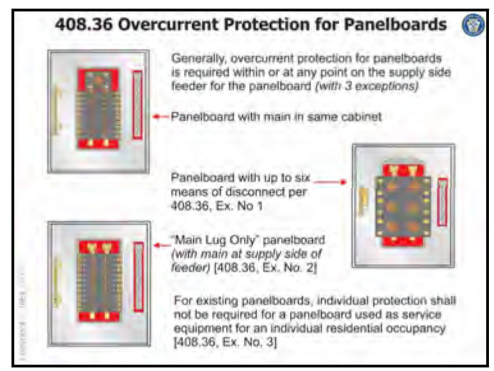


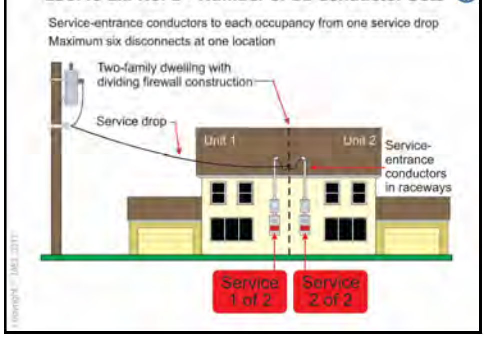
81

Installing Service-Entrance Equipment for Two-Family Dwellings

- Service equipment for **two-family dwellings** is usually installed in one of two methods:
  - **Locate service disconnects in or on the individual dwelling units** *(not grouped)*
    - Metering equipment at one location *(typically required by the serving utility)*
    - Service-entrance conductors run to each dwelling unit
    - Permitted by ***NEC* 230.40 Exception No. 1**
  - **Group the service disconnects at one location** *(typically near the metering equipment)*
    - Feeder run to each dwelling units to subpanel or feeder panelboard
    - Permitted by ***NEC* 230.40 Exception No. 2**
- Requirements for installing services for one-family dwellings apply for two-family dwellings as well

82

230.40 Ex. No. 1 - Number of SE Conductor Sets



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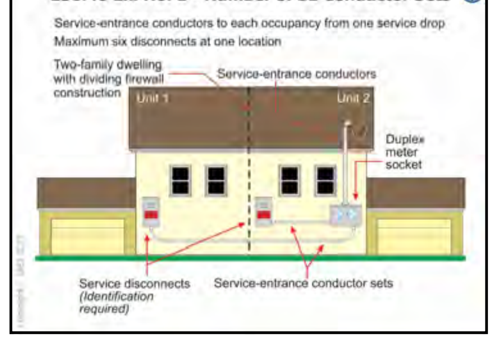
230.40 Ex. No. 1 - Number of SE Conductor Sets



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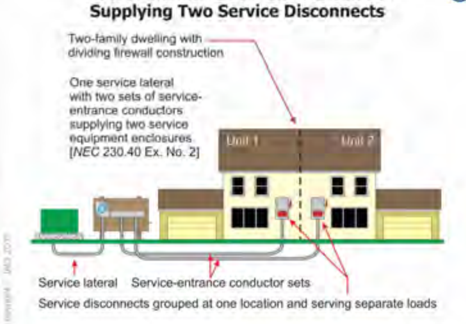
230.40 Ex. No. 2 One Service Lateral Supplying Two Service Disconnects



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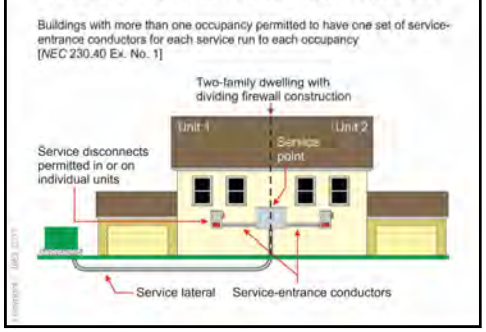
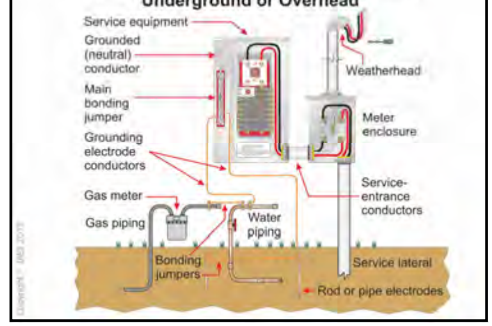
230.40 Ex. No. 1 Number of SE Conductor Sets



86

Typical Dwelling Services Components - Underground or Overhead



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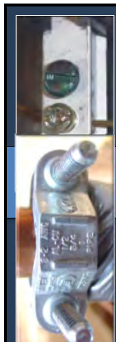
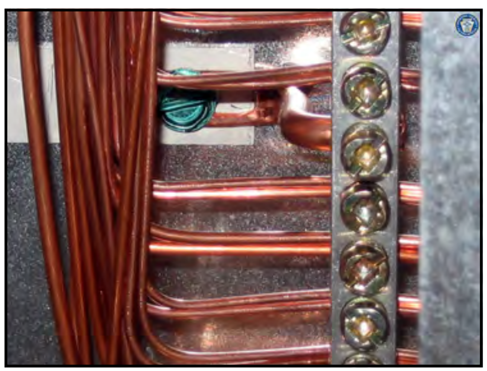


Volume II Chapter Five

Grounding and Bonding

88



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Purpose of Grounding

- **Limit voltages** due to lightning, line surges, or unintentional contact with higher voltage lines
- Proper grounding also serves to **stabilize the voltage to ground** during normal operation [250.4(A)(1)]
- Conductive materials enclosing electrical conductors or equipment shall be connected to earth so as to **limit the voltage to ground** on these materials [250.4(A)(2)]
- Conductive materials are grounded to **limit the voltage to ground** on these materials

90

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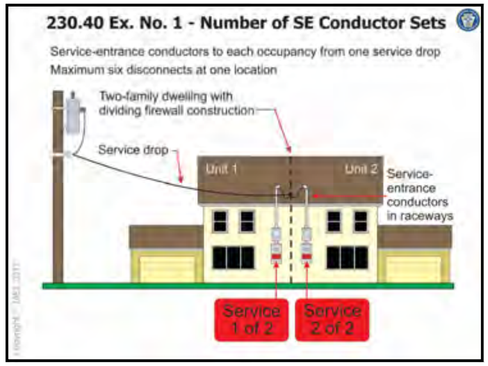
- Service equipment for **two-family dwellings** is usually installed in one of two methods:
  - **Locate service disconnects in or on the individual dwelling units** *(not grouped)*
    - Metering equipment at one location *(typically required by the serving utility)*
    - Service-entrance conductors run to each dwelling unit
    - Permitted by ***NEC* 230.40 Exception No. 1**
  - **Group the service disconnects at one location** *(typically near the metering equipment)*
    - Feeder run to each dwelling units to subpanel or feeder panelboard
    - Permitted by ***NEC* 230.40 Exception No. 2**
- Requirements for installing services for one-family dwellings apply for two-family dwellings as well

82



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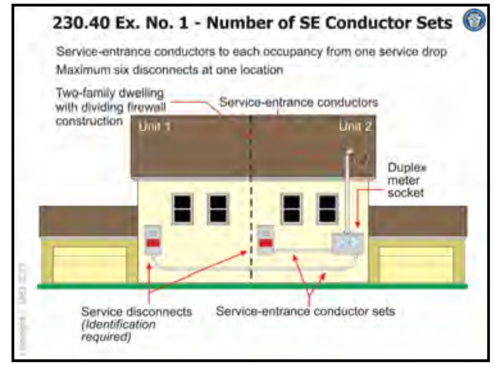

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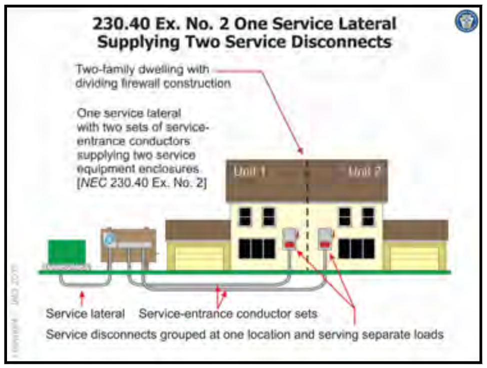

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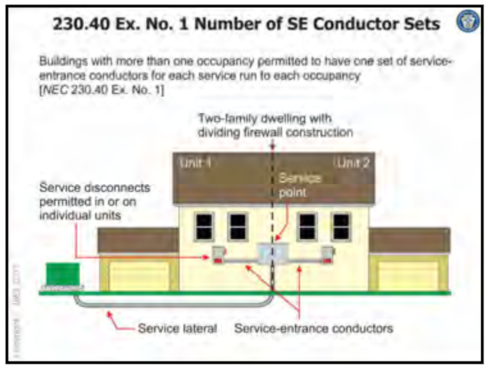

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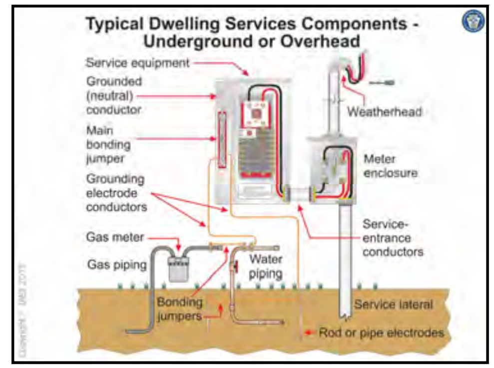

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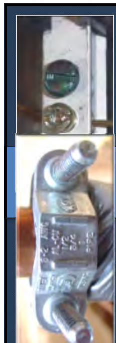
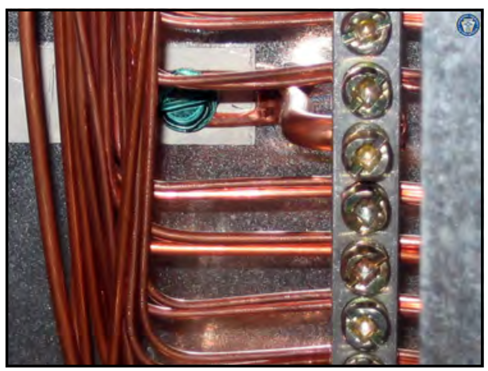


Volume II Chapter Five

Grounding and Bonding

88



89

Purpose of Grounding

- **Limit voltages** due to lightning, line surges, or unintentional contact with higher voltage lines
- Proper grounding also serves to **stabilize the voltage to ground** during normal operation [250.4(A)(1)]
- Conductive materials enclosing electrical conductors or equipment shall be connected to earth so as to **limit the voltage to ground** on these materials [250.4(A)(2)]
- Conductive materials are grounded to **limit the voltage to ground** on these materials

90

Purpose of Bonding

- **Electrically conductive materials** such as metal water piping, metal gas piping, and structural steel members are to be **bonded** to the supply system grounded conductor in a manner which **establishes an effective path for fault current** [250.4(A)(3) and (4)]
- **Effective fault current path** must be continuous, capable of carrying the maximum fault current likely to be imposed on it, and shall have low impedance to facilitate overcurrent device operation [250.4(A)(5)]

91

Article 100: Definitions

- **Bonded (Bonding):** "Connected to establish electrical continuity and conductivity."
- **Bonding Conductor or Jumper:** "A reliable conductor to ensure the required electrical conductivity between metal parts required to be electrically connected."
- **Bonding Jumper, Equipment:** "The connection between two or more portions of the equipment grounding conductor."
- **Bonding Jumper, Main:** "The connection between the grounded conductor and the equipment grounding conductor at the service."

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Article 100: Definitions

- **Bonding Jumper, System::** "The connection between the grounded circuit conductor and the supply-side bonding jumper, or the equipment grounding conductor, or both, at a separately derived system."
- **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." (250.2)
- **Effective Ground-Fault Current Path:** "An intentionally constructed, low-impedance electrically conductive path designed and intended to carry current under ground-fault conditions from the point of a ground fault on a wiring system to the electrical supply source and that facilitates the operation of the overcurrent protective device or ground fault detectors."

93

Article 100: Definitions

- **Ground:** "The earth."
- **Ground Fault:** "An unintentional, electrically conductive connection between an ungrounded conductor of an electrical circuit and the normally non–current-carrying conductors, metallic enclosures, metallic raceways, metallic equipment, or earth."
- **Grounded (Grounding):** "Connected (connecting) to ground or to a conductive body that extends the ground connection."
- **Grounded Conductor:** "A system or circuit conductor that is intentionally grounded."

94

Article 100: Definitions

- **Ground-Fault Current Path:** "An electrically conductive path from the point of a ground fault on a wiring system through normally non–current-carrying conductors, equipment, or the earth to the electrical supply source."
  - ***Informational Note:*** *Examples of ground-fault current paths are any combination of equipment grounding conductors, metallic raceways, metallic cable sheaths, electrical equipment, and any other electrically conductive material such as metal, water, and gas piping; steel framing members; stucco mesh; metal ducting; reinforcing steel; shields of communications cables; and the earth itself.*

95

Article 100: Definitions

- **Grounding Conductor, Equipment (EGC):** "The conductive path(s) that provides a ground-fault current path and connects normally non–current-carrying metal parts of equipment together and to the system grounded conductor or to the grounding electrode conductor, or both."
- **Grounding Electrode:** "A conducting object through which a direct connection to earth is established."
- **Grounding Electrode Conductor:** "A conductor used to connect the system grounded conductor or the equipment to a grounding electrode or to a point on the grounding electrode system."

96

Article 100: Definitions

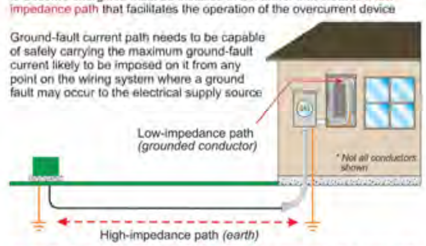
- **Intersystem Bonding Termination:** "A device that provides a means for connecting intersystem bonding conductors for communications systems to the grounding electrode system."

97

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

Electrical equipment, wiring and other electrically conductive material likely to become energized must be installed in a manner that creates a low-impedance path that facilitates the operation of the overcurrent device

Ground-fault current path needs to be capable of safely carrying the maximum ground-fault current likely to be imposed on it from any point on the wiring system where a ground fault may occur to the electrical supply source



The earth shall not be considered as an effective ground-fault current path

98

99

250.24 (C) Grounded *(Neutral)* Conductor Brought to Service Equipment

- Where ac system *(less than 1000 volts)* is grounded at any point, generally the **grounded conductor** *(usually a neutral conductor in dwellings)* required to be run to and bonded to each service-disconnecting means enclosure
- Grounded conductor must be **routed with the service-entrance phase conductors**
- Grounded *(neutral)* service conductor serves **dual role**:
  - Allows line-to-neutral loads to be served
  - Typically the **lowest impeded path** for ground-fault current in faulted conditions *(provides low-impedance path from the service to the utility transformer)*

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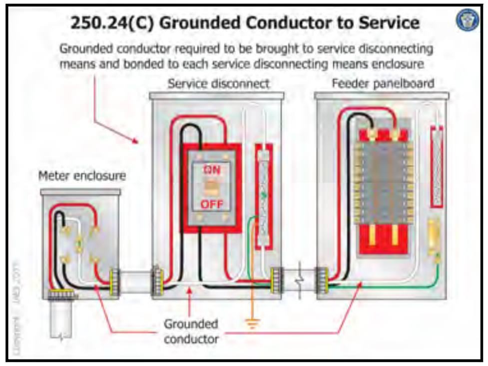

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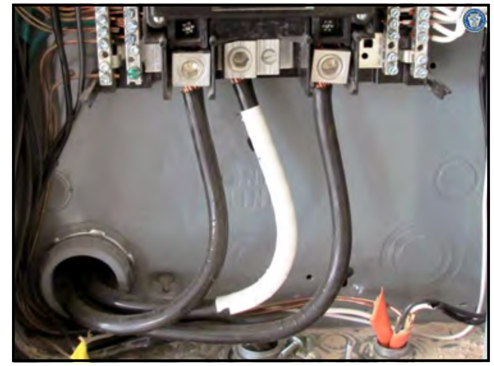

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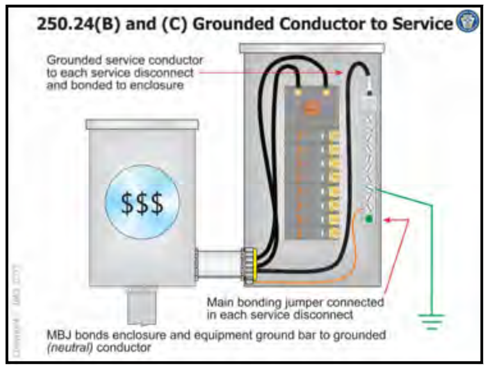
250.24 (B) and (C) MBJ Bonding Grounded *(Neutral)* Conductor at Service

- Where ac system *(less than 1000 volts)* is grounded at any point, generally the **grounded conductor** *(usually a neutral conductor in dwellings)* required to be run to and bonded to each service-disconnecting means enclosure
- For grounded systems, an unspliced **main bonding jumper** is generally required to be installed to connect the equipment grounding conductor(s) and the service-disconnect enclosure to the grounded conductor **within each service disconnect**

103

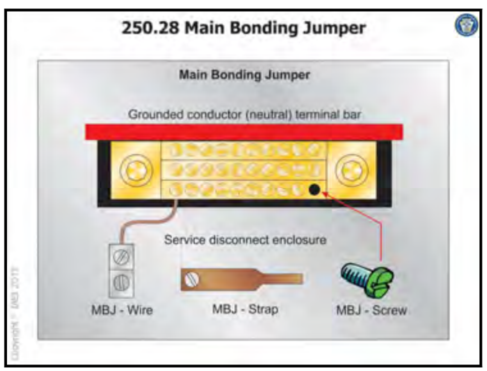


104

250.28 Main Bonding Jumper

- Main bonding jumpers must be of **copper or other corrosion-resistant material**
- Main bonding jumper is required to be in the form of:
  - Wire
  - Bus
  - Screw *(green color finish)*
  - Similar suitable conductor *(strap)*
- For dwelling units, a properly sized main bonding jumper will usually be included as part of a **listed panelboard**
- Sizing of a **wire-type main bonding jumper** would be based on *NEC* **Table 250.102(C)(1)**

105



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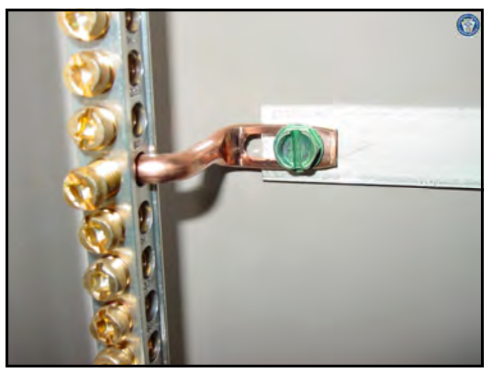

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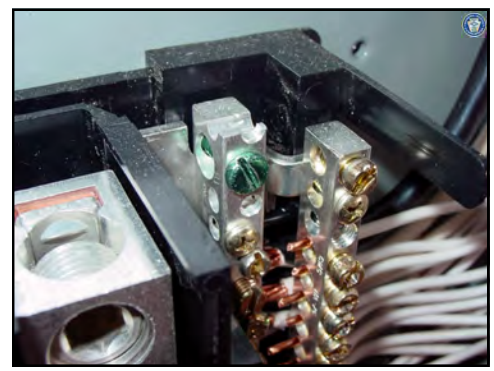

108

The Grounding Target

- For grounded electrical systems, **four conductors or components** must come together in the service equipment for effective grounding and bonding
- These four conductors connected within the service equipment are sometimes referred to as the ***"grounding target"***
- The four conductors are:
  - Grounded service conductor (neutral conductor)
  - Main bonding jumper
  - Grounding electrode conductor(s)
  - Equipment grounding conductor(s)

109

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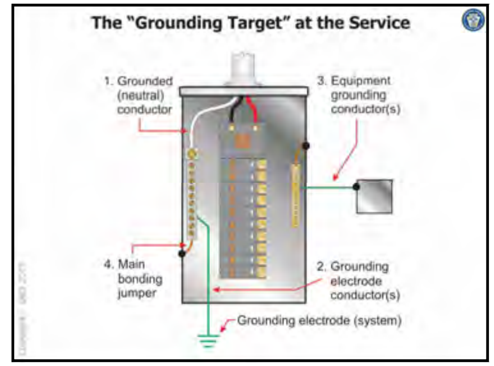

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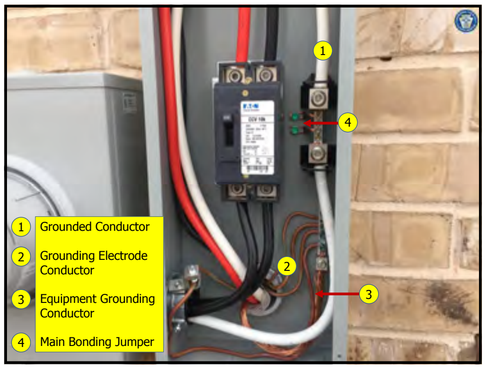

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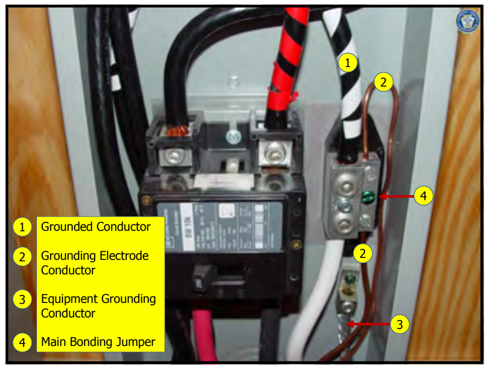


113

250.92(A) Bonding Requirements at Service Equipment

- All non–current-carrying metal parts of service equipment must be **effectively bonded together** including:
  - Service raceways
  - Service equipment enclosures containing service conductors (including meter fittings, boxes, or the like)
  - Metallic raceway or armor enclosing a grounding electrode conductor
- Bonding of these enclosures is critical as there is **no overcurrent protection** on the line (supply) side of service equipment
- Effective bonding provides a **low-impedance path** for fault current back to the source *(usually utility transformer)*

114

250.92(B) Methods of Bonding Service Equipment

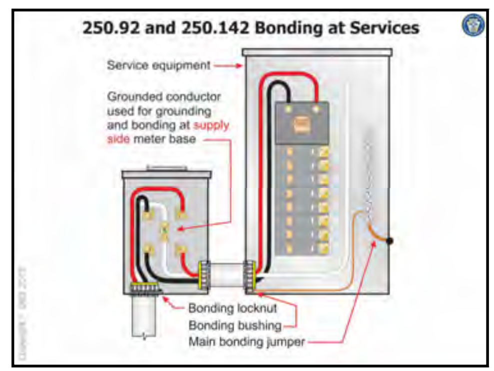
- Bonding of metallic enclosures and raceways at service equipment must be effective
- Electrical continuity at service equipment on the **line side** is to be ensured by any of the following methods:
  - Bonding of the service equipment to the **grounded (neutral) service conductor**
  - **Threaded couplings** and **threaded hubs** on enclosures with joints that are made up wrenchtight
  - **Threadless couplings and connectors** made up tight for metal raceways and metal-clad cables
  - Other listed devices, such as **bonding-type locknuts**, **bonding bushings**, or bushings with bonding jumpers

115

250.142 Use of Grounded (Neutral) Circuit Conductor for Grounding Equipment

- Grounded *(neutral)* conductor is **permitted** to be used to ground non–current-carrying metal parts of equipment, raceways and other enclosures on the **supply (line) side** of a service disconnecting means *[NEC 250.142(A)]*
- Neutral conductor terminal bar is typically **bonded to the enclosure** at the factory in listed meter socket
- Neutral conductor serves as bonding conductor between the meter socket and the service enclosure
- Generally, **not permitted** to use the system grounded conductor *(often a neutral conductor)* for bonding or grounding equipment downstream from the service equipment ***(load side)*** *[NEC 250.142(B)]*

116



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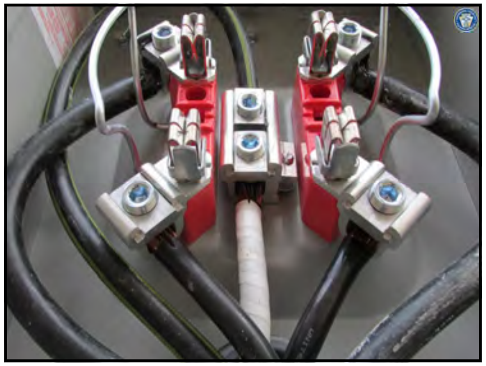

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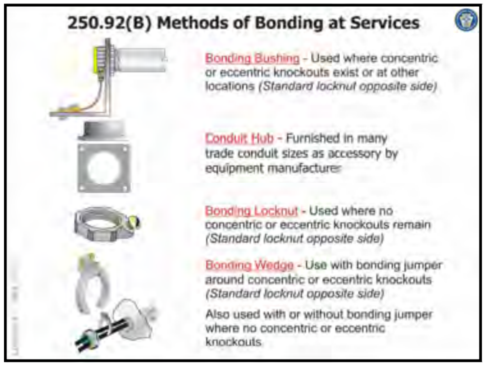

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121

SSBJ Size on Supply Side of Service

- Where a supply-side bonding jumper is installed on the supply of the service it shall be:
  - Not smaller than the sizes given in Table 250.102(C)(1)
  - Table 250.102(C)(1) is based on service-entrance conductor size, not overcurrent device or service equipment ampere rating
- *See 250.102(C)*

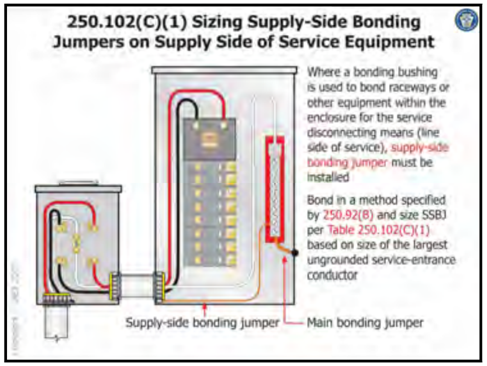
122

SSBJ Size on Supply Side of Service

Example:

- A 200-ampere service has 4/0 AWG aluminum service-entrance conductors
- Section 250.102(C)(1) requires that the supply-side bonding jumper be not smaller than the sizes given in Table 250.102(C)(1)
- Using Table 250.102(C)(1), the minimum size of the supply-side bonding jumper in this example would be a 4 AWG copper or a 2 AWG aluminum

123



124

125

Purpose of Intersystem Grounding & Bonding for Communication Systems

- Low voltage systems and circuits in Chapter 8 of the *Code* must be grounded *(earthed)* and bonded to the electrical power system grounding electrode or electrode system for the building or structure
- Grounding to a grounding electrode affords reasonable protection from spike and surge currents as well as brief elevated potentials due to lightning strikes
- Bonding the electrodes of the two systems together **limits differences of potential** during normal operation and during spike or surge events on the systems and lightning strikes at close proximities
- Bonding the electrodes of the two systems together limits potential differences and shock hazards that could result from isolated grounding connections

126

Article 100: Definitions

- **Intersystem Bonding Termination:** "A device that provides a means for connecting intersystem bonding conductors for **communications systems** to the grounding electrode system."

127

250.94 Intersystem Bonding for Communication Systems

- An ***intersystem bonding termination (IBT)*** for connecting intersystem bonding conductors required for communication systems shall be provided **external to enclosures** at the service or metering equipment and at the disconnecting means for any additional buildings or structures
- A **listed IBT device** shall comply with the following:
  - Be accessible for connection and inspection
  - Have the capacity for connection of **not less than three** intersystem bonding conductors
  - Not interfere with opening a service or metering equipment enclosure

128

250.94 Intersystem Bonding for Communication Systems *(cont.)*

- A **listed IBT device** shall comply with the following: *(cont.)*
  - Listed as grounding and bonding equipment
  - Securely mounted and electrically connected to:
    - Service equipment
    - Meter enclosure
    - Building disconnecting means
    - Exposed nonflexible metallic service raceway or…
  - Mounted at one of these enclosures and be connected to the enclosure or to the grounding electrode conductor with a minimum **6 AWG copper conductor**

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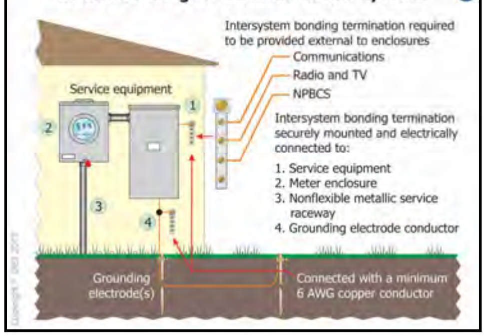
250.94 Bonding for Communication Systems



130

Intersystem Bonding termination is required to be:
- External to the enclosure
- Accessible for connection and inspection

- Capable of connection of not less than three intersystem bonding conductors
- Shall not interfere with the opening of any service or metering equipment enclosure
- Listed as grounding and bonding equipment

Courtesy of Thomas and Betts

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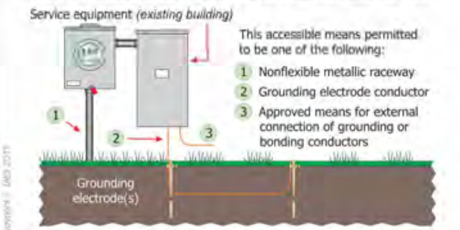
250.94 Exception: Intersystem Bonding and Grounding at Existing Buildings

- At **existing buildings**, an accessible means external to the service equipment enclosure and at the disconnecting means for any additional buildings or structures shall be permitted for intersystem bonding and grounding conductors [250.94, Exception]
  - Exposed nonflexible metallic service raceway(s)
  - Exposed grounding electrode conductor
  - A 6 AWG copper bonding or grounding electrode conductor not shorter than 150 mm (6 in.) and bonded to the service equipment enclosure or raceway with a listed and identified fitting

133

250.94(A) Ex. - Bonding for Communication Systems at Existing Buildings or Structures

In lieu of an intersystem bonding termination, at existing installations, an accessible means external to enclosures is permitted to be provided for connection of communication bonding conductors at service equipment where any intersystem bonding and grounding electrode conductors exist



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Grounding Electrode System

- Grounding electrodes provide essential function of **connecting** the electrical system and electrical equipment **to the earth**
- Primary purpose of grounding electrode(s) is to maintain the electrical equipment at the **same voltage potential** as the earth voltage potential where the grounding electrode(s) is located
- Another essential function of the grounding electrode(s) is to **dissipate overvoltages** into the earth
- *Code* requires equipment grounding conductors, service-equipment enclosures, grounded service conductor to be connected to the grounding electrode(s) [*NEC* 250.24(D)]
- Conductor used to make this connection is the **grounding electrode conductor**

136

Article 100: Definitions

- ***Grounding electrode***: "A conducting object through which a direct connection to earth is established."
- This definition needs to be used cooperatively with the list of electrodes identified in *NEC* 250.52(A)
- List of grounding electrodes can be a device or other conducting object such as a building footing or metal well casing that establishes and maintains a direct connection to the earth
- Resistance in the connection between an electrode and the earth will vary based on:
  - Soil conditions
  - Electrode depth
  - Type of electrode
  - Seasonal conditions or geographical location(s)

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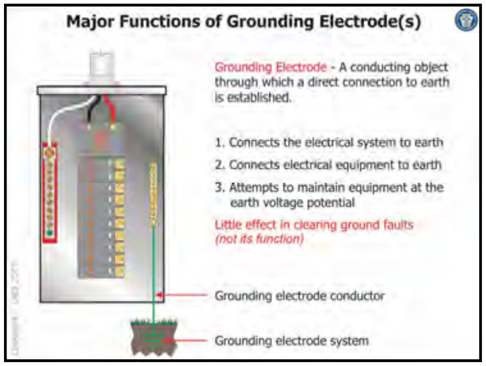

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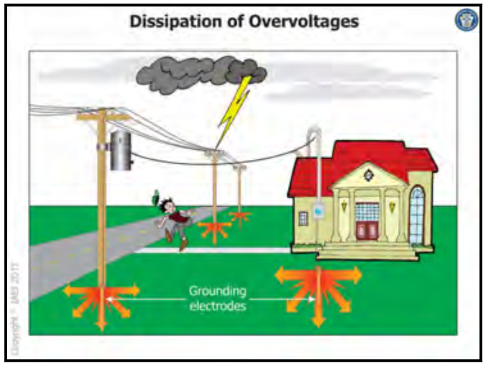


139

250.50 Grounding Electrode System

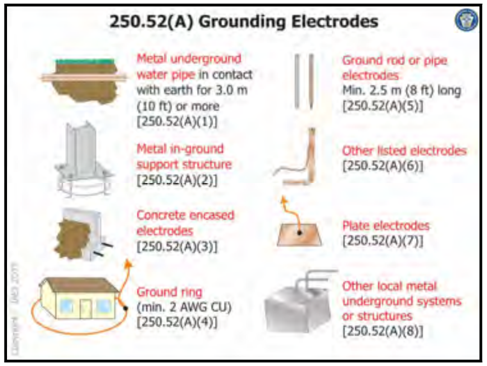
- These grounding electrodes are required to be used **where present**
- If any of these electrodes are inherent to the building or structure or installed, they shall be used in the grounding electrode system:
  - 250.52(A)(1) Metal underground water pipe
  - 250.52(A)(2) Metal frame of a building or structure
  - 250.52(A)(3) Concrete-encased electrode
  - 250.52(A)(4) Ground ring
  - 250.52(A)(5) Rod and pipe electrode
  - 250.52(A)(6) Other listed electrodes
  - 250.52(A)(7) Plate electrodes
  - 250.52(A)(8) Other local metal underground systems or structures

140

250.50 Grounding Electrode System

- Where none of the grounding electrodes described in 205.52(A)(1) through (7) are present, one or more of the grounding electrodes specified below shall be installed and used:
  - 250.52(A)(4) Ground ring
  - 250.52(A)(5) Rod and pipe electrode
  - 250.52(A)(6) Other listed electrodes
  - 250.52(A)(7) Plate electrodes
  - 250.52(A)(8) Other local metal underground systems or structures

141



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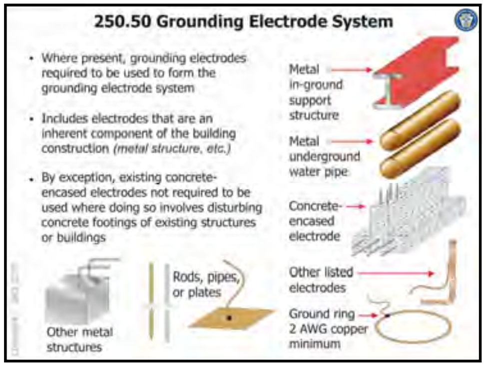
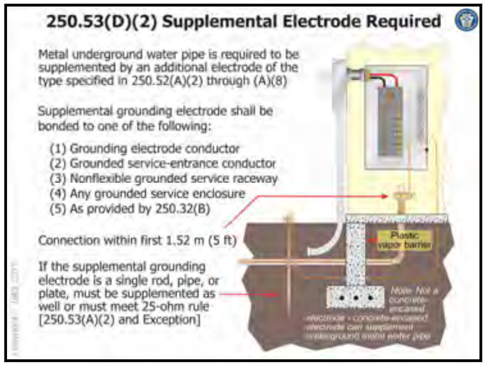


143

250.52(A)(1) Metal Underground Water Piping Systems

- **Metal underground water piping systems** required to be used for the grounding electrical systems *(where present)*
- Must be in direct contact with the earth for 3.0 m **(10 ft) or more** and electrically continuous
- Includes any metal well casing bonded to the pipe
- Can be made electrically continuous by bonding around insulating joints or insulating pipe
- Must not be coated or otherwise insulated from direct contact with the earth

144



145

250.52(A)(2) Metal In-Ground Support Structure(s)

- **Metal in-ground support structure** required to be used for the grounding electrical systems *(where present and qualifies)*
- Must be in direct contact with the earth vertically for **3.0 m (10 ft) or more** *(with or without concrete encasement)*
- If multiple metal in-ground support structures are present, **permitted to bond only one** into the grounding electrode system
- Could include *(but are not limited to)* pilings, casing, and other structural metal
- Metal in-ground support structures uncommon for dwelling unit construction

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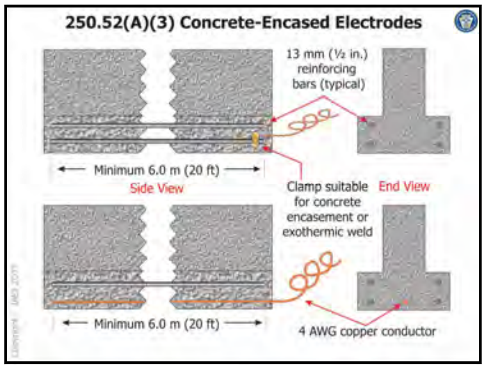
250.52(A)(3) Concrete-Encased Electrode

- **Concrete-encased electrodes** required to be used when consisting of:
  - At least **6.0 m (20 ft)** of bare copper conductor not smaller than **4 AWG** or one or more bare or electrically conductive coated steel reinforcing bars or rods of not less than **13 mm (½ in.) in diameter**
  - Installed in **one continuous 6.0 m (20 ft) length**, or multiple pieces connected together by the usual steel tie wires, exothermic welding, welding, etc. to create a 6.0 m (20 ft) or greater length
  - Metallic components encased by at least **50 mm (2 in.) of concrete**
  - Located **horizontally** within portions of a concrete foundation or footing or **vertical** structural components in direct contact with the earth

147



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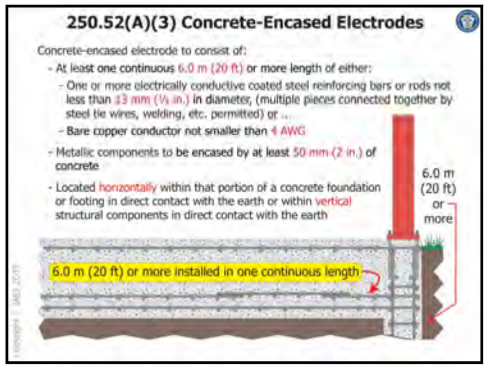

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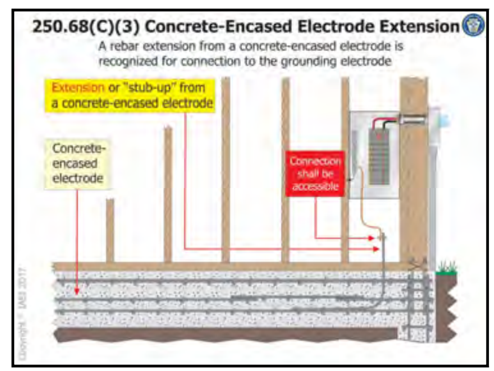
250.68(C)(3) Concrete-Encased Electrode Extension

- Common practice to extend a **rebar-type extension** from a concrete-encased electrode out of the footing or foundation before the slab or foundation is poured
- Typically accomplished by using a piece of rebar connected to the concrete-encased electrode and **"stubbed-up"** out of the poured concrete to provide an **accessible connection point** above the slab
- Electrician can make the grounding electrode conductor connection after the foundation has been poured and cured
- The extension or "stub-up" is not part of the concrete-encased electrode

152



153

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250.52(A)(5) Rod or Pipe Electrodes

- Requirements or conditions a **rod and pipe electrode** must meet to qualify as a grounding electrode are as follows:
  - Not be less than 2.44 m (8 ft) in length
  - **Pipe or conduit grounding electrodes** must consist of the following materials:
    - Not smaller than metric designator 21 (trade size ¾)
    - Where of steel, outer surface must be galvanized or otherwise metal-coated for corrosion protection

155

250.52(A)(5) Rod or Pipe Electrodes *(cont.)*

- Requirements or conditions a **rod and pipe electrode** must meet to qualify as a grounding electrode are as follows:
  - Not be less than 2.44 m (8 ft) in length
  - **Rod-type grounding electrodes** must consist of the following materials:
    - Stainless or copper or zinc coated steel
    - At least 15.87 mm (⅝ in.) in diameter, unless listed

156

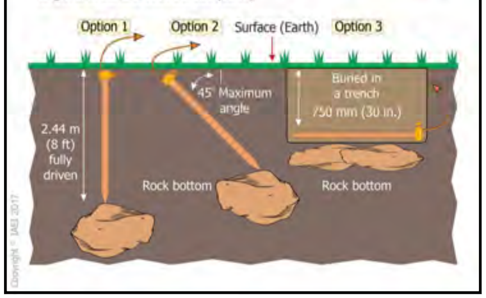
250.53(G) Installation of Rod and Pipe Electrodes

- **Rod and pipe electrodes** required to be installed with least **2.44 m (8 ft)** is in contact with the soil
- Required to be **driven vertically** unless rock bottom is encountered
- If rock bottom is encountered *(preventing rod or pipe from being driven 2.44 m (8 ft) vertically)*, rod or pipe permitted to be installed at an **oblique angle** of not more than **45 degrees** from vertical
- Where driven at an angle cannot be achieved, only then can the rod or pipe be **buried in a trench** that is at least **750 mm (30 in.)** deep

157

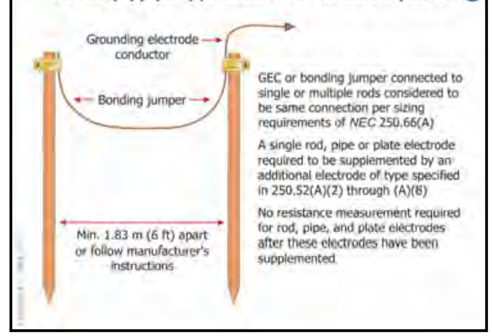
250.53(G) Installation of Rod or Pipe Electrodes

Rod or pipe electrodes must be installed such that at least 2.44 m (8 ft) of length is in contact with the soil (earth)



158

250.53(A)(2) Supplemental Electrode Required



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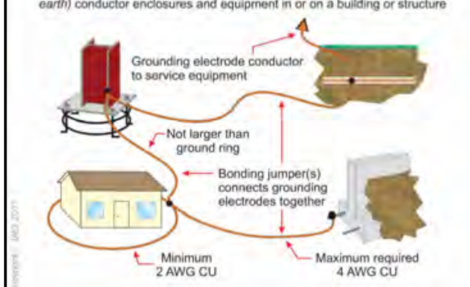
250.58 Common Grounding Electrode

- A grounding electrode system may consist of **one or more electrodes**
- The same **"common grounding electrode"** to be used to ground *(connect to earth)* conductor enclosures and equipment in or on a building or structure
- Prohibited from installing one grounding electrode for the electrical service or system and another one for grounding electrical equipment *(such as a hydromassage tub motor)*
- Two or more services supply a single building required to be connected to the **same grounding electrode system**
- Two or more grounding electrodes that are effectively bonded together are considered as a **single or common grounding electrode**

160

250.58 Common Grounding Electrode

The same "common grounding electrode" to be used to ground *(connect to earth)* conductor enclosures and equipment in or on a building or structure

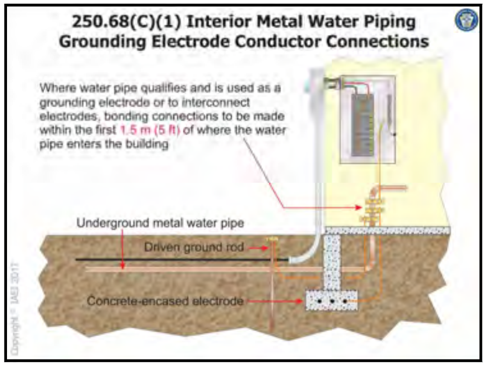


161

250.68(C)(1) Sizing Grounding Electrode System Bonding Jumpers

- Bonding jumper installed to connect multiple grounding electrodes together for the system must be sized in accordance with *NEC* Table 250.66
- Where **interior metal water pipe** is used to bond other electrodes together *(such as concrete-encased electrodes, building in-ground support structures, or a ground ring)*, bonding connections must be made **within the first 1.5 m (5 ft)** from where water pipe enters the building
- At a dwelling unit, metal water pipe is **not permitted** to be used for bonding the grounding electrodes together beyond this first **1.5 m (5 ft)**

162



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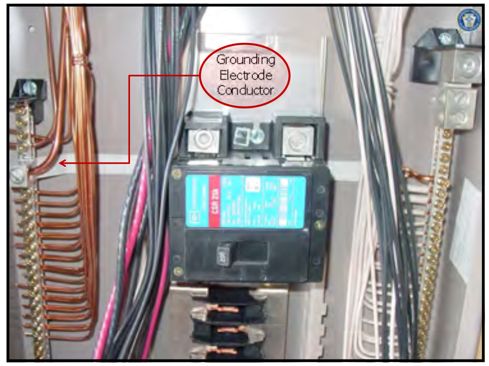

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250.70 Grounding Electrode Conductor Connections

- Exothermic welding
- Listed lug, pressure connectors
- Listed clamps of cast bronze or brass, or plain or malleable iron, or other listed means
- Clamps listed for material of both grounding electrode and grounding electrode conductor
- Where used underground, must be listed for direct burial or concrete encasement
- One conductor unless listed for more than one
- Connections that depend on solder must not be used

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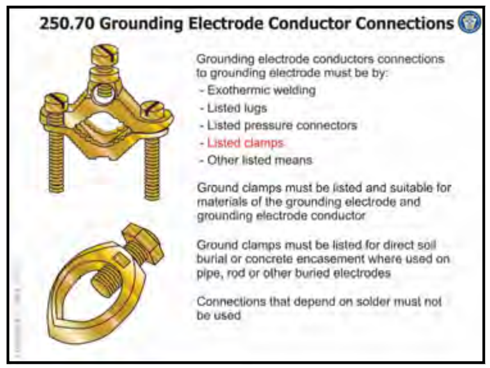

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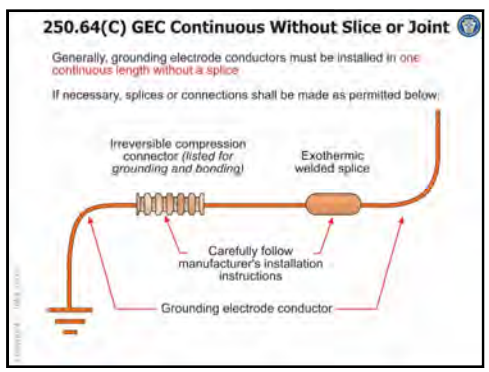
250.64(C) GEC Without Splice or Joint

- Grounding electrode conductors can be solid or stranded, insulated, covered or bare
- Generally, must be installed **in one continuous length without a splice or joint**
- Permitted to be spliced only by means of:
  - **Irreversible compression-type connector** that is listed as grounding and bonding equipment
  - **Exothermic welding process**
- Sections of busbars are also permitted to be connected together to form a grounding electrode conductor

169



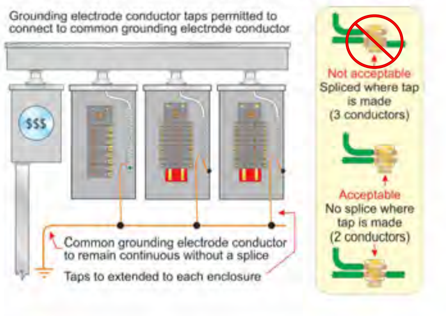
170

250.64(D)(1) Common GEC and Taps

- The *Code* permits the connection of **taps** to the grounding electrode conductor (GEC)
- Common method of installing the GEC where two or more service disconnecting means enclosures are grouped at the same location
- A common GEC is run from the grounding electrode to the vicinity of the service disconnecting means
- Each GEC tap conductor is required to extend from the common GEC to inside each such enclosure
- Common GEC sized based on largest service-entrance conductors using Table 250.66
- GEC taps to each disconnect permitted to be sized for the largest conductor serving the separate enclosures

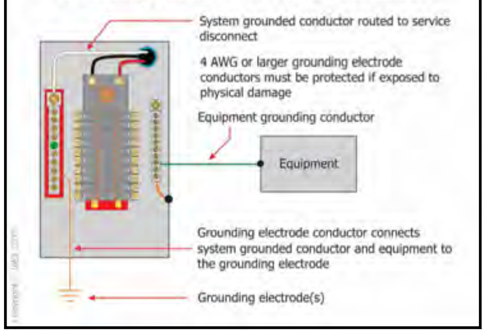
171

250.64(D)(1) Grounding Electrode Conductor Taps



172

Grounding Electrode Conductor Installation



173

250.66 Sizing of Grounding Electrode Conductors

- Sizing of grounding electrode conductor(s) (GEC) cannot be less than that given in *NEC* **Table 250.66**
- Size of the GEC is based on the **size of the largest service-entrance conductor** *(not on the rating of the circuit breaker or fuse in the service equipment)*
- To use **Table 250.66**:
  - Determine the size of the largest service-entrance conductor
  - Is it copper or aluminum?
  - Follow column for the size and type of conductor down until the size of the largest service-entrance conductor is found
  - Move to the right to find the copper or aluminum GEC required

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250.66 Sizing of Grounding Electrode Conductors *(cont.)*

- Note that neither the ampere rating of the service equipment nor the ampere rating of a main breaker or fuse is used to determine the size of the GEC
- Ampere rating of the service equipment or the main circuit breaker or fuse could be used to determine the size of the largest service-entrance conductors
- **Example**: If the size of the service-entrance conductors is **400 kcmil copper**, the GEC must be either **1/0 AWG copper** or **3/0 AWG aluminum**
- *NEC* **250.66(A), (B), and (C)** give specific sizes of GECs for connection to rod, pipe, or plate electrodes; concrete-encased electrodes; or a grounding electrode ring that **do not extend** on to other types of electrodes that require a larger size conductor

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Table 250.66 Grounding Electrode Conductor for Alternating-Current Systems

Size of Largest Ungrounded Service-Entrance Conductor or Equivalent Area for Parallel Conductors[a] (AWG/kcmil)		Size of Grounding Electrode Conductor (AWG/kcmil)	
Copper	Aluminum or Copper-Clad Aluminum	Copper	Aluminum or Copper-Clad Aluminum[b]
2 or smaller	1/0 or smaller	8	6
1 or 1/0	2/0 or 3/0	6	4
2/0 or 3/0	4/0 or 250	4	2
Over 3/0 through 350	Over 250 through 500	2	1/0
Over 350 through 600	Over 500 through 900	1/0	3/0
Over 600 through 1100	Over 900 through 1750	2/0	4/0
Over 1100	Over 1750	3/0	250

Notes:
1. If multiple sets of service-entrance conductors connect directly to a service drop, set of overhead service conductors, set of underground service conductors, or service lateral, the equivalent size of the largest service-entrance conductor shall be determined by the largest sum of the areas of the corresponding conductors of each set.
2. Where there are no service-entrance conductors, the grounding electrode conductor size shall be determined by the equivalent size of the largest service-entrance conductor required for the load to be served.

[a] This table also applies to the derived conductors of separately derived ac systems
[b] See installation restrictions in 250.64(A)

176

250.66 Sizing of Grounding Electrode Conductors *(cont.)*

- Grounding electrode conductors are generally required to be not smaller than the values in **Table 250.66**
- Grounding electrode conductor or bonding jumper may be sized as follows where **not extended on to other types of electrodes that require a larger size conductor**:
  - Not required to be larger than 6 AWG copper or 4 AWG aluminum to **rod, pipe, or plate** type grounding electrodes *[250.66(A)]*
  - Not required to be larger than 4 AWG copper to **concrete-encased electrode** *[250.66(B)]*
  - Not larger than the **ground ring** conductor *[250.66(C)]*

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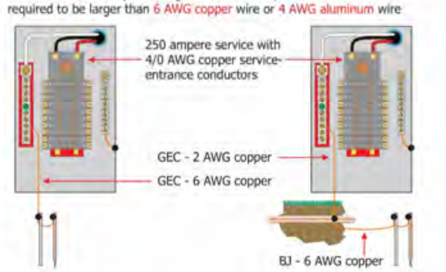
250.66(A) Sizing Grounding Electrode Conductors

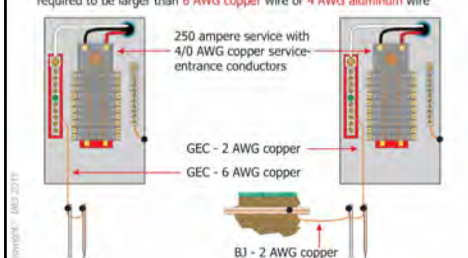
GEC or bonding jumper connected to a single or multiple rod, pipe, or plate electrode(s), or any combination thereof does not extend on to other types of electrodes that require a larger size conductor, the GEC shall not be required to be larger than 6 AWG copper wire or 4 AWG aluminum wire



178

250.66(A) Sizing Grounding Electrode Conductors

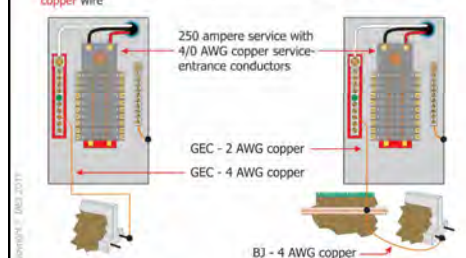
GEC or bonding jumper connected to a single or multiple rod, pipe, or plate electrode(s), or any combination thereof does not extend on to other types of electrodes that require a larger size conductor, the GEC shall not be required to be larger than 6 AWG copper wire or 4 AWG aluminum wire



179

250.66(B) Sizing Grounding Electrode Conductors

GEC or bonding jumper connected to a single or multiple concrete-encased electrode(s) that does not extend on to other types of electrodes that require a larger size conductor, the GEC shall not be required to be larger than 4 AWG copper wire



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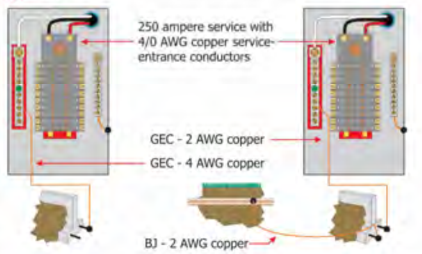
250.66(B) Sizing Grounding Electrode Conductors

GEC or bonding jumper connected to a single or multiple concrete-encased electrode(s) that does not extend on to other types of electrodes that require a larger size conductor, the GEC shall not be required to be larger than 4 AWG copper wire



181

250.64(B) Grounding Electrode Conductor Installation

- Must be **securely fastened** to mounting surface if exposed
- Permitted to be installed on or through framing members
- Sizes 4 AWG or larger copper or aluminum conductor must be protected if exposed to physical damage
- A 6 AWG that is free from physical damage is permitted to be run on surface, otherwise protected by installation in raceway or armor
- GEC smaller than 6 AWG must be protected by installation in raceway or armor

182

250.64(A) Grounding Electrode Conductor Installation

- Bare aluminum GEC not to be in contact with masonry or earth or subject to corrosive conditions
- Aluminum GEC not to be terminated within **450 mm (18 in.)** of earth

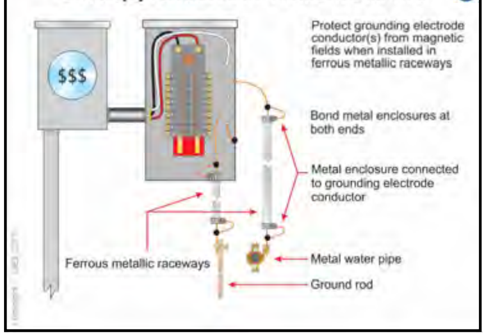
183

250.64(E) Bonding Metal Enclosures for Grounding Electrode Conductors

- Common practice to enclose a grounding electrode conductor in a **raceway** or enclosure to protect it from **physical damage**
- If the raceway or enclosure is **ferrous metal**, the *Code* requires the metallic enclosure to be protected from **magnetic fields**
- Required to bond ferrous metallic raceways and enclosures for GECs to the GEC itself
- Bonding puts the ferrous metallic enclosure and the GEC in **parallel** with each other
- Ferrous metal enclosures for GECs required to be **electrically continuous** from the point of attachment to cabinets or equipment to the grounding electrode
- Bonding jumper(s) required to be at least the same size as the GEC itself

184

250.64(E) Ferrous Metal Enclosures for GEC



185

250.104(A) Bonding of Metal Water Piping Systems

- Metal water piping systems are required to be bonded to one of the following:
  - The service equipment enclosure
  - The grounded (neutral) conductor at the service
  - The grounding electrode conductor where of sufficient size, or…
  - To the one or more grounding electrodes used *(GEC or bonding jumper of sufficient size)*
- The metallic water piping system required to be bonded would include ether piping systems installed in or attached to a building or structure

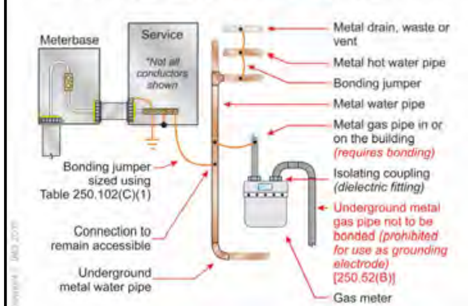
186

250.104(A) Bonding of Metal Water Piping Systems *(cont.)*

- The metal water piping system bonding jumper must be sized in accordance with *NEC* Table 250.66 *(just as though this bonding conductor were being connected to the metal water pipe as a grounding electrode conductor)*
- Bonding applies to both supply and metal drain lines
- Points of attachment of the bonding jumper to the metal piping are required to be accessible

187

250.104(A) and (B) Bonding of Piping Systems



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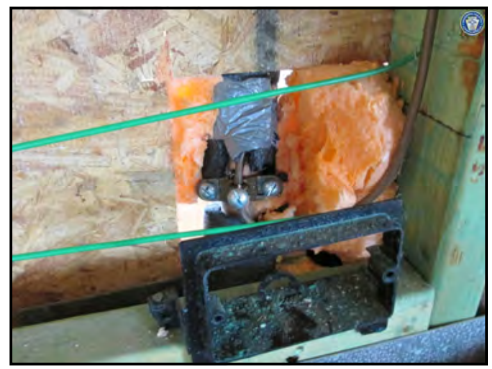

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190

250.104(B) Bonding of Other Piping Systems

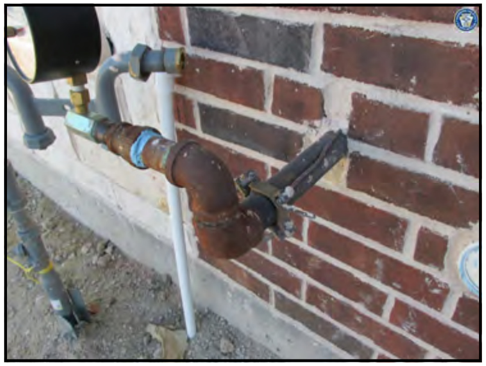
- Metal gas piping system(s) and other metallic piping systems that are likely to become energized are required to be bonded to any of the following:
  - Equipment grounding conductor for the circuit that is likely to energize the piping system
  - Service equipment enclosure
  - Grounded conductor at the service
  - Grounding electrode conductor, if of sufficient size
  - One or more grounding electrodes used *(if GEC or bonding jumper are of sufficient size)*

191

250.104(B) Bonding of Other Piping Systems *(cont.)*

- Bonding conductor(s) or jumper(s) used to bond other piping systems must be sized in accordance with 250.122, using the rating of the circuit that is likely to energize the piping system(s)
- The equipment grounding conductor for the circuit that is capable of energizing the piping is permitted to serve as the bonding means
- The points of attachment of the bonding jumper(s) to be accessible

192



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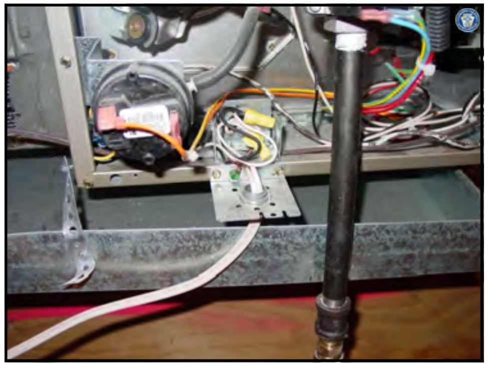

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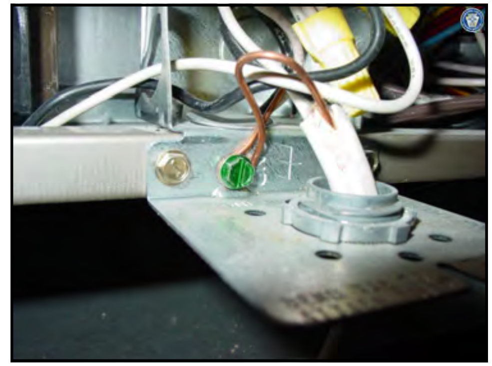


195

Table 250.122 *(in part)*

Minimum Size Equipment Grounding Conductors for Grounding Raceway and Equipment

Rating or Setting of Automatic Overcurrent Device in Circuit Ahead of Equipment, Conduit, etc., Not Exceeding *(Amperes)*	Size *(AWG or kcmil)*	
	Copper	Aluminum or Copper-Clad Aluminum
15	14	12
20	12	10
60	10	8
100	8	6
200	6	4
300	4	2
400	3	1
500	2	1/0
600	1	2/0
800	1/0	3/0
1000	2/0	4/0

Note: Where necessary to comply with 250.4(A)(5) or 250.4(B)(4), the equipment grounding conductor shall be sized larger than given in this table.

*See installation restrictions in 250.120

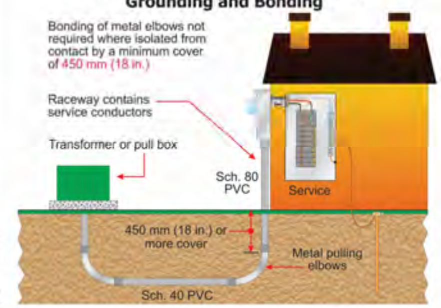
196

250.80 Exception: Service Raceway Grounding and Bonding

- All metal enclosures for service enclosures and equipment required to be connected to the grounded system conductor
- **Metal elbows** and metal components are **exempted** from this bonding that is installed in an **underground installation** of nonmetallic conduit where it is isolated from possible contact by a minimum earth cover of **450 mm (18 in.)** to any part of the elbow or metal component
- Common practice to install **metal elbows for pulling purposes** in an underground service raceway of rigid polyvinyl chloride conduit (PVC) to prevent damaging the PVC raceways during cable pulling operations

197

250.80 Exception: Service Raceway Grounding and Bonding



198

Bonding and Grounding Remote Metering Equipment

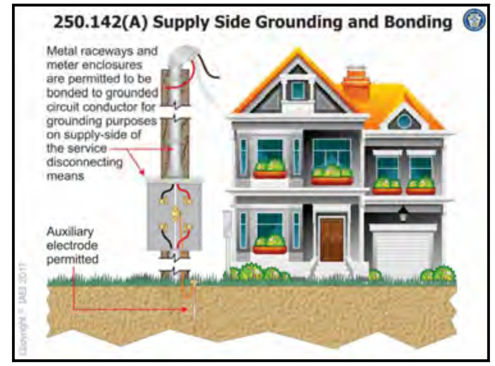
- The *Code* requires all equipment containing service conductors to be grounded and bonded *(including meter enclosures)* (*NEC* 250.80; 250.92)
- Important that the grounded service (neutral) conductor be connected to the meter enclosure
- Provides a low-impedance path from any line-to-ground fault that may occur in the remote metering equipment back to the source *(typically utility transformer)*
- The use of the grounded service conductor for bonding equipment on the line side of the service disconnecting means is permitted by the *Code* for this purpose [*NEC* 250.142(A)]

199

Bonding and Grounding Remote Metering Equipment *(cont.)*

- Where a ground rod or other electrode such as a plate or pipe is installed at the remote meter equipment, it is considered a **auxiliary grounding electrode**
- Permitted to be installed in addition to the required safety bonding and grounding connections
- The earth is not permitted to be used as a substitute for a required equipment grounding conductor
- See *NEC* 250.54

200

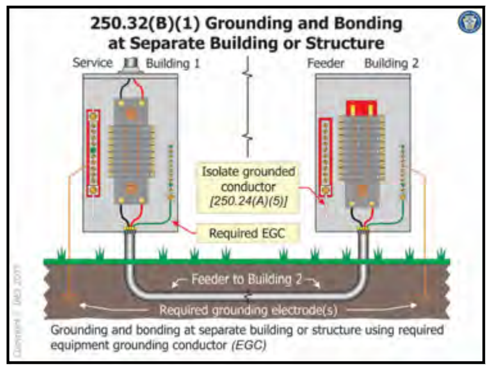


201

Grounding at Separate Buildings or Structures (Outbuildings)

- For **new installations**, feeders and branch circuits to separate outbuildings must employ an **equipment grounding conductor**
- Feeder or branch circuit to the outbuilding must provide a means to ground equipment in the outbuilding ***(EGC with the supply conductors to the outbuilding)***
- Grounded conductor cannot be connected to the EGCs or to the established grounding electrode system at the second building
- Grounding electrode system must be established at the outbuilding if there is no existing grounding electrode system present at the outbuilding
- See *NEC* 250.32(A) and (B)

202

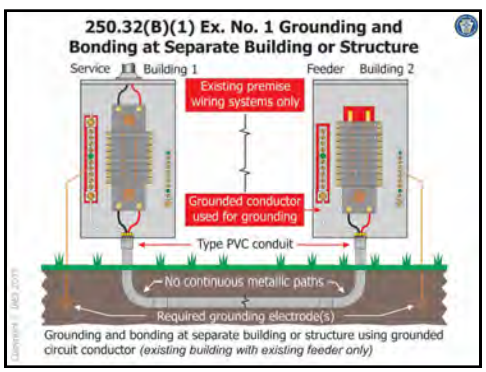


203

Grounding at Separate Buildings or Structures (Outbuildings) *(cont.)*

- Exception to *NEC* 250.32(B) permits the use of grounded (neutral) circuit conductor for grounding at outbuilding *(existing building with existing feeder or branch circuit)*
- Grounded (neutral) conductor permitted to be grounded again at additional building or structure if all the following conditions are met:
  - **No EGC** with supply to the second building or structure
  - **No continuous metallic paths** bonded to the grounding system in each building or structure involved *(metallic wiring method, metallic water or gas lines, phone lines, etc.)*
  - **No Ground-fault protection** of equipment on the common ac service *(not typical for dwelling units)*
- See *NEC* 250.32(B)(1) Ex. No. 1

204



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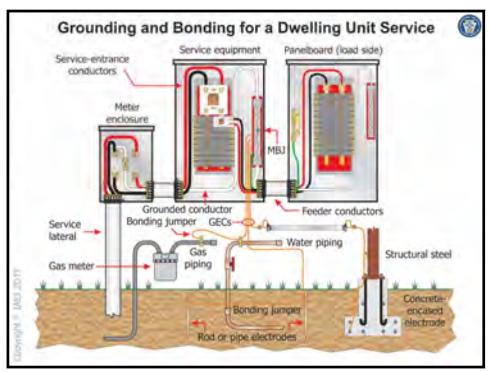

206

Volume II
Chapter Six
Requirements For Feeders

207

Bonding and Grounding Remote Metering Equipment

- The *Code* requires all equipment containing service conductors to be grounded and bonded *(including meter enclosures)* (*NEC* 250.80; 250.92)
- Important that the grounded service (neutral) conductor be connected to the meter enclosure
- Provides a low-impedance path from any line-to-ground fault that may occur in the remote metering equipment back to the source *(typically utility transformer)*
- The use of the grounded service conductor for bonding equipment on the line side of the service disconnecting means is permitted by the *Code* for this purpose [*NEC* 250.142(A)]

199

Bonding and Grounding Remote Metering Equipment *(cont.)*

- Where a ground rod or other electrode such as a plate or pipe is installed at the remote meter equipment, it is considered a **auxiliary grounding electrode**
- Permitted to be installed in addition to the required safety bonding and grounding connections
- The earth is not permitted to be used as a substitute for a required equipment grounding conductor
- See *NEC* 250.54

200

250.142(A) Supply Side Grounding and Bonding

201

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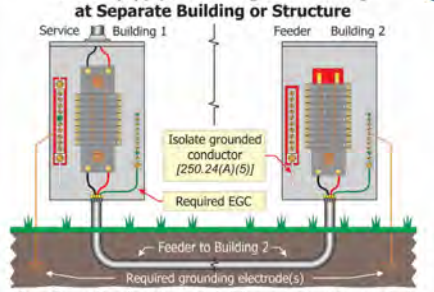
- For **new installations**, feeders and branch circuits to separate outbuildings must employ an **equipment grounding conductor**
- Feeder or branch circuit to the outbuilding must provide a means to ground equipment in the outbuilding ***(EGC with the supply conductors to the outbuilding)***
- Grounded conductor cannot be connected to the EGCs or to the established grounding electrode system at the second building
- Grounding electrode system must be established at the outbuilding if there is no existing grounding electrode system present at the outbuilding
- See *NEC* 250.32(A) and (B)

202

250.32(B)(1) Grounding and Bonding at Separate Building or Structure



Grounding and bonding at separate building or structure using required equipment grounding conductor *(EGC)*

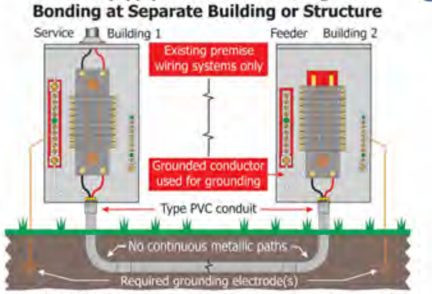
203

Grounding at Separate Buildings or Structures (Outbuildings) *(cont.)*

- Exception to *NEC* 250.32(B) permits the use of grounded (neutral) circuit conductor for grounding at outbuilding *(existing building with existing feeder or branch circuit)*
- Grounded (neutral) conductor permitted to be grounded again at additional building or structure if all the following conditions are met:
  - **No EGC** with supply to the second building or structure
  - **No continuous metallic paths** bonded to the grounding system in each building or structure involved *(metallic wiring method, metallic water or gas lines, phone lines, etc.)*
  - **No Ground-fault protection** of equipment on the common ac service *(not typical for dwelling units)*
- See *NEC* 250.32(B)(1) Ex. No. 1

204

250.32(B)(1) Ex. No. 1 Grounding and Bonding at Separate Building or Structure



Grounding and bonding at separate building or structure using grounded circuit conductor *(existing building with existing feeder only)*

205

Grounding and Bonding for a Dwelling Unit Service

206

Volume II Chapter Six

Requirements For Feeders

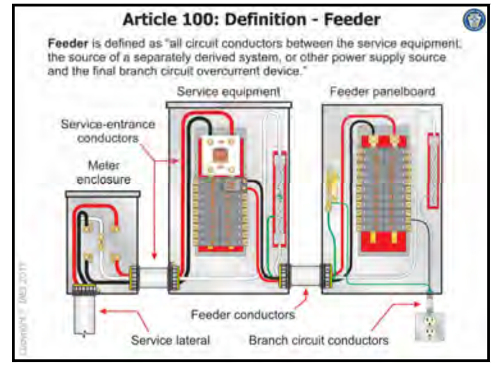
207

208

Article 100: Definitions

- **Concealed:** "Rendered inaccessible by the structure or finish of the building."
  - **Informational Note:** Wires in concealed raceways are considered concealed, even though they may become accessible by withdrawing them.
- **Exposed *(as applied to wiring methods)*:** "On or attached to the surface or behind panels designed to allow access."
- **Feeder:** "All circuit conductors between the service equipment, the source of a separately derived system, or other power supply source and the final branch-circuit overcurrent device."

209

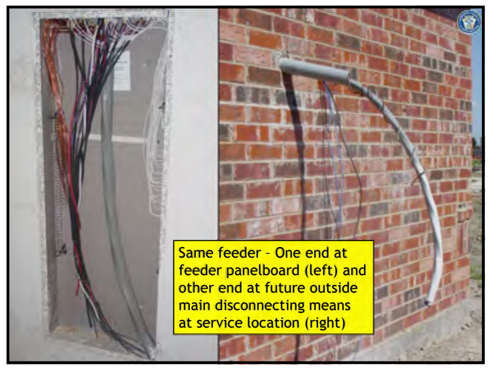


210

Sizing Feeder Conductors

- Feeders must sized to have an ampacity not less than required to supply the loads as calculated in Parts III, IV, and V of Article 220 [215.2(A)(1)]
- Feeder conductors for a dwelling unit or mobile home need not be larger than the service-entrance conductors
- 83 percent ampacity adjustment factor given at 310.15(B)(7) shall be permitted to be used for the "main power feeder"
- Ampacity values for feeders other than the "main power feeder" are derived from Table 310.15(B)(16)

211

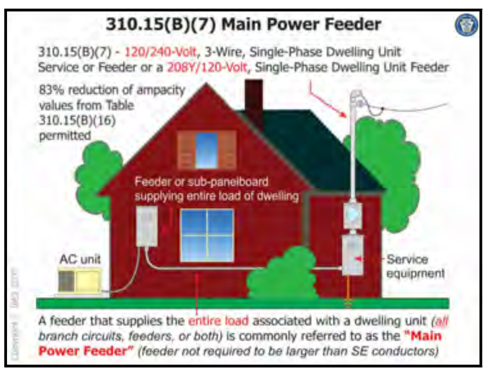


212

310.15(B)(7) Main Power Feeder

- 310.15(B)(7) permits an **83 percent** adjustment to the ampacity values of Table 310.15(B)(16) to a feeder conductor that serve as the "main power feeder" of a dwelling unit
- For application of this section, the main power feeder shall be the feeder that supplies the entire load of a dwelling unit installed between the main service disconnect and a feeder panelboard *(sub-panelboard)*

213

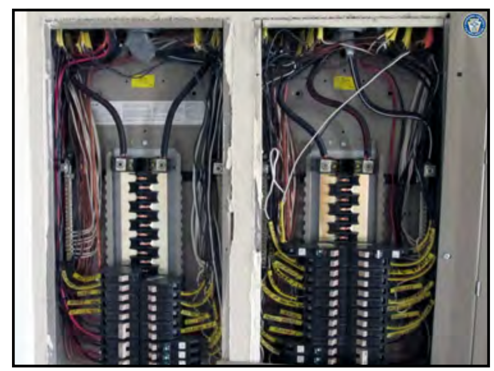


214

Feeder Overcurrent Protection

- Feeder conductors are required to be protected against overcurrent *(which includes overload, ground faults and short circuits)* in accordance with the provisions of Part I of Article 240
- Protect conductors against overcurrent in accordance with their ampacities as specified in 310.15, unless otherwise provided [240.4]
- Generally, overcurrent device for dwelling unit feeders must be selected so as to not exceed ampacity of conductors in Table 310.15(B)(16)
- Generally, the overcurrent protection is required to be located at the point where the conductor receives its supply

215



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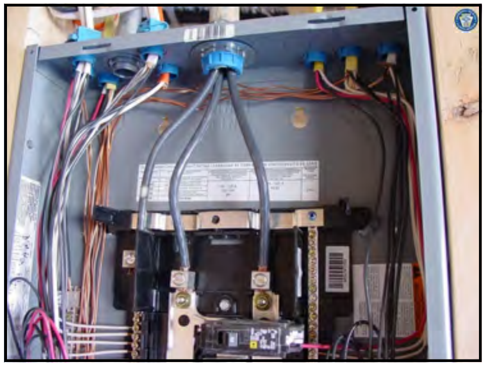

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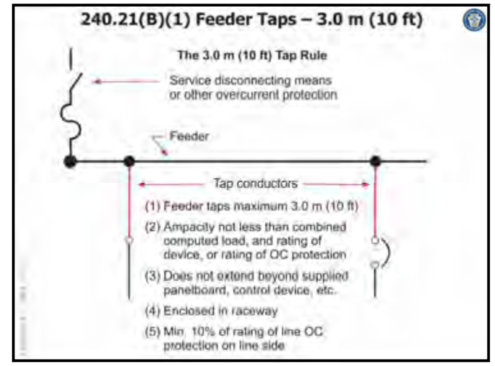
Tap Rules for Feeders

- Protect feeders generally at the point where the feeder receives its supply
- Feeder taps permitted in 240.21(B)
  - 3.0 m (10 ft) tap rule [240.21(B)(1)]
  - 7.5 m (25 ft) tap rule [240.21(B)(2)]

218



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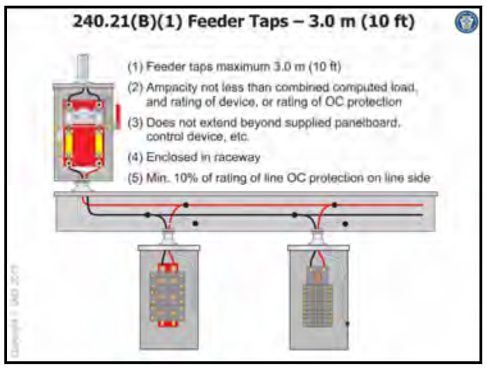

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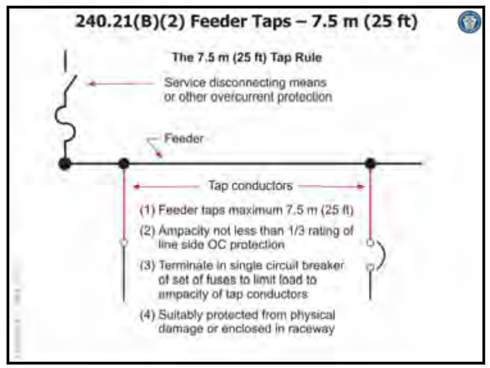

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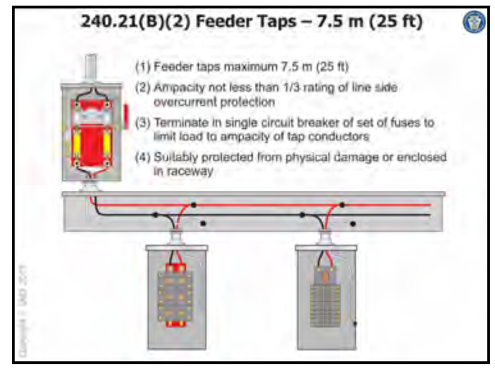
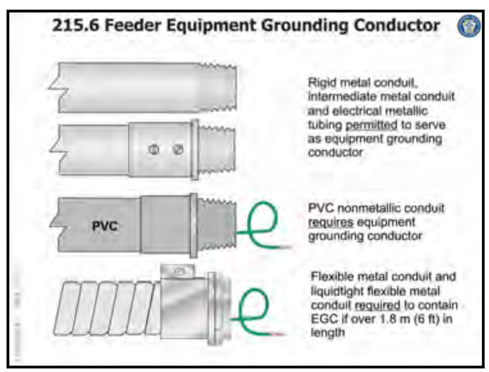


222

Equipment Grounding Conductors

- *NEC* 215.6 requires a feeder supplying branch circuits in which equipment grounding conductors are required, the **feeder must include or provide an EGC** in accordance with 250.134, to which all EGCs of the branch circuits will be connected
- Section 250.134(A) permits any EGC permitted by 250.118
- Section 250.134(B) permits a grounding means by connecting to an EGC contained within the same raceway, cable, or otherwise run with the circuit conductors

223



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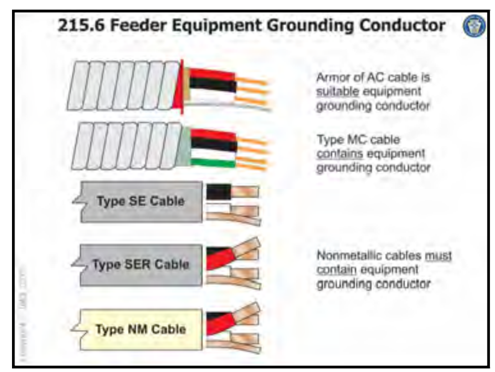

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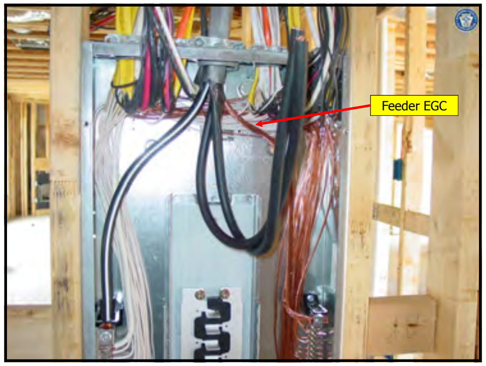


226

250.118 Types of Equipment Grounding Conductors

- Types of EGCs employed with the most commonly used wiring methods at dwelling units:
  - Copper or other corrosion-resistant conductor
  - Rigid metal conduit
  - Intermediate metal conduit
  - Electrical metallic tubing
  - Flexible metal conduit *(specific conditions)*
  - Liquidtight flexible metal conduit *(specific conditions)*
  - Armor of Type AC Cable
  - Type MC Cable listed for grounding
  - Other electrically continuous metal raceways listed for grounding

227

334.108 EGC for Type NM Cable

- In addition to the insulated conductors, Type NM cable shall have an insulated or bare equipment grounding conductor (EGC)
- This equipment grounding conductor shall be sized in accordance with Table 250.122

228

250.119 Identification of EGCs

- Identification of equipment grounding conductor must be by continuous green color, or green with one or more yellow stripes
- EGCs can also be bare, covered, or insulated
- An insulated or covered EGC larger than 6 AWG shall be permitted, at the time of installation, to be permanently identified as an EGC at each end and at every point where the conductor is accessible
- Identification shall encircle the conductor

229

Table 250.122 *(in part)*

Minimum Size Equipment Grounding Conductors for Grounding Raceway and Equipment

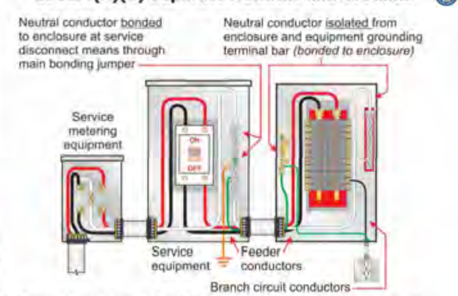
Rating or Setting of Automatic Overcurrent Device in Circuit Ahead of Equipment, Conduit, etc., Not Exceeding *(Amperes)*	Size *(AWG or kcmil)* Copper	Aluminum or Copper-Clad Aluminum
15	14	12
20	12	10
60	10	8
100	8	6
200	6	4
300	4	2
400	3	1
500	2	1/0
600	1	2/0
800	1/0	3/0
1000	2/0	4/0

Note: Where necessary to comply with 250.4(A)(5) or 250.4(B)(4), the equipment grounding conductor shall be sized larger than given in this table.

*See installation restrictions in 250.120

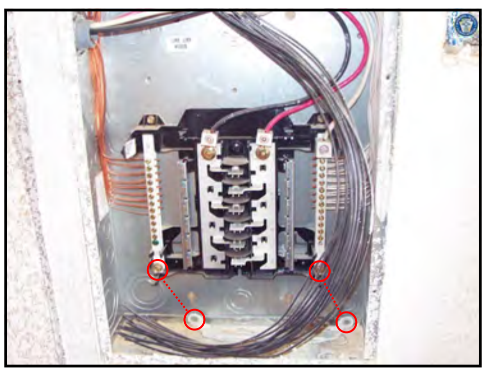
230

250.24(A)(5) Separate Neutrals and Grounds



Grounded conductor shall not be used for grounding noncurrent-carrying metal parts of equipment on the load side of service disconnecting means

231



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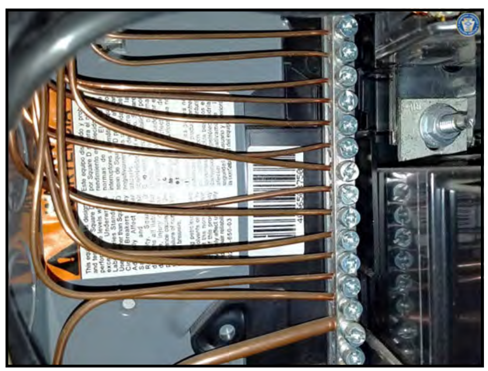

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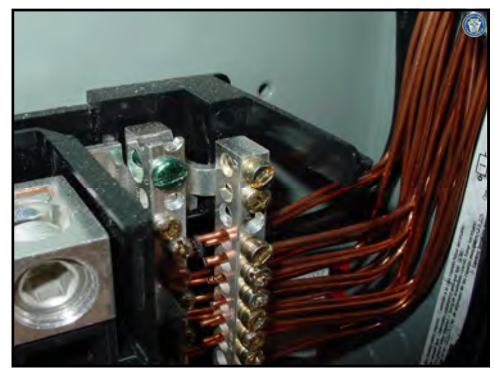

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Types of Feeder Conductors

- A wide variety of feeder conductors is permitted in dwelling units in the form of both cable and raceways
- Feeders installed in a conduit or as a cable assembly required to include conductors having insulation that is recognized by *NEC* Table 310.104(A)
- Typical feeder cable assemblies may include:
  - Type AC Type NM
  - Type UF Type SER
- Typical raceways used for feeders may include:
  - ENT EMT RMC
  - PVC IMC

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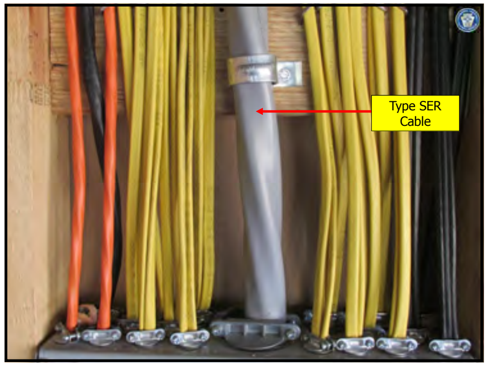

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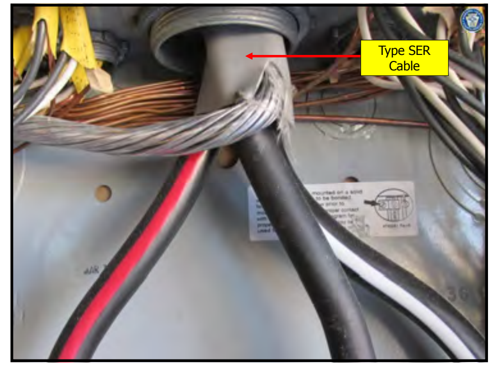
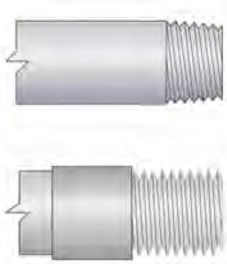


237

Installation Requirements for Raceways



Must be suitable for the environment and conditions where installed

Number of conductors not to exceed maximum fill percentages

Cut ends reamed or otherwise finished to remove rough edges

Field threads: standard cutting die with a taper of 1 in 16 (¾ in. taper per ft)

Running threads not to be used at couplings

See NEC Article 300 and Chapter 3 wiring method articles for more details

238

Minimum Size of Raceways

- Conduit fill requirements are important
- *NEC* 300.17 as well as "XXX.22" of the wiring method articles provides general information relative to the number and size of conductors permitted in raceways
- Limits the build up of heat from current-carrying conductors and minimizes damage to the conductors
- *NEC* Table 1 Chapter 9 provides maximum percentages for conduit fill

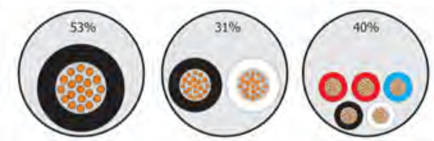
Percentage of Fill for Raceways			
Number of Conductors/Cables	1	2	Over 2
Cross-Sectional Area (%)	53%	31%	40%

239

NEC Chapter 9 Tables: Table 1

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%



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Informative Annex C Conduit Fill Example

- **What is the minimum size EMT for a 100-ampere feeder using three 4 AWG THHN conductors?**
  - **Step 1.** EMT is the raceway; therefore, Table C.1 applies.
  - **Step 2.** THHN is the insulation type. Follow down the left column until the insulation type THHN is found. Stop at conductor size 4 AWG.
  - **Step 3.** Follow across the columns until the smallest size EMT for 3 conductors is found. Metric designator 21 (¾ in.) is too small. Metric designator 27 (1 in.) will accept 4 conductors.

241

Expansion Fittings

- **Expansion fittings** for PVC conduit are required to be provided to compensate for thermal expansion and contraction in a straight run between securely mounted equipment such as boxes, cabinets, elbows, or other conduit terminations
- Applies where the calculated expansion will exceed **6 mm (¼ in.)**
- *NEC* Tables 352.44 give the expansion characteristics of PVC conduit for various temperature changes
- As a rule of thumb, add **30°F** to the expected temperature change for direct sunlight exposure
- Gray PVC conduit has a tendency to absorb the ultraviolet (UV) rays of the sun

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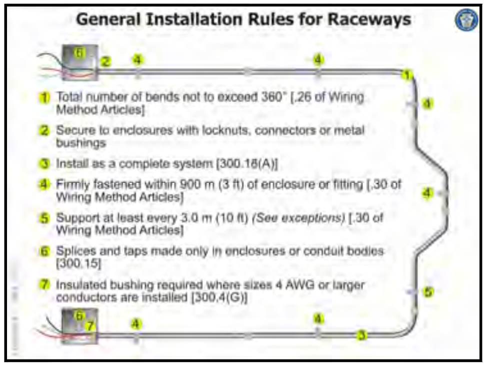

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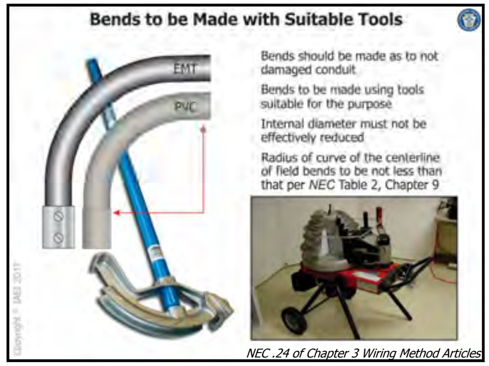

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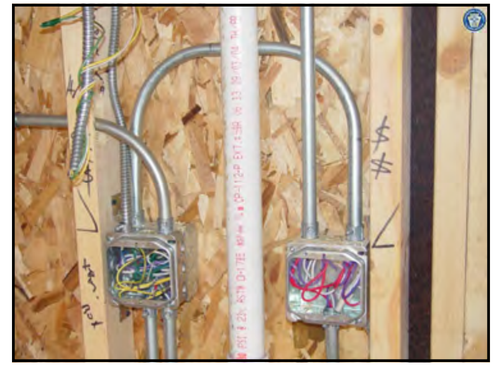

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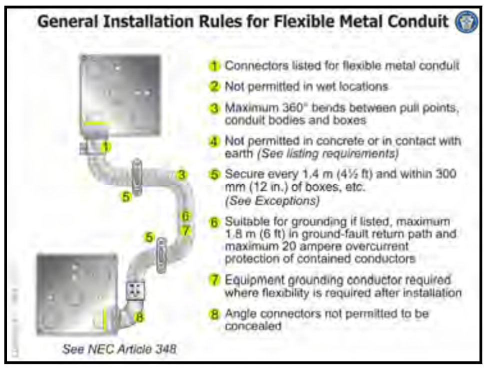

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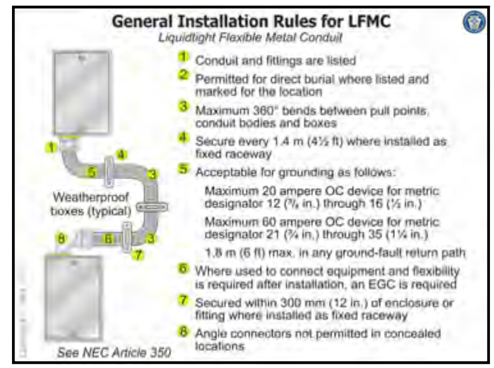

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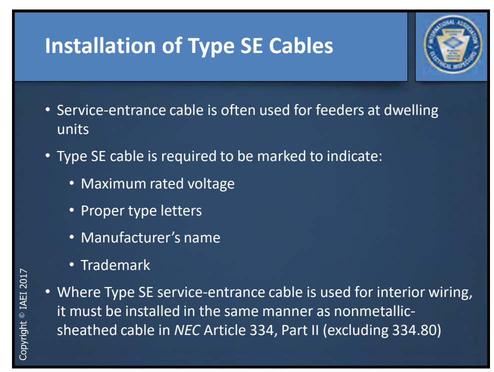
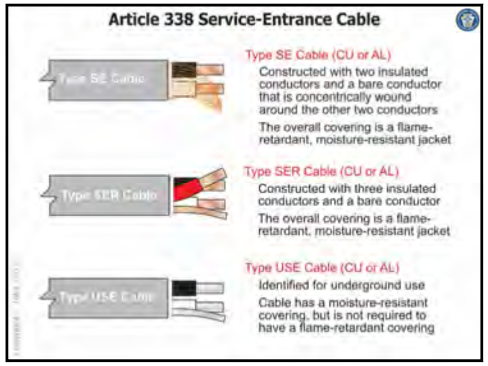


252

Installation of Type SE Cables *(cont.)*

- Type USE conductors are usually limited to installation underground
- This is due to the Type USE insulation not being of flame-retardant construction
- The *Code* permits Type USE cable to rise aboveground as long as it is outside of the building

253



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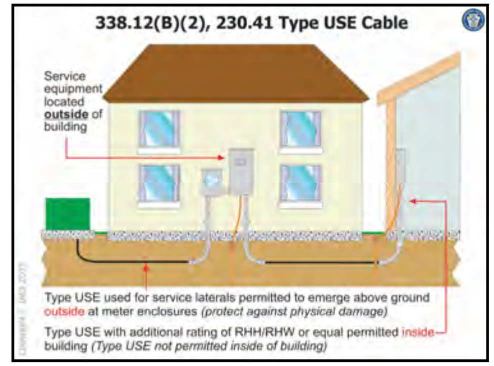

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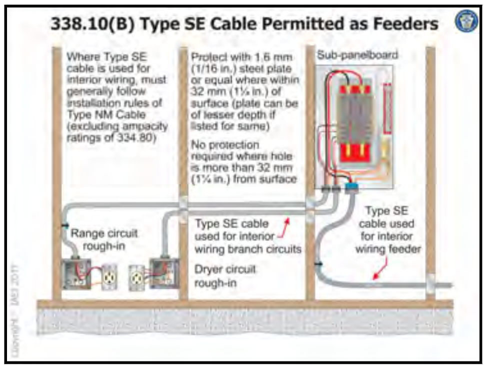


256

Cables and Electrical Nonmetallic Tubing Through Metal Framing Members

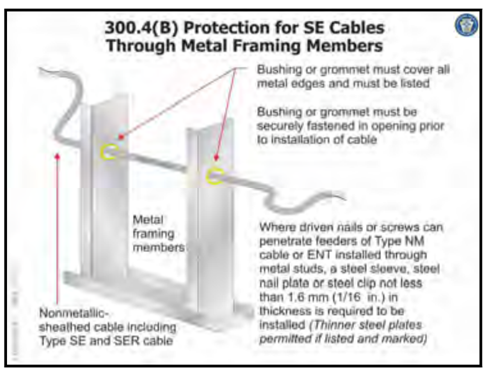
- Where **nonmetallic-sheathed feeder cables** are run exposed or concealed and pass through either factory- or field-punched, cut, or drilled slots or holes in **metal framing members**, the cable assembly must be protected by **bushings or grommets** securely fastened in the opening **before the cable is installed**
- Bushing or grommet required to cover **all metal edges** and it shall be **listed** *(variety of products that meet this requirement)*
- The use of a piece of cardboard or other non-approved material is not acceptable and must not be permitted as damage to the cable could be the result
- See *NEC* 300.4(B)(1)

257

Cables and Electrical Nonmetallic Tubing Through Metal Framing Members *(cont.)*

- Where **driven nails or screws** can penetrate feeders of nonmetallic-sheathed cable or electrical nonmetallic tubing installed through 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 protect cable or tubing from possible penetration
- Thinner steel plates permitted here if **listed and marked** appropriately
- Not applicable to Type AC feeder cable assemblies
- See *NEC* 300.4(B)(2)

258



259

260

Conduit Bodies

- Requirements for installing **conduit bodies** are found in *NEC* Article 314
- Conduit bodies generally are **not permitted to contain splices** unless they are **durably and legibly marked** with their cubic inch capacity
- If they are marked, **conductor fill** is determined using the same procedure for other than standard boxes
- See *NEC* 314.16(C)(2)

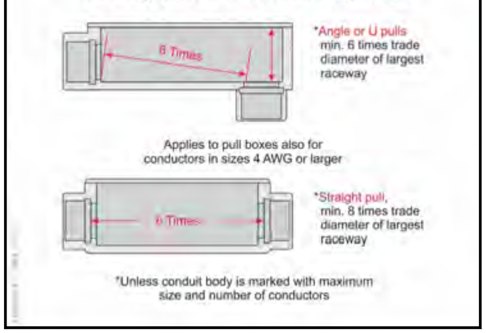
261

Conduit Bodies *(cont.)*

- Conduit bodies that are used as **pull or junction boxes** are required to comply with *NEC* 314.28(A)(1) through (A)(3)
- For **straight-through pulls**, the length of the conduit body normally must not be less than **eight times** the diameter of the largest raceway
- Where used with **angle or U pulls**, the distance between raceway entries and the opposite wall must not be less than **six times** the diameter of the largest conduit
- Dimension can be reduced where the conduit entry is opposite a **removable cover** and that distance is not less than in *NEC* Table 312.6(A) for one conductor per terminal

262

314.28(A) Box and Conduit Body Sizes



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Volume II Chapter Seven

Requirements for Major Household Appliances

264

265

Article 100: Definitions

- **Appliance:** "Utilization equipment, generally other than industrial, that is normally built in standardized sizes or types and is installed or connected as a unit to perform one or more functions such as clothes washing, air conditioning, food mixing, deep frying, and so forth."
- **Utilization Equipment:** "Equipment that utilizes electric energy for electronic, electromechanical, chemical, heating, lighting, or similar purposes."

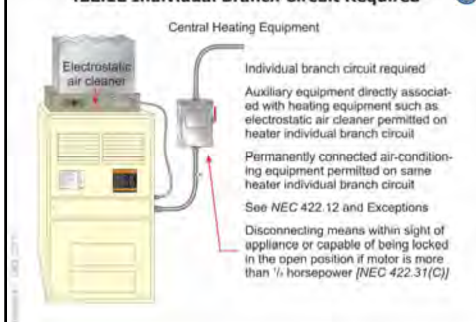
266

Branch Circuit Requirements for Appliances

Rating of branch circuit	422.10
Individual branch circuit	422.10(A)
Circuits supplying two or more loads	422.10(B)
Branch-circuit overcurrent protection	422.11
Individual branch circuit required	422.12 *(central heating equipment)*
Disconnecting means within sight	422.31(C) *(motor-operated appliance rated over ⅛ hp)*

267

422.12 Individual Branch Circuit Required



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270

Conduit Bodies *(cont.)*

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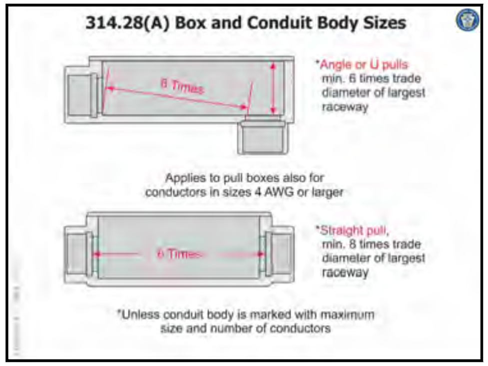
262



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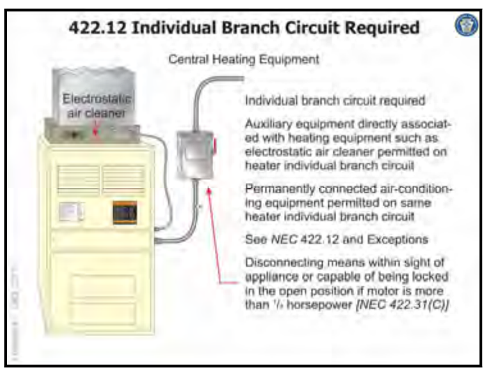
266

Branch Circuit Requirements for Appliances

• Rating of branch circuit	422.10
• Individual branch circuit	422.10(A)
• Circuits supplying two or more loads	422.10(B)
• Branch-circuit overcurrent protection	422.11
• Individual branch circuit required	422.12 *(central heating equipment)*
• Disconnecting means within sight	422.31(C) *(motor-operated appliance rated over ⅛ hp)*

267



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270

422.16 Appliances Connected with Flexible Cords

- Flexible cords permitted to be used for the connection of some appliances
- Flexible cord permitted to facilitate frequent interchange or to prevent the transmission of noise or vibration to an appliance *(such as a sump pump)*
- Flexible cord is also permitted to be used to facilitate the removal or disconnection of appliances that are fastened in place - appliance must be specifically identified for a flexible cord connection *(such as range, dishwasher, etc.)*
- Central heating appliances and electric water heaters are not permitted to be cord-and-plug-connected *(flexible cords typically not listed for heating appliance)*

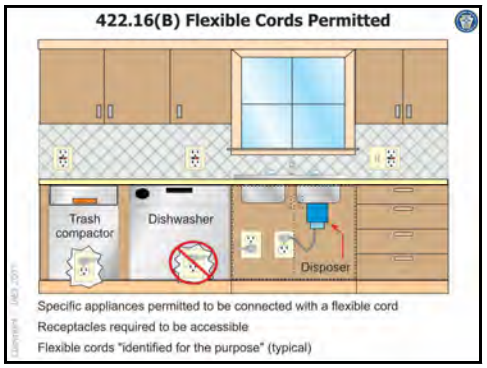
271

272

422.16(B) Appliances Connected with Flexible Cords

- Some appliances are specifically permitted to be cord-and plug-connected even though they are not portable appliances
- The attachment plugs must be of the grounding-type
- Specific appliances permitted to be cord-and-plug connected [422.16(B)]:
  - Kitchen waste disposers
  - Dishwashers
  - Trash compactors
  - Ovens and ranges
  - Range vent-a-hoods

273



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422.16(B)(1) Wiring of In-Sink Kitchen Waste Disposal

- Permitted to be cord-and-plug connected
- Flexible cord shall be terminated with a grounding-type attachment plug
- Length - 450 mm (18 in.) to 900 mm (36 in.)
- Flexible cord and receptacle not to be subject to physical damage
- Connection required to be accessible

276

277

422.16(B)(2) Wiring of Built-in Dishwasher

- Permitted to be cord-and-plug connected
- Flexible cord shall be terminated with a grounding-type attachment plug
- Length – 900 mm (36 in.) to 2.0 m (6.5 ft)
- Flexible cord and receptacle not to be subject to physical damage
- Receptacle to be located in the space adjacent to the appliance
- Receptacle required to be accessible

278

279

422.16(B)(2) Wiring of Trash Compactor

- Permitted to be cord-and-plug connected
- Flexible cord shall be terminated with a grounding-type attachment plug
- Length – 900 mm (36 in.) to 1.2 m (4 ft)
- Flexible cord and receptacle not to be subject to physical damage
- Receptacle to be located in same space as appliance or adjacent space to the appliance
- Receptacle required to be accessible

280

422.16(B)(4) Wiring of Range Hoods

- Permitted to be cord-and-plug connected
- Flexible cord shall be terminated with a grounding-type attachment plug
- Length – 450 mm (18 in.) to 1.2 m (4 ft)
- Flexible cord and receptacle not to be subject to physical damage
- Receptacle required to be accessible
- Receptacle supplied by an individual branch circuit

281

422.16(B)(4) Range Hoods

Range hoods permitted to be cord-and-plug connected where identified on installation instructions by manufacturer and meets the following:

- Cord terminates in a grounding type plug
- Cord length is at least 450 mm (18 in.) and not more than 1.2 m (4 ft)
- Receptacle located to avoid physical damage to the cord
- Receptacle is accessible
- Receptacle is supplied by an individual branch circuit

Maximum length of cord for cord-and-plug connected range hoods has been increased from 900 mm (36 in.) to 1.2 m (4 ft)

282

283

Wall-Mounted Ovens and Counter-Mounted Cooking Units

- Wall-mounted ovens and counter-mounted cooking units are permitted to be either permanently connected or cord-and-plug connected
- No minimum or maximum length of the cord for this type of appliance
- The cord, the separable connector, or plug and receptacle combination in the supply circuit to the oven or cooking unit shall be suitable for the **maximum temperature** of the space in which it is located *(consult manufacturer's installation instructions)*

284

Wall-Mounted Ovens and Counter-Mounted Cooking Units *(cont.)*

- The *Code* prohibits the use of flexible cords where they will run through holes in walls, structural ceilings, suspended ceilings, dropped ceilings, or floors
- Flexible cord permitted to pass through a hole in the side of a kitchen cabinet in order to reach a receptacle outlet located in an adjacent cabinet *(side of a kitchen cabinet is not a wall)*
- Flexible cord must be protected from physical damage
- Generally, grounding-type attachment plug is required

285

Range receptacle for counter-mounted cooking unit

286

422.18 Support of Ceiling-Suspended (Paddle) Fans

- Ceiling-suspended (paddle) fans is considered an appliance
- Must be **supported independent** of an outlet box by one of the following means:
  - A **listed outlet box** or **listed outlet box system** identified for use with a ceiling-suspended (paddle) fan and installed to meet the requirements of *NEC* 314.27(C)
  - A listed outlet box system with a **listed locking support and mounting receptacle**, and a compatible factory installed **attachment fitting** designed for support, identified for the use and installed in accordance with *NEC* 314.27(E)

287

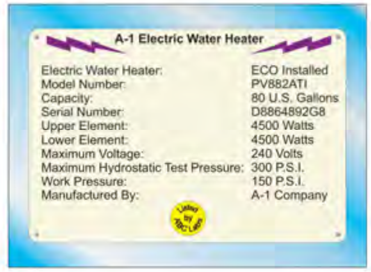
288

422.13 Wiring of Electric Water Heaters

- Where a branch circuit supplies a fixed storage-type water heater having a capacity of 120 gallons or less, load to be considered a **continuous load**
- Branch circuit required to be rated at not less than **125%** of the rating of the water heater shown on the nameplate
- This includes both the overcurrent device [422.11] and the conductors [422.10(A)]

289

Typical Electric Water Heater Nameplate



290

422.13 Wiring of Electric Water Heaters *(cont.)*

- Branch-Circuit Ampacity Example:
  - Nameplate rating = 4500 watts
  - 4500 watts x 125% = 5625 watts
  - 5625 watts ÷ 240 volts = 23.4 amperes
  - **23.4 amperes** = Minimum ampacity for branch-circuit conductors

291

422.11 OCPD for Electric Water Heaters

- Overcurrent Protection Example:
  - Nameplate rating = 4500 watts
  - 4500 watts ÷ 240 volts = 18.8 amperes
  - 18.8 amperes x 150% = 28.2 amperes *[422.11(E)(3)]*
  - Permitted to round up to next standard overcurrent device rating *[422.11(E)(3)]*
  - Minimum overcurrent device = **30 ampere** fuse or circuit breaker

292

422.31 Disconnecting Means for Appliances

- Disconnecting means are generally required for all appliances to disconnect all ungrounded conductors
- 422.31(A) Rated at **Not Over 300 VA or ⅛ hp**
  - Branch-circuit overcurrent device permitted as disconnecting means with…
    - Switch or circuit breaker within sight from appliance or…
    - Capable of being locked in accordance with 110.25
  - Locking device must remain in place with or without the lock installed

293

422.31 Disconnecting Means for Appliances *(cont.)*

- Disconnecting means are generally required for all appliances to disconnect all ungrounded conductors
- 422.31(B) Rated at **Over 300 VA**
  - Branch-circuit switch or circuit breaker is permitted as the disconnecting means where…
    - Switch or circuit breaker within sight from appliance or…
    - Capable of being locked in accordance with 110.25
  - Locking device must remain in place with or without the lock installed

294

422.31 Disconnecting Means for Appliances *(cont.)*

- Disconnecting means are generally required for all appliances to disconnect all ungrounded conductors
- 422.31(C) Motor-Operated Rated **Over ⅛ hp**
  - Disconnecting means must be:
    - Within sight from appliance or…
    - Capable of being locked in accordance with 110.25
  - Locking device must remain in place with or without the lock installed
  - Branch-circuit switch or circuit breaker is permitted to be out of sight of the appliance *(with **unit switch**)*

295

422.31 Disconnecting Means Required

Permitted disconnecting means for appliances where located within sight of the appliance or capable of being locked in the open position:

Not over 300 watts or ⅛ hp - branch-circuit OCPD

Over 300 watts - branch-circuit switch or circuit breaker

Over ⅛ hp - branch-circuit switch or circuit breaker *(permitted to be located out of sight of the appliance with unit switch on the appliance)*

296

297

422.34 Unit Switch as Disconnecting Means

- Unit switch *(on appliance)* permitted as the required disconnect where other means of disconnection is provided
  - *(Service disconnecting means can serve as "other disconnecting means" at one- and two-family dwellings)*
- Switch is provided by the manufacturer as part of the appliance
- Unit switch has a marked "off" position
- Switch disconnects all ungrounded (hot) conductors

298

299

422.11 Overcurrent Protection for Appliances

- Appliances are required to be protected against overcurrent
- The limits on the maximum size of the OCPD are based upon the type of appliance and the information provided on the nameplate
- If an OCPD rating is marked on the appliance, the branch-circuit OCPD rating can not exceed the protective device rating marked on the appliance

300

422.11 Overcurrent Protection for Appliances *(cont.)*

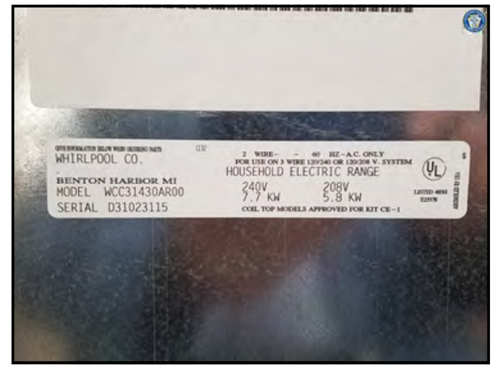
- Appliances with **Surface Heating Elements**:
  - A household-type appliance provided with surface heating elements having a maximum demand of **more than 60 amperes** is required to have its power supply subdivided into two or more circuits
  - Each subdivided circuit is to be provided with overcurrent protection rated at not over 50 amperes
  - *(Subdivision of circuit is not common in household-type appliances)*
- See 422.11(B)

301

422.11 Overcurrent Protection for Appliances *(cont.)*

- **Single, Non-Motor-Operated Appliances**:
  - Rating of OCPD must not be in excess of that marked on the appliance nameplate
  - If the OCPD rating is not marked on the nameplate and the appliance is rated at **over 13.3 amperes**, overcurrent protection cannot exceed **150%** of the appliance rated current *(next higher standard size rating permitted)*
  - If the OCPD rating is not marked and the appliance is rated **13.3 amperes or less**, the maximum rating of the OCPD is **20 amperes** *(lower values are permitted)*
- See 422.11(E)

302



303

422.11 Overcurrent Protection for Appliances *(cont.)*

- Electric Heating Appliances with **Heating Elements Rated More than 48 Amperes**:
  - Must have their heating elements subdivided
  - Each subdivided load cannot exceed **48 amperes** and is required to be protected at not more than **60 amperes**
  - Supplementary-type overcurrent protective devices are permitted to be used for this application *(cont. on next slide)*
- See 422.11(F)(1)

304

422.11 Overcurrent Protection for Appliances *(cont.)*

- Electric Heating Appliances with **Heating Elements Rated More than 48 Amperes**: *(cont.)*
  - Supplementary-type overcurrent protective devices are permitted to be used for this application
  - Supplementary OCPD are required to be:
    - (1) factory installed within or on the heater enclosure, or provided as a separate assembly by the heater manufacturer
    - (2) accessible, but need not be readily accessible
    - (3) suitable for branch-circuit protection
- See 422.11(F)(1)

305

422.11 Overcurrent Protection for Appliances *(cont.)*

- **Resistance-type immersion electric heating elements**:
  - Permitted to be subdivided into circuits not exceeding **120 amperes** and protected at not more than **150 amperes** where:
    - (1) contained in ASME-rated and stamped vessels
    - (2) included in listed instantaneous water heaters
    - (3) installed in low-pressure water heater tanks or open-outlet water heater vessels
- See 422.11(G)

306

422.11 Overcurrent Protection for Appliances *(cont.)*

- **Motor-Operated Appliances**:
  - Overload protection for the motors of motor-operated appliances must be provided per Part III of Article 430
  - In many cases, the manufacturer builds this overload protection into the appliance
  - Where separate motor-operated appliance OCPD are required, information for selection of these devices must be marked on the appliance nameplate
- See 422.11(G)

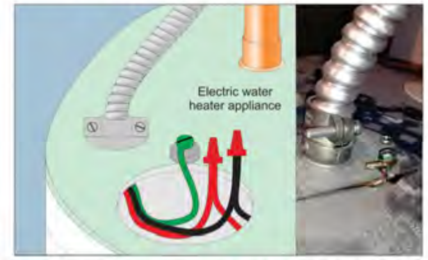
307

250.110 Grounding of Appliances

- Dwelling unit appliances must be **properly grounded** by connection to an **equipment grounding conductor** under the following conditions:
  - Where located within 2.5 m (8 ft) vertically or 1.5 m (5 ft) horizontally of earth grade or grounded metal objects and subject to contact by persons
  - Where located in wet or damp locations *(not isolated)*
  - Where in electrical contact with metal
  - Where supplied by a metal-clad, metal-sheathed, metal-raceway or other wiring method that provides an equipment grounding conductor

308

250.110 Grounding of Appliances



Exposed, normally non-current-carrying metal parts of appliances *(fixed equipment)* that are likely to become energized must be properly grounded by connection an equipment grounding conductor

309

Types of Equipment Grounding Conductors for Appliances

- The type of EGC used to ground appliances will depend on the type of wiring method employed
  - **Cable wiring systems** – EGC typically contained in the cable
  - **Metal-clad cable** – metal cable jacket may qualify and serve as EGC
  - **Metal raceways** – metal raceway itself permitted as EGC
  - **Nonmetallic raceways** – EGC must be installed inside raceway
  - **Cord- and plug-connected equipment** may be grounded by EGC consisting of a bare conductor or insulated conductor that is green or green with one or more yellow stripes that is part of a cable assembly or flexible cord
- See *NEC* 250.118

310

311

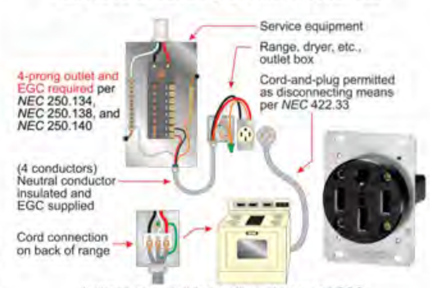
312

Grounding of Cooking Appliances and Clothes Dryers

- **New Installations**:
  - Frames of ranges, wall-mounted ovens, counter-mounted cooking units, and clothes dryers required to be grounded by connection to an equipment grounding conductor (EGC)
  - Outlet or junction boxes that are part of the circuit must be grounded in a similar manner
  - For a typical 120/240-volt, single-phase dwelling unit system – **(4) conductors** to these appliances
  - For cord- and plug-connected equipment, the EGC will typically terminate in a grounding type attachment plug with a fixed grounding contact

313

250.140 Grounding of New Appliances



Isolated grounded (neutral) conductor and EGC at range terminals *(Required for new installations)*

314

315

Grounding of Cooking Appliances and Clothes Dryers *(cont.)*

- **Existing Installations**:
  - For **existing branch-circuit installations only** where an EGC is not present, the frames of electric ranges, wall-mounted ovens, counter-mounted cooking units, clothes dryers are permitted to be connected to the grounded circuit conductor if all the following conditions are met:
    - (1) Supply circuit is 120/240-volt, single-phase, 3-wire; or 208Y/120-volt derived from a 3-phase, 4-wire, wye-connected system
    - (2) Grounded conductor is not smaller than 10 AWG copper or 8 AWG aluminum

(cont. on next slide)

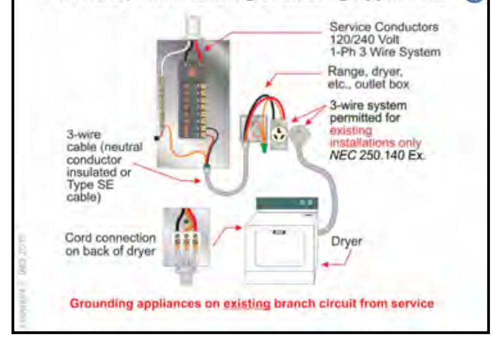
316

Grounding of Cooking Appliances and Clothes Dryers *(cont.)*

- **Existing Installations**: *(cont.)*
  - For **existing branch-circuit installations only** where an EGC is not present, the frames of electric ranges, wall-mounted ovens, counter-mounted cooking units, clothes dryers are permitted to be connected to the grounded circuit conductor if all the following conditions are met:
    - (3) Grounded conductor insulated, or the grounded conductor is uninsulated and part of a Type SE service-entrance cable and the branch circuit originates at the service equipment
    - (4) Grounding contacts of receptacles furnished as part of the equipment are bonded to the equipment

317

250.140, Ex. Grounding of Existing Appliances



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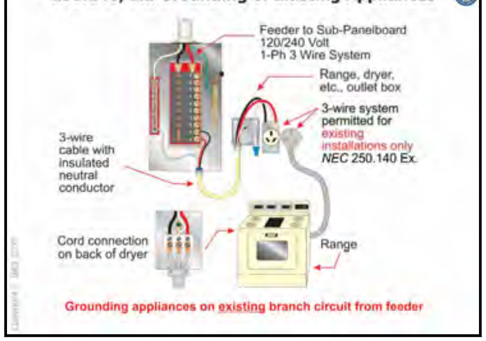
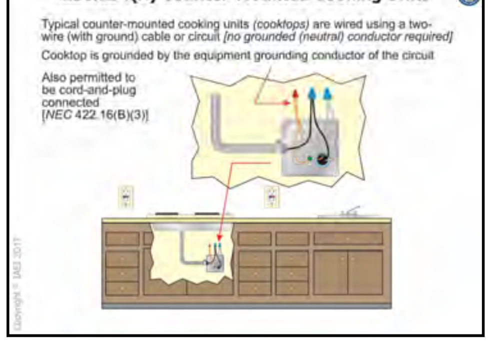
250.140, Ex. Grounding of Existing Appliances



319

250.134(A) Counter-Mounted Cooking Units



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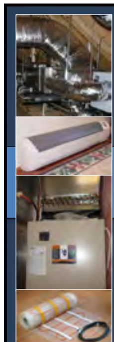


Volume II Chapter Eight

Fixed Electric Space-Heating Equipment

322

323

324

File Attachments for Item:

ER-3 Soares Grounding and Bonding (2017 NEC) (IAEI Central)

All certifications (five 2-hour sessions)

Staff Notes: The five sessions include two sessions presented on January 12 and March 9, for which retroactive approval is sought. The Committee can ignore the two sessions listed for the year 2024. They will be submitted at the proper time.

ESIAC Recommendation:

Committee Recommendation:

APPLICATION FOR CONTINUING EDUCATION APPROVAL
COURSE CONDITIONS AND GUIDELINES

The Ohio Board of Building Standards is committed to the ongoing education and professional development of board-certified personnel through the delivery of high-quality, accurate and engaging professional continuing education content. To this end, the Board reviews and approves Continuing Education Courses for building department personnel.

Board approval is granted for course instruction on current codes and standards, including the OBC, OMC, OPC, and RCO, and any other content areas directly related to the responsibilities of the certification for which credit is being requested.

Promotion: Any person or organization promoting an approved course is required to make full and accurate disclosure regarding course title, course approval number, number of credit hours, categories for which the BBS has approved the class, and fees in promotion materials and advertising. ***The Board does not grant retroactive approval. It is recommended that courses be submitted for approval well in advance of any scheduling of classes and advertising***. Advertising may not falsely state BBS approval before approval is granted. Course providers may state that BBS approval is pending.

Application Submission: All Applications and associated materials shall be submitted by email in .pdf format. Instructions for completing the application are attached.

Certificate of Completion: Course providers shall provide participants a certificate of completion containing the following information:

- Name of participant
- Title of approved courses
- BBS approval #
- BBS approved certifications
- Date of the continuing education program
- Number of approved credit hours awarded, and
- Signature of authorized sponsor or instructor.

Any person or organization administering an approved course shall return a completed BBS Course Attendance form by email.

Participants: Participants must attend the complete course as presented by the instructor to receive credit hours approved by the Board. The organization or instructor of online courses shall plan and execute methods to verify the individual's attendance and completion of the course. No partial credit will be given to any participant who failed to complete the entire course as approved.

Board approval: All courses are approved for the calendar year in which application is made. Courses may be renewed so long as the referenced code is in effect, and the CEUs, certification and content remain unchanged. When the referenced code is updated, courses must be updated, and new approvals obtained.

Facility/training area: BBS Course may be delivered in person or online, or both, at the sponsor's option.
Course facilities shall include the following:

In Person Classes:
Sufficient seating capacity
ADA accessible facilities
Appropriate Audio/Visual devices for delivery
Writing surfaces for participants

Online Classes:
Web-accessible
ADA accessible delivery
Tech support available
Live and recorded courses permitted

In-person facilities shall comfortably and safely seat at least the number of attendees present in the room and shall be climate controlled, non-smoking, and sound controlled so that outside noise will not interfere with the training.

Ohio | Department of Commerce

Mike DeWine, Governor
Jon Husted, Lt. Governor

Sheryl Maxfield, Director

Board of Building Standards

Application for Continuing Education Course Approval

Provider Information:

Name: International Association of Electrical Inspectors (IAEI) Central Ohio division

Organization: International Association of Electrical Inspectors (IAEI) Central Ohio division

Address: 1081 Lewis Center Road Lewis Center, OH 43035

E-mail: lettherebelight110@yahoo.com Telephone: 937-763-6361

Website: ____

Conference Sponsor (if applicable) ____ Conference Email: ____

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

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

New Course Information:

Course title: 1 & 2 Family Dwelling (2017 NEC), Soares Grounding and bonding (2017 NEC).

Course instructor: Eric M. Klintworth PE; Matthew Ross; Chad Roberts

Course description: These classes will cover the 2017 NEC; via PowerPoint slides created by t
of Electrical Inspectors (IAEI)

Instructional hours per session: 2 hours ea. Number of Sessions: 10; 13 if able to backd

Course Date(s) and Location: 1/12, 2/9, 3/9, 4/13, 5/11, 6/8, 9/14, 10/12, 11/9, & 12/14/2023; 1/11
1081 Lewis Center Road Lewis Center, OH 43035

Special Content:

Code Administration: ☐
Existing Buildings: ☐
Electrical Instruction: ☑
Plumbing Instruction: ☑

Conference Course: ____
Conference Name: ____
Conference location: ____

Course to be offered online? ☐ **On Demand** ☐ **Webinar** ☐

Course Website: ____

Detail online course participation confirmation method (*i.e. test, quizlets, participant activity confirmation*):

____

Course applicable for the following certifications

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

Application materials included:

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

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

Ohio | Department of Commerce

Mike DeWine, Governor
Jon Husted, Lt. Governor

Sheryl Maxfield, Director

Instructions for new Continuing Education Approval form

Provider Information

1. Please include all contact information.
2. If course is not part of a conference, leave conference sponsor and email blank.

Course Renewal

1. Indicate if the course is being submitted for renewal. Include prior approval letter and write in prior course number.
2. Certification approval for courses has now changed: all existing courses being renewed will be approved within the new classification system.
   a. Courses previously approved for only residential certifications will be approved for all residential certifications.
   b. Courses previously approved for at least on commercial certification will now be approved for all commercial certifications and all residential certifications.
   c. Courses on required instruction topics, Ohio Ethics, Code Administration and Existing Buildings, will be noted as Administrative Courses and be approved for all certifications.
3. Courses being renewed should skip the New Course information section and are not required to submit outline, agenda, slides or other instructional materials for review. Skip to Special Content, and mark any item that applies to the course.

New Course Information

1. Enter course title, name of instructor, and a brief description of the course content. Learning objectives may be substituted for course description, if desired.
2. Number of instructional hours per session is the length of instructional time.
3. Number of sessions: can be 1 or the number of sessions planned.
4. Course date(s) and location: not necessary at this time, enter if known.

Special Content

1. Indicate if the course will meet instructional time in Code Administration or Existing Buildings.
2. Indicate if the course is a plumbing or electrical course, for ESIAC review and trainee course tracking.
3. If the course is associated with a conference, indicate the conference name and location, as this will allow BBS to coordinate approvals with the conference provider.
4. If the course will be offered online, specify whether it will be on demand or offered as a virtual webinar, or both. Include website where the course will be provided.

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

Timothy Galvin, Chair

614-644-2613
Fax 614 -644-3147
TTY/TDD 800-750-07
com.ohio.gov/dico/

Course applicable for the following certifications

This section represents a major change from previous BBS course approval forms.

1. If the course is only for residential certifications, check 'Residential Certifications Only'. The course, if approved, will be approved for all residential certifications.
2. If the course is appropriate for any commercial certifications, check Commercial Certifications. The course, if approved, will be approved for all commercial certification **AND** all residential certifications.
3. If the course is intended to meet required instruction in Code Administration (Chapter 1) or Existing Buildings (commercial or residential) check 'Administrative Course, All Certifications'.

Application Materials Included

This is a checklist for the course submitter's use, to be sure all materials necessary for review are included with the application. All materials should be submitted in .pdf format, along with the application, via email to Michael.Lane@com.ohio.gov or BBS@com.ohio.gov

IAEI Central Ohio Division 2023-2024 syllabus

1. January 12, 2023
    1. Soares 2017 NEC Part 1 (Final) 2--Chapter 4 Grounding Electrical Services. Instructor, Matthew Ross.
2. February 9, 2023
    1. 1 & 2 Family (2017 NEC) (Vol I) Chapter 3. Instructor, Eric Klintworth.
3. March 9, 2023
    1. Soares 2017 NEC Part 1 (Final) 2--Chapter 5 Main bonding Jumpers and Services. Instructor, Matthew Ross.

The above classes have already been taught if it is possible to backdate to get credit for these classes, that would be great. If not, I understand. We have an attendance roster for verification.

4. April 13, 2023
    1. Soares 2017 NEC Part 1 (Final) 2--Chapter 6 Grounding Electrode Systems. Instructor, Matthew Ross.
5. May 11, 2023
    1. 1 & 2 Family (2017 NEC) (Vol II) Chapter 4. Instructor, Eric Klintworth.
6. June 8, 2023
    1. 1 & 2 Family (2017 NEC) (Vol II) Chapter 5. Instructor, Eric Klintworth.
7. September 14, 2023
    1. Soares 2017 NEC Part 1 (Final) 2--Chapter 7 Grounding Electorde Conductors. Instructor, Matthew Ross.
8. October 12, 2023
    1. 1 & 2 Family (2017 NEC) (Vol II) Chapter 6. Instructor, Eric Klintworth.
9. November 9, 2023
    1. Soares 2017 NEC Part 1 (Final) 2--Chapter 8 Bonding Enclosures and Equipment. Instructor, Matthew Ross.
10. December 14, 2023
    1. 1 & 2 Family (2017 NEC) (Vol II) Chapter 7. Instructor, Eric Klintworth.
11. January 11, 2024
    1. Soares 2017 NEC Part 1 (Final) 2--Chapter 9 Equipment Grounding Conductors. Instructor, Matthew Ross.
12. February 8, 2024
    1. 1 & 2 Family (2017 NEC) (Vol II) Chapter 8. Instructor, Eric Klintworth.
13. March 14, 2024
    1. Soares 2017 NEC Part 1 (Final) 2--Chapter 10 Enclosure and Equipment Grounding. Instructor, Matthew Ross.

Matthew E. Ross

1000 Township Road 3475 - Perrysville, Ohio 44864
419-512-5025
metdross@hotmail.com

Education

1988 | Loudonville High School

Loudonville High School - 421 Campus Ave. - Loudonville, Ohio 44842

2004 | Journeyman Electrician

Associated Builders and Contractors, Northern Ohio Chapter - 9255 Market Place West - Broadview Heights, Ohio 44147

Professional Certifications and Licenses

2003 | Fire Alarm Installation and Testing

Division of State Fire Marshal - 8895 E. Main St. - Reynoldsburg, Ohio 43068

2006 | Electrical Safety Inspector

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

2007 | Electrical Contractor

Ohio Construction Industry Licensing Board - 6606 Tussing Rd. - Reynoldsburg, Ohio 43068

2009 | Residential Building Official

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

2010 | Building Inspector

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

2014 | Electrical Plans Examiner

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

2015 | Building Official

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

Experience

07/1996 – 10/1998 | General Construction Worker

Johnson and Johnson Construction - 7342 Armstrong Rd. - Butler, Ohio 44822

Job responsibilities included but were not limited to general construction of steel frame buildings for residential, agricultural, and commercial applications.

10/1998 – 11/2000 | Cabinetmaker

Self Employed (Posse Isle Wood Works) - 1014 Twp. Rd. 3475 - Perrysville, Ohio 44864

Job responsibilities included but were not limited to general woodworking and cabinetry for use in residential and commercial applications.

11/2000 – 04/2002 | Electrician

Clark-Fowler Electric - 510 W. Henry St. - Wooster, Ohio 44691

Job responsibilities included but were not limited to the installation and service of power, control, and signaling systems in residential, commercial, and industrial applications.

04/2002 – 02/2007 | Electrician

Carter Electric, Inc. - 844 Edwards St - Galion, Ohio 44833

Job responsibilities included but were not limited to the installation and service of power, control, and signaling systems in residential, commercial, and industrial applications.

03/2007 – 07/2013 | Electrical Inspector, Chief Building Inspector

Galion Building and Zoning Department - 301 Harding Way East - Galion, Ohio 44833

Job responsibilities included but are not limited to the enforcement of regulations and policy related to property and structures such as commercial and residential construction, zoning, property maintenance, flood plain administration, and nuisance abatement.

07/2013 – 09/2016 | Building/Electrical Inspector

Wayne County Building Department – 428 W. Liberty St. – Wooster, Ohio 44691

Job responsibilities included but are not limited to the enforcement of regulations and policy related to commercial and residential construction.

09/2016 - Present | Building Inspector, Electrical Inspector

City of Dublin - Building Standards Division – 5200 Emerald Pkwy, Annex – Dublin, Ohio 43017

Job responsibilities include but are not limited to the enforcement of regulations and policy related to commercial and residential construction.

Chapter Four: Grounding Electrical Services

- Important requirements for grounding electrical services
- Proper location of service grounding connection
- Rules for low-impedance grounding electrode connections
- Grounded conductor /dwelling unit services and feeders
- Proper sizing of grounded service conductor
- Rules for parallel service conductors
- Rules for multiple services to one building
- Rules for high-impedance grounded systems
- Grounding rules for instrument transformers, relays, etc.
- Hazards of services from grounded systems without grounded conductor

Grounding Electrical Services

- Electrical services are furnished to the premises by the serving utility as either **grounded** or **ungrounded**
- At the service disconnecting means, system is one of the following:
  - Solidly grounded
  - Ungrounded
  - Resistance or reactance grounded

Grounding Electrical Services *(cont.)*

- How the services are grounded depends on:
  - Type of system installed
  - Design criteria
  - *Code* rules
  - How the utility grounded the supply system

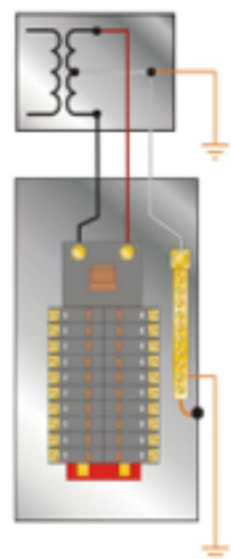
Definitions

- ***Grounded Conductor:*** A system or circuit conductor that is intentionally grounded.
- ***Service:*** The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

Grounded Conductor Size and Routing

- Shall be routed with service-entrance phase conductors
- Shall be connected to the grounded conductor terminal and bonded to service disconnecting means enclosure through the main bonding jumper
- Shall be sized to carry the load per 220.61
- Grounded conductor is not required to be larger than the largest ungrounded service-entrance phase conductor
- For high-impedance grounded neutral systems, see 250.36 for grounded conductor installation and sizing requirements
- Grounded conductor of a 3-phase, 3-wire delta service to have an ampacity not less than ungrounded conductors
- See 250.24(C)

250.24(C) Grounded Conductor Brought to Service

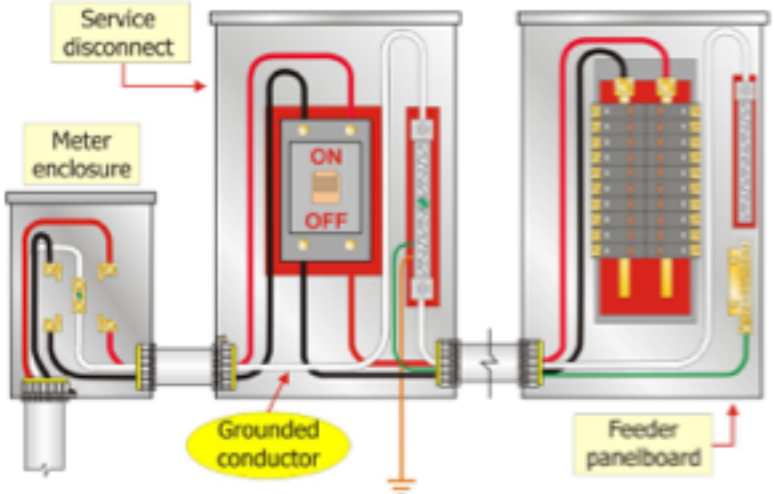


Grounded service conductor of 1000 V or less must be:

1. Routed with phase conductors
2. Run to each service disconnecting means
3. Connected to the grounded conductor terminal and bonded to service disconnecting means enclosure through the main bonding jumper
4. Sized no smaller than grounding electrode conductor
5. Sized at least 12½ percent of area of conductors where larger than given in Table 250.102(C)(1)
6. Based on equivalent area of ungrounded parallel service-entrance conductors
7. Installed in parallel where service is installed in parallel in two or more raceways
8. Must not have an ampacity rating less than the ungrounded conductor of a 3-phase, 3-wire delta service
9. Sized in accordance with minimum service neutral load requirements of 220.61

Grounded Conductor Run to Each Service Disconnect

The grounded conductor(s) is required to be brought to the grounded conductor terminal bus at each service disconnecting means and bonded to each service disconnecting means enclosure using a main bonding jumper [250.24(C)]

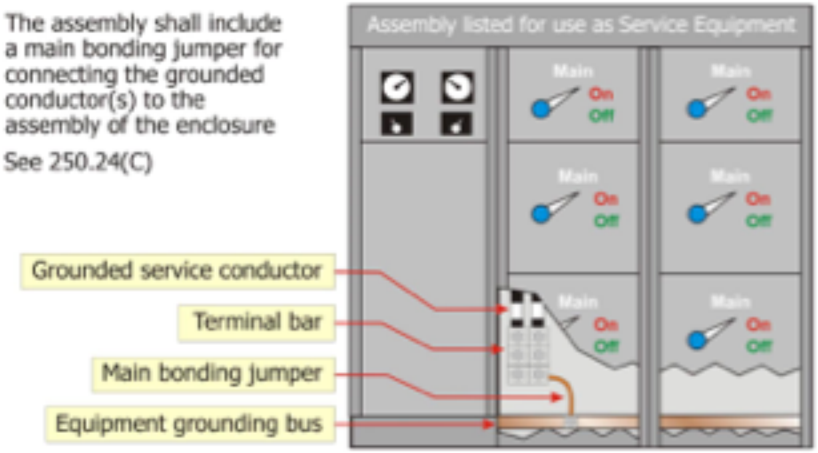


Grounded Conductor to Service Equipment

Where two or more service disconnecting means are located in a single assembly listed for use as service equipment, it shall be permitted to connect the grounded conductor(s) to the assembly common grounded conductor(s) terminal or bus

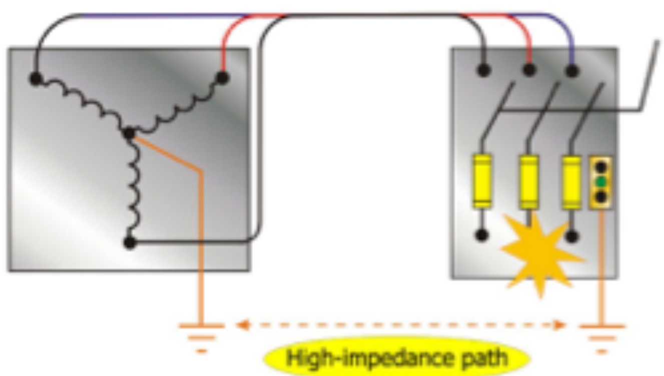
The assembly shall include a main bonding jumper for connecting the grounded conductor(s) to the assembly of the enclosure

See 250.24(C)



High-Impedance Path

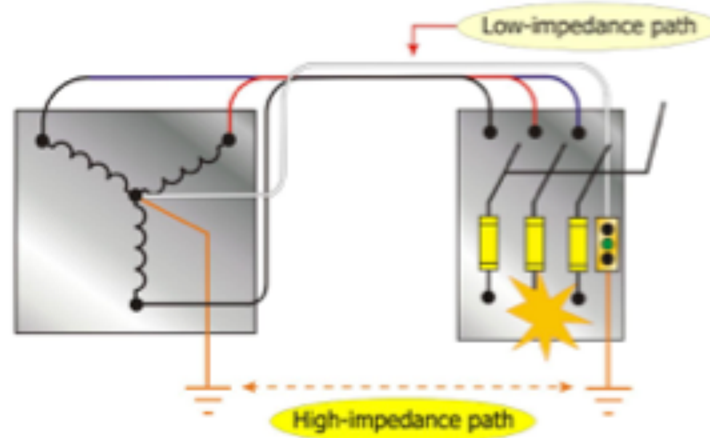
Grounded conductor not installed from source to service disconnect



Only path for return of ground-fault current from service disconnect to grounded source is a high-impedance path

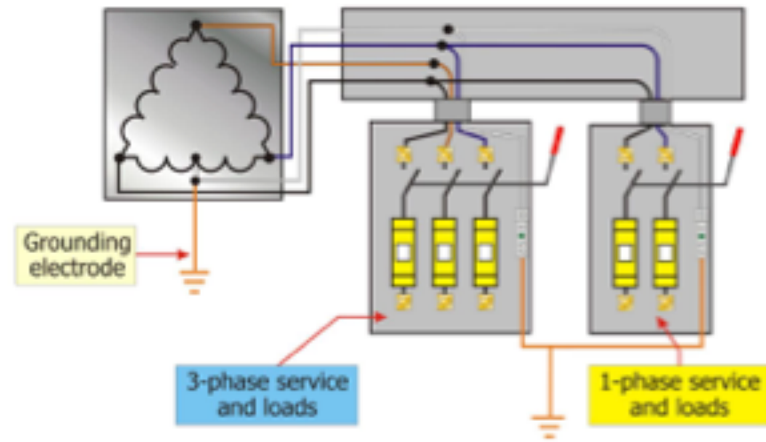
Low-Impedance Path

Grounded conductor installed from source to service disconnect



Both high- and low-impedance paths for return of ground-fault current from source to service disconnect to source

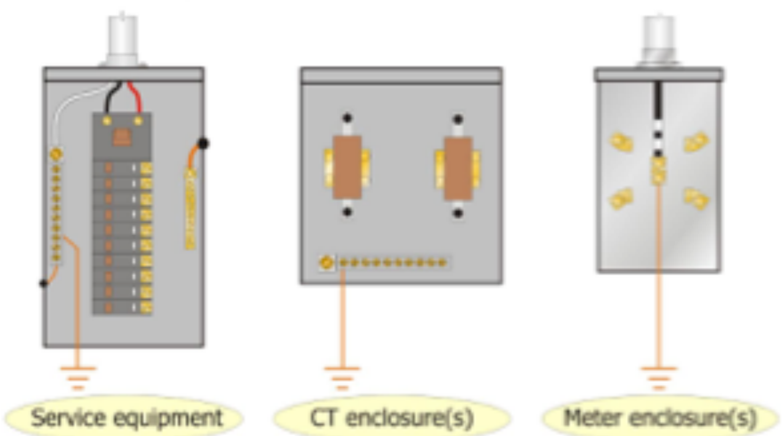
Power and Lighting Service for 3-Phase System



Grounded service conductor run to both service disconnects and bonded to each enclosure

Service Grounding Connection to be Accessible

Location of grounding electrode conductor connection to grounded service conductor must be accessible and at load end of overhead service conductors, service drop, underground service conductors, or service lateral



See 250.24(A)(1)

Minimum Size of Grounded Service Conductor

- Calculate load on grounded conductor according to 220.61
- Compare calculated size with Table 250.102(C)(1)
- Use larger of two conductor sizes determined
- Grounded conductor shall not be smaller than specified in Table 250.102(C)(1)
- Use 12½ percent rule for service-entrance conductors that exceed the kcmil values given in Table 250.102(C)(1) *(see Note 1 to table)*
- Grounded conductor based on size of ungrounded service conductors, not on overcurrent device rating

Minimum Size of Grounded Service Conductor

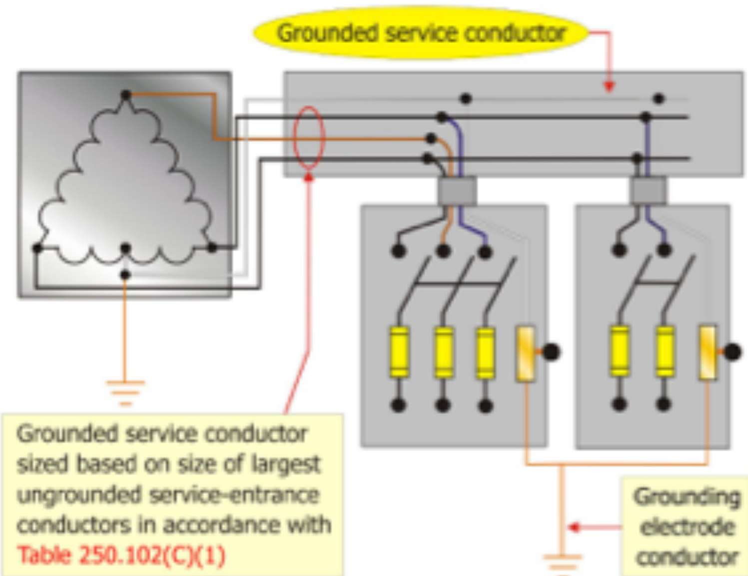


Table 250.102(C)(1) Grounded Conductor, Main Bonding Jumper, System Bonding Jumper, and Supply-Side Bonding Jumper for Alternating-Current Systems

Size of Largest Ungrounded Conductor or Equivalent Area for Parallel Conductors (AWG/kcmil)		Size of Grounded Conductor or Bonding Jumper* (AWG/kcmil)	
Copper	Aluminum or Copper-Clad Aluminum	Copper	Aluminum or Copper-Clad Aluminum
2 or smaller	1/0 or smaller	8	6
1 or 1/0	2/0 or 3/0	6	4
2/0 or 3/0	4/0 or 250	4	2
Over 3/0 through 350	Over 250 through 500	2	1/0
Over 350 through 600	Over 500 through 900	1/0	3/0
Over 600 through 1100	Over 900 through 1750	2/0	4/0
Over 1100	Over 1750	See Notes 1 and 2	

Notes:
[See NEC for complete text of the (4) notes to Table 250.102(C)(1)]

*For the purposes of applying this table and its notes, the term bonding jumper refers to main bonding jumpers, system bonding jumpers, and supply-side bonding jumpers.

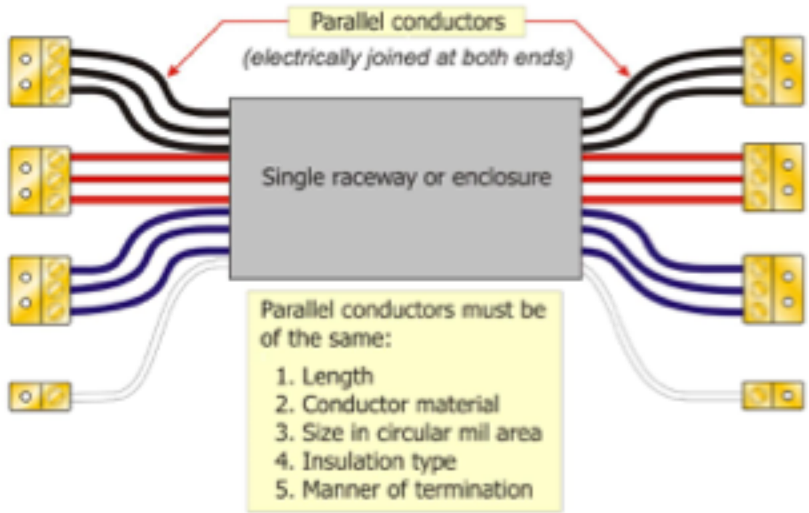
Dwelling Unit Services and Feeders

- Special rules for dwelling unit services and the main power feeder at 310.15(B)(7)(1) through (4)
- Grounded conductor is permitted to be smaller than ungrounded conductors
- Section 215.2 - feeder to be adequate for load, of minimum sizes, and not larger than the service-entrance conductors
- 220.61 - calculation of feeder neutral load; carry maximum unbalanced load
- 230.42 - sufficient to carry the load, not smaller than required by 250.24(C)(1)
- 250.24(C)(2) is required for parallel service-entrance conductors *(not smaller than 1/0)*

Sizing Parallel Grounded Conductors

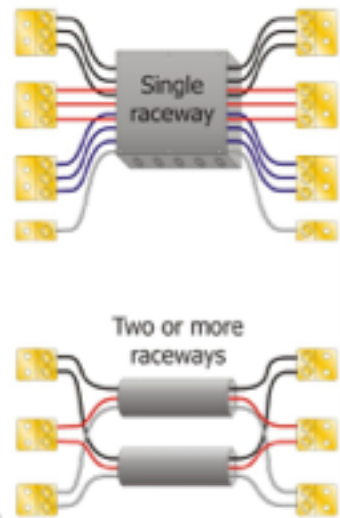
- Where the service-entrance conductors are **run in parallel**, the size of the grounded conductor shall be based on the total cm area of the parallel conductors in the same enclosure
- Where the service-entrance conductors are installed in **two or more raceways**, the size of the grounded conductor shall be based on the size of the ungrounded service-entrance conductor in the raceway but not smaller than 1/0
- See 250.24(C)(2)

310.10(H) Parallel Service Conductors



(Parallel conductors are generally required to be 1/0 AWG and larger in size)

Parallel Service Conductors



Where all service-entrance conductors are in the same raceway, the grounded conductor is to be sized at not less than given in Table 250.102(C)(1) *[see 250.24(C)(1)]*

For ungrounded conductors larger than Table 250.102(C)(1), sizing of grounded conductors to be not less than 12½ percent of total area of largest set of ungrounded conductors per Table 250.102(C)(1), Note 1

Where installed in two or more raceways, the grounded conductor size is based on the size of the ungrounded conductors in each raceway based on Table 250.102(C)(1), but not smaller than 1/0 AWG *[see 250.24(C)(2)]*

Parallel Service-Entrance Conductors

Example Number 1:

3 - 4/0 copper conductors per phase

Chapter 9, Table 8

4/0 = 211,600 circular mils

3 X 211,600 = 634,800 cm

Refer to Table 250.102(C)(1)

Minimum size grounded service conductor is **2/0 copper** or **4/0 aluminum**

Parallel Service-Entrance Conductors

Example Number 2:

6 - 4/0 copper conductors per phase

Chapter 9, Table 8

4/0 = 211,600 circular mils

6 X 211,600 = 1,269,600 cm

Exceeds 1100 kcmils of T. 250.102(C)(1), use **12.5% rule**

1,269,600 cm x .125 = 158,700 cm

Chapter 9, Table 8, next larger size = **3/0 copper**

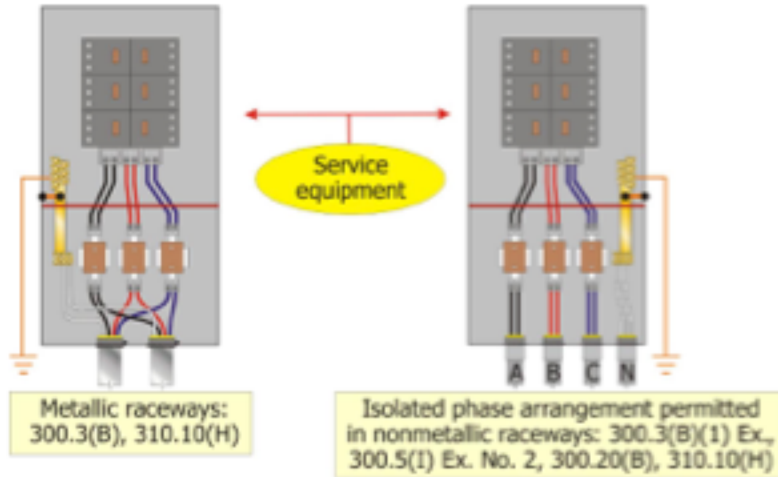
Underground Parallel Service Conductors

- All conductors of each phase permitted to be installed in the **same raceway** for **underground installations** in **nonmetallic raceways** *[300.3(B)(1) Exception]*
- Also permitted by 300.5(I) Exception No. 2
- All the ungrounded conductors of phase A are permitted to be installed in one raceway, phase B in another, phase C in the third, and the grounded service conductors in another
- Allows phase conductors to readily line up with bus terminations in bottom-fed switchboards
- Reduces the "rat's nest" in the bottom of enclosures caused by many conductors crossing each other for termination

Underground Parallel Conductors

All conductors of the same circuit *(including the grounded conductor)* are generally required to be contained within the same raceway

Per exception, Isolated phase arrangement permitted in nonmetallic raceways



Multiple Services to One Building

- Multiple services to one building permitted under one of several conditions allowed by 230.2
- Each service supplied from a grounded system must be provided with a **grounded service-entrance conductor**
- Size of ungrounded service-entrance conductor *(for each service)* determines the minimum size grounded service conductor for that service
- Each service is considered individually for sizing the grounded service conductor

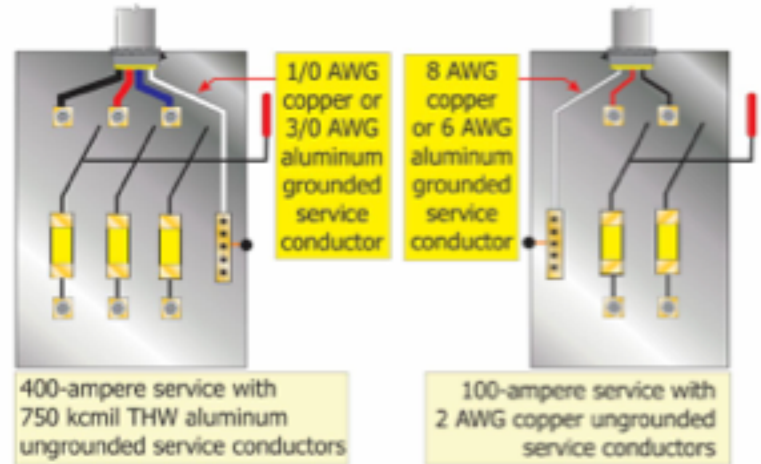
Multiple Services to One Building

- **Example:**
- Building has a 400-ampere, 480-volt 3-phase service and a 100-ampere 120/240-volt service
- Minimum size of grounded service conductor is determined as follows:
  - 400-ampere service
  - 750 kcmil THW aluminum ungrounded service conductors
  - Table 250.102(C)(1) = **1/0 AWG copper** or **3/0 AWG aluminum** grounded service conductor

Multiple Services to One Building

- **Example: *(cont.)***
- Building has a 400-ampere, 480-volt 3-phase service and a 100-ampere 120/240-volt service
- Minimum size of grounded service conductor is determined as follows:
  - 100-ampere service
  - 2 AWG copper ungrounded service conductors
  - Table 250.102(C)(1) = **8 AWG copper** or **6 AWG aluminum** grounded service conductor

Two Services to One Building from Grounded System



Minimum size of grounded service conductor to each service is based upon the size of ungrounded service conductor to each individual service

See 250.102(C)(1) and Table 250.102(C)(1)

Multiple Services to One Building

- This method determines minimum size of grounded service conductor to comply with 250.24(C)
- Larger conductor may be required to carry the maximum unbalanced load on the neutral conductor as determined by 220.61

High-Impedance Grounded Neutral Systems

- Continuous industrial process plants and other continuous operations such as data centers often need uninterrupted electrical power and systems
- Common to see these plants located near a power company substation with more than one high-voltage service supply to improve system reliability
- **High-impedance grounded neutral systems** *(rather than solidly grounded systems)* is another step that is commonly taken to improve system reliability

High-Impedance Grounded Neutral Systems (cont.)

- Advantages to high-impedance grounded neutral systems include:
  - Improved reliability
  - Ability to have ground-fault relaying that alarms rather than trips
  - Fewer problems to the system from transient overvoltages

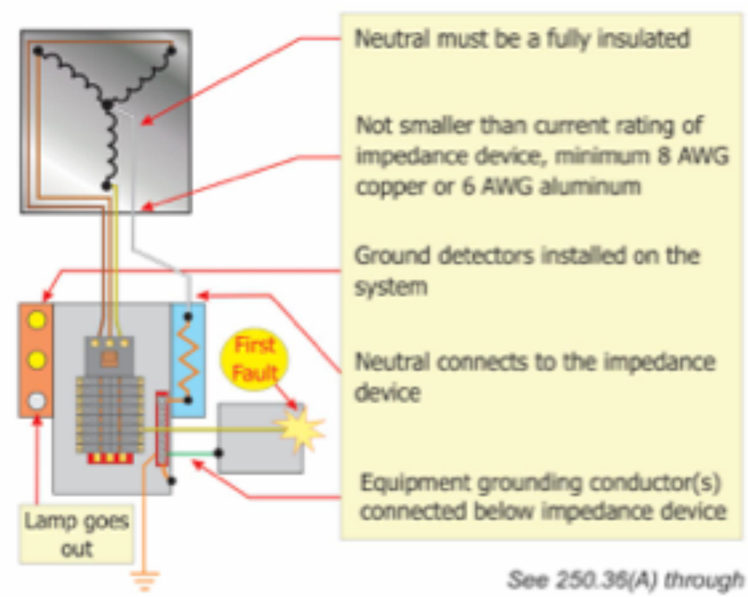
High-Impedance Grounded Neutral Systems (cont.)

- Three conditions must be met before the *Code* will permit high-resistance grounded neutral systems to be installed:
  - Qualified persons must be available to service the system
  - Ground detectors must be installed to indicate an insulation failure
  - Line to neutral loads are not served
- See 250.36

High-Impedance Grounded Neutral Systems (cont.)

- Systems in which a grounding impedance *(usually a resistor)* limits the ground-fault current to a low value by installing the resistor between the transformer supplied grounded service-entrance conductor and the grounding electrode
- Permitted for 3-phase ac systems of 480 volts to 1000 volts
- Impedance device is typically sized to a value greater than the capacitive charging current of the system *(for 480-volt systems, this is usually about 10 amperes)*
- Provides enough separation so that a fault will still be detected at minimal damage levels while normal charging current would not be detected causing false alarms

High-Impedance Grounded Neutral Systems



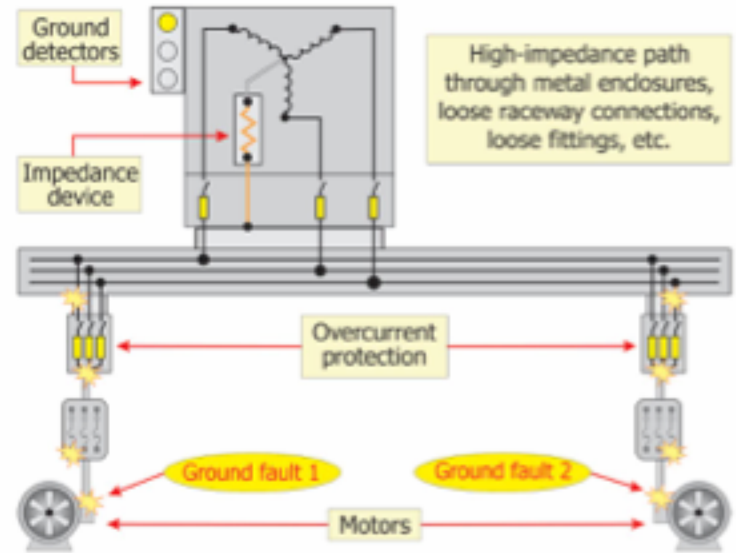
See 250.36(A) through (G)

Equipment for High-Impedance Grounded Neutral Systems

Resistor for high-impedance grounded neutral system with single-phase grounding transformer *(provides low current grounding at voltages 2.4 kV and higher)*

High resistance grounded system cabinets complete with tapped resistor and controls

Second Ground Fault on High-Impedance Grounded Neutral System



Grounding of Ungrounded Systems

- Ungrounded systems that experience a ground fault are subject to relatively severe transient over-voltages that can reach several times normal voltage to ground
- Such abnormal voltages become potential hazards and often cause insulation failure and equipment breakdowns in other parts of the system
- Grounded systems *(with one conductor purposely grounded)* greatly reduces the value of such transient over-voltages as they develop

Grounding of Ungrounded Systems *(cont.)*

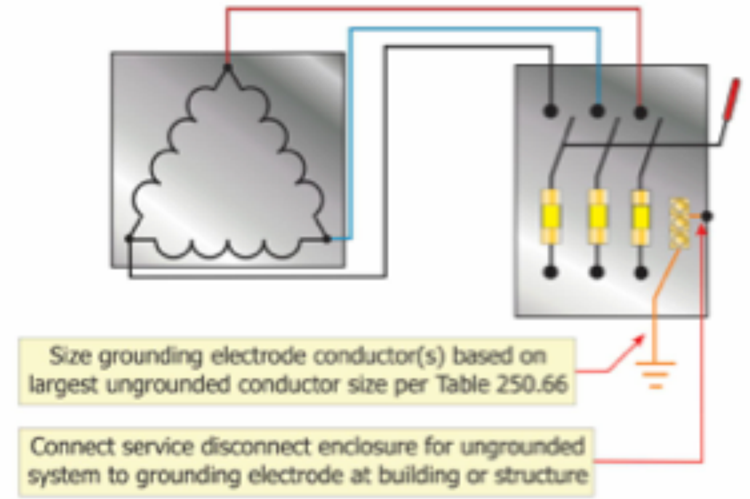
- Ungrounded system must have its conductor and equipment enclosures connected to a grounding electrode system at the building or structure served
- This keeps such enclosures as near to ground potential as possible and reduces shock hazards to a minimum
- Service equipment enclosures are grounded by connecting them to a grounding electrode system

Grounding of Ungrounded Systems *(cont.)*

- Enclosures, raceways, etc. of an ungrounded system are required to be grounded
- Grounding electrode system and equipment grounding conductors are required
- **No system grounded conductor present**
- Grounding electrode conductor sizing based on 250.66 using the largest ungrounded phase conductor(s)
- Equipment grounding conductors in ungrounded systems are sized based on the rating of the overcurrent device using Table 250.122
- See 250.24(E)

Grounding Requirements for Ungrounded Systems

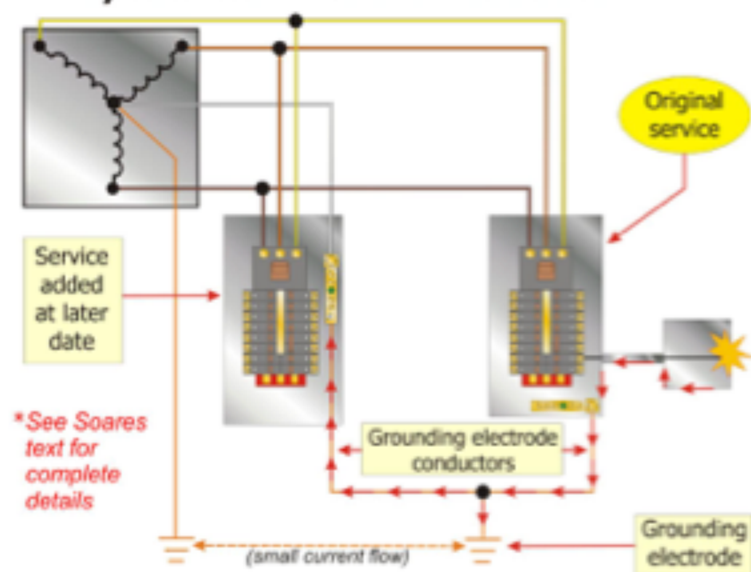
Enclosures, raceways, etc. of an ungrounded system are required to be grounded



Hazard of Services Without a Grounded Conductor Supplied from a Grounded System

- The illustration on the next slide illustrates the hazard of operating a service from a grounded system without installing a grounded service conductor
- Original ungrounded service *(on right)* in the illustration existed before the newer service *(on left)* was installed
- First and original service was supplied by an ungrounded utility system with the service and feeder shown supplying equipment protected by large overcurrent devices
- Sometime later, the service on the left, which included a grounded service conductor, was installed
- ***See Soares textbook (page 82) for complete details***

Hazard of Ungrounded Service from Grounded System Without a Grounded Conductor



Chapter Five:
Main Bonding Jumpers and Bonding at Services

- Definitions of bonding and bonding jumpers
- Functions of the main and supply-side bonding jumper
- Sizing of the main and supply-side bonding jumpers
- Methods for bonding at service equipment
- Use of grounded conductor (neutral) for bonding on line side of service
- Requirements for grounding and bonding of remote metering

Main Bonding Jumpers and Bonding at Services

- Main bonding jumper is one of the most critical elements in the safety grounding and bonding system
- Main bonding jumper serves as the link between:
  - Grounded service conductor
  - Equipment grounding conductor(s)
  - Grounding electrode conductor

Main Bonding Jumpers and Bonding at Services *(cont.)*

- Primary purpose of the main bonding jumper is to **carry the ground-fault current** from the service enclosure and from the equipment grounding conductor system that is returning to the source during ground-fault conditions
- Ensures equipment grounding bus is at the **same potential as the earth** where the grounding electrode conductor is connected directly to the grounded service conductor *(neutral)* bus
- Main bonding jumper **completes the earth connection** to the grounded (neutral) conductor where the grounding electrode conductor is connected to the equipment grounding bus as permitted in 250.24(A)(4)

Definitions

- ***Bonded (Bonding):*** "Connected to establish electrical continuity and conductivity"
- ***Bonding Jumper, Main:*** "The connection between the grounded circuit conductor and the equipment grounding conductor at the service"
- ***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" [250.2]

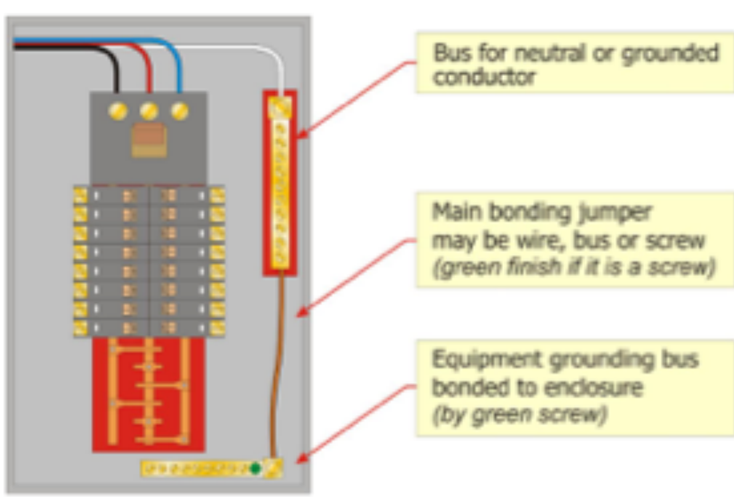
Main Bonding Jumper in Listed Equipment

- Can be used without calculation of size
- Sized in accordance with sizing requirements of the applicable product safety standard
- Example:
  - Dead-front switchboards, UL-891
  - Motor Control Centers, UL-845
  - Panelboards, UL-67
  - Power Outlets, UL-231
  - Furnished by the manufacturer

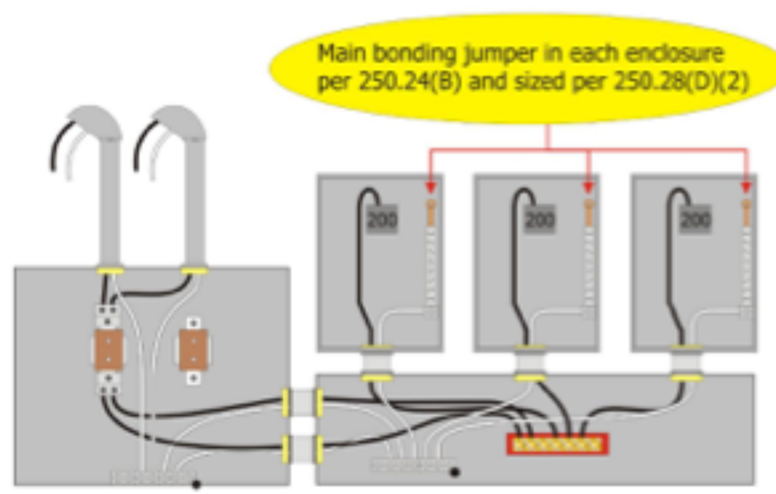
Main Bonding Jumper

- For a grounded system, 250.24(B) requires an unspliced main bonding jumper to be used to connect:
  - **Equipment grounding conductor(s)** and the **service disconnect enclosure** to the **grounded conductor** of the electrical system
- Connection must be made within the enclosure for **each service disconnect** *(see 250.28)*

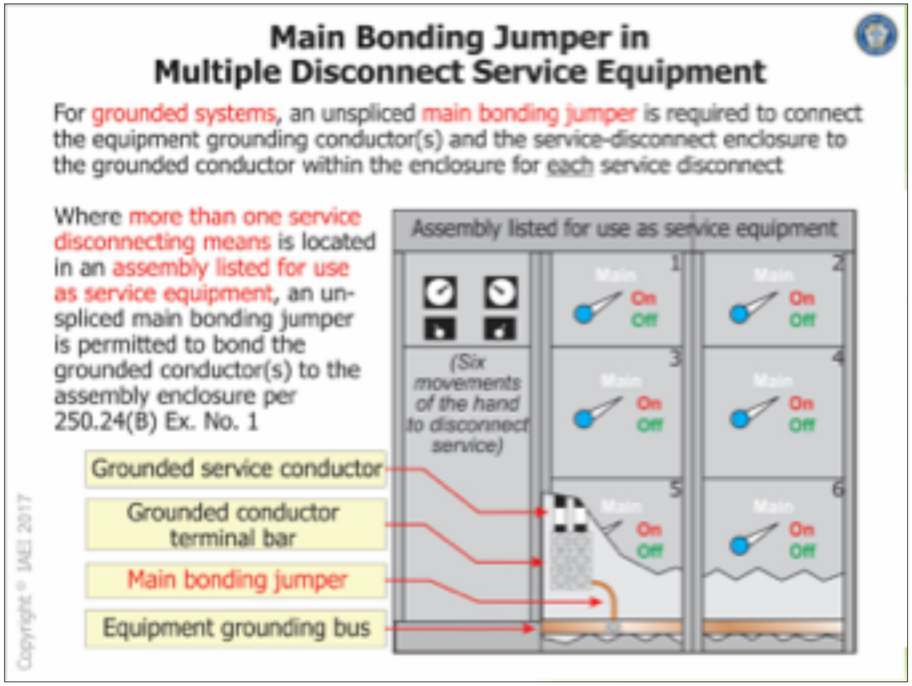
250.28 Main Bonding Jumper

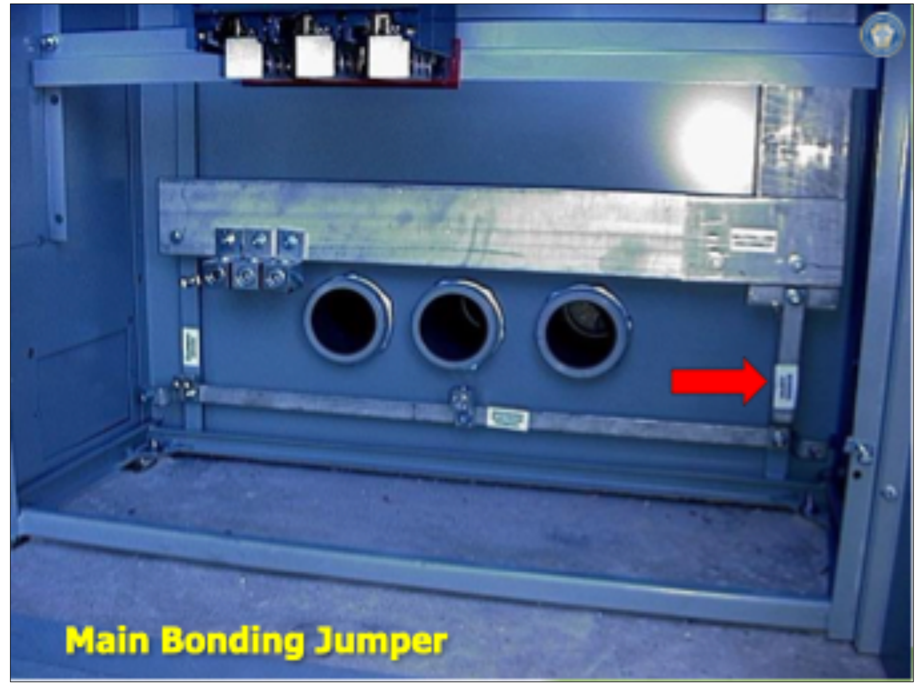


Main Bonding Jumper - Multiple Enclosures



(All conductors not shown)


Main Bonding Jumper in
Multiple Disconnect Service Equipment
For grounded systems, an unspliced main bonding jumper is required to connect the equipment grounding conductor(s) and the service-disconnect enclosure to the grounded conductor within the enclosure for each service disconnect
Where more than one service disconnecting means is located in an assembly listed for use as service equipment, an unspliced main bonding jumper is permitted to bond the grounded conductor(s) to the assembly enclosure per 250.24(B) Ex. No. 1
Assembly listed for use as service equipment
(Six movements of the hand to disconnect service)
Main
On
Off
Grounded service conductor
Grounded conductor terminal bar
Main bonding jumper
Equipment grounding bus
Copyright © IAEI 2017

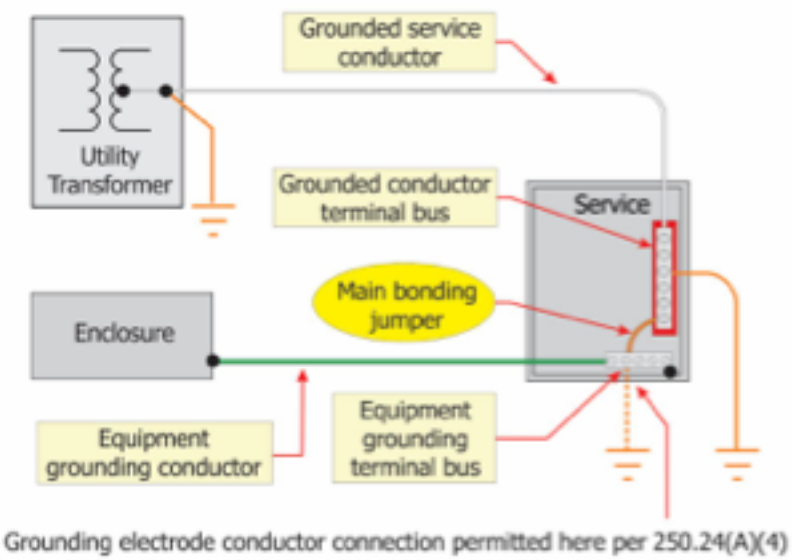

Main Bonding Jumper


NEUTRAL LINK
DISCONNECT
BONDING
JUMPER

Functions of Main Bonding Jumper

- The main bonding jumper performs **three major functions**:
  - Connects grounded service conductor to the equipment grounding bus or conductor and the service enclosure
  - Provides **low-impedance path** for return of ground-fault currents to the grounded service conductor by completing the ground-fault return circuit from the equipment grounding conductors and enclosure to the source via the service grounded (neutral) conductor
  - Connects the grounded service conductor to the grounding electrode conductor where the grounding electrode conductor is terminated on the equipment grounding bus or bar

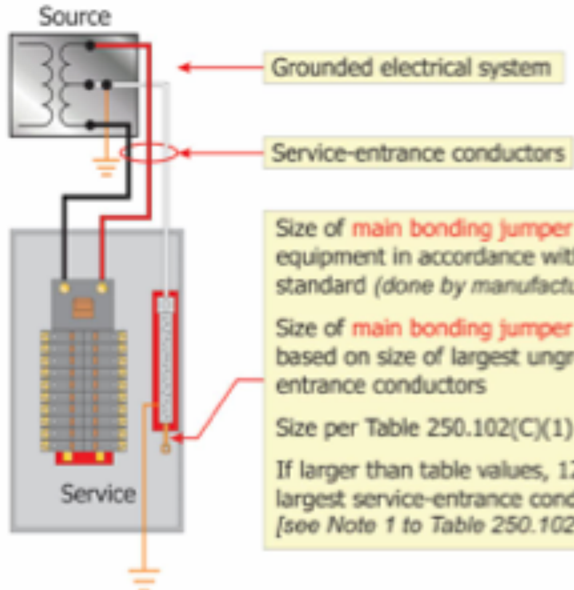
Major Functions of Main Bonding Jumper



Sizing of Main Bonding Jumper

- Main bonding jumper must carry the full ground-fault current of the system back to the grounded service conductor *(which may be a neutral)*
- Size must relate to the rating of the service conductors which supply the service
- Minimum size of the main bonding jumper is determined from the requirements of 250.28(D)

Main Bonding Jumper at Single Disconnect



Size of main bonding jumper in listed service equipment in accordance with the applicable standard *(done by manufacturer)*

Size of main bonding jumper *(if conductor)* based on size of largest ungrounded service-entrance conductors

Size per Table 250.102(C)(1) and table notes

If larger than table values, 12½ percent of largest service-entrance conductor area *[see Note 1 to Table 250.102(C)(1)]*

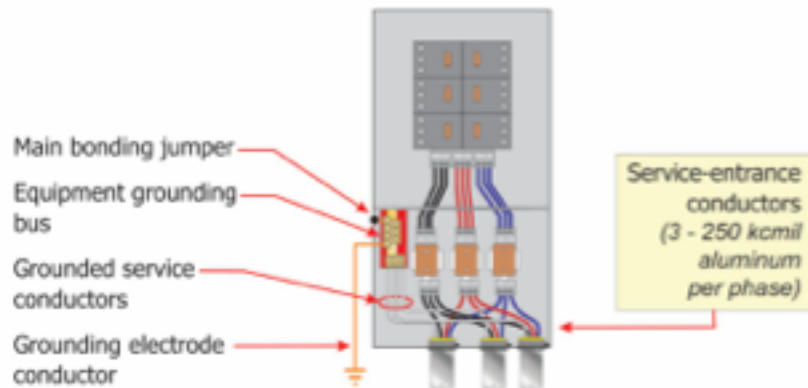
Sizing Main Bonding Jumper (Conductor)

- **Example 1:**
  - 250 kcmil aluminum service-entrance conductors
  - Table 250.102(C)(1)
  - Minimum **4 AWG copper** or **2 AWG aluminum** or copper-clad aluminum main bonding jumper required

Sizing Main Bonding Jumper (Conductor)

- **Example 2:** (3) 500-kcmil copper conductors are installed in parallel as service-entrance conductors
  - Add circular mil area together and if larger than 1100 kcmil copper or 1750 kcmil aluminum, use **12½ % rule**
  - 3 x 500 kcmil = 1500 kcmil
  - 1500 x .125 = 187,500 circular mils
  - Refer to *NEC* Chapter 9, Table 8
  - Next conductor that would exceed 187,500 circular mils is a **4/0 AWG conductor** *(211,600 circular mils)*

Sizing Main Bonding Jumper *(Conductor)* for Parallel Service Conductors



Step 1- (3) 250 kcmil aluminum conductors per set *[3 x 250 = 750 kcmil]*
Step 2- Refer to Table 250.102(C)(1)
Step 3- Minimum size MBJ (conductor) for 750 kcmil aluminum: 1/0 AWG copper or 3/0 AWG aluminum

Supply-Side Bonding Jumper

- Review of the definition:
  - ***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" *[250.2]*

Functions of Supply-Side Bonding Jumper

- 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
- Connects bonding bushings *(where used)* to service grounded *(neutral)* conductor in service equipment enclosure(s)
- Carries ground-fault current from ground faults that occur on the supply side of the main overcurrent protection
- Provides a low impedance path for the ground-fault current to return to the source

Supply-Side Bonding Jumper

- Supply-side bonding jumper can be non-flexible metal raceway or a wire type
- Service grounded conductor can sometimes also serve as the supply-side bonding jumper

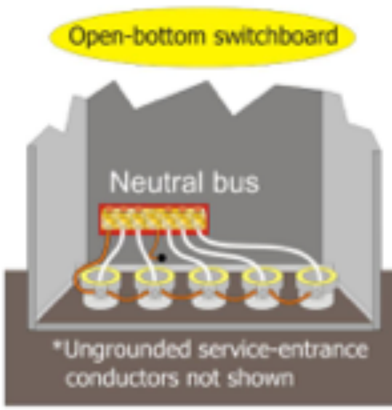
Sizing Supply-Side Bonding Jumpers

- Line side of service and main bonding jumper
- Size per Table 250.102(C)(1)
- Based on size of ungrounded service-entrance conductor(s)
- Use rules in 250.102(C)
  - Parallel conductors in the *same* raceway or enclosure *[see 250.102(C)(1)]*
  - Parallel conductors in *separate* raceways or enclosures *[see 250.102(C)(2)]*

Size of Supply-Side Bonding Jumper on Line Side of Service

Where installed in series, a supply-side bonding jumper is sized for the total circular mil area of ungrounded service-entrance conductors installed in parallel

Single supply-side bonding jumper connects all conduits together and then is bonded to the service grounded *(neutral)* bus

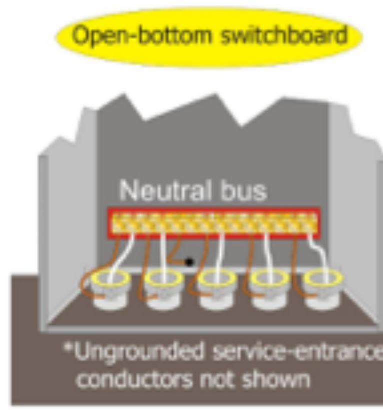


Note: Metal enclosure and raceways must be connected to the grounded conductor/neutral bus per 250.80

Size of Supply-Side Bonding Jumper on Line Side of Service

Where installed individually, supply-side bonding jumpers are sized based on the total circular mil area of ungrounded service-entrance conductors installed in <u>each</u> raceway

Individual supply-side bonding jumpers bond all conduits to the service grounded *(neutral)* bus



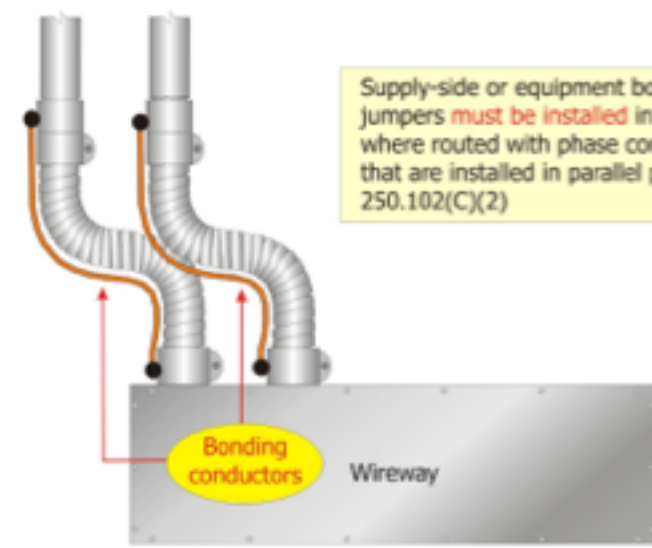
Note: Metal enclosure and raceways must be connected to the grounded conductor/neutral bus per 250.80

Parallel Supply-Side Bonding Jumpers

- Paralleled service-entrance conductors installed in two or more raceways or cables along with supply-side bonding jumpers require the supply-side bonding jumpers to be run in parallel as well *[see 250.102(C)(2)]*
- Size of the bonding jumper for each raceway is based upon size of the service-entrance conductor in the raceway *[Table 250.102(C)(1) and 250.102(C)(2)]*
- Must make bonding jumper connections on both sides of the raceway with equipment or fittings that are suitable for that use

250.102(C)(2) Parallel Bonding Conductors

Supply-side or equipment bonding jumpers must be installed in parallel where routed with phase conductors that are installed in parallel per 250.102(C)(2)



Courtesy of Thomas and Betts

Bonding Service Equipment Enclosures

- Special rules are provided for bonding enclosures on the line side of the service disconnecting means
- All metallic enclosures that contain service conductors must be bonded together
- This equipment does not have overcurrent protection on the line side *(like feeders and branch circuits)*
- See 250.92(A)

Bonding Service Equipment Enclosures *(cont.)*

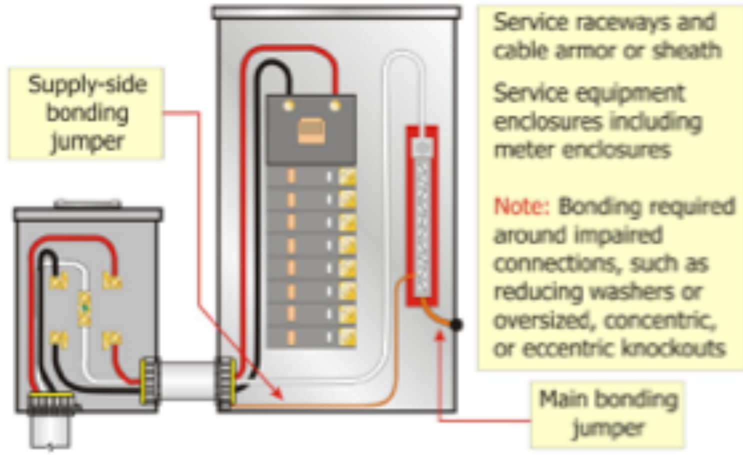
- Bonding at service equipment:
  - Ensures that none of the equipment enclosures can become **electrically isolated** and become a shock hazard should a line-to-ground fault occur in that enclosure
  - Provides a **low-impedance path** for fault current so the fuse or circuit breaker on the supply side of the electric utility transformer will open or operate
- See 250.92(A)(1) and (A)(2)

Bonding Service Equipment Enclosures *(cont.)*

- The normally non-current-carrying metal parts of service equipment required to be effectively bonded together include:
  - Service raceways, cable trays, cablebus framework, auxiliary gutters, or service cable armor or sheath that enclose, contain, or support service conductors *(except as permitted in 250.80)*
  - All enclosures containing service conductors, including meter fittings, boxes or the like, interposed in the service raceway or armor
- See 250.92(A)

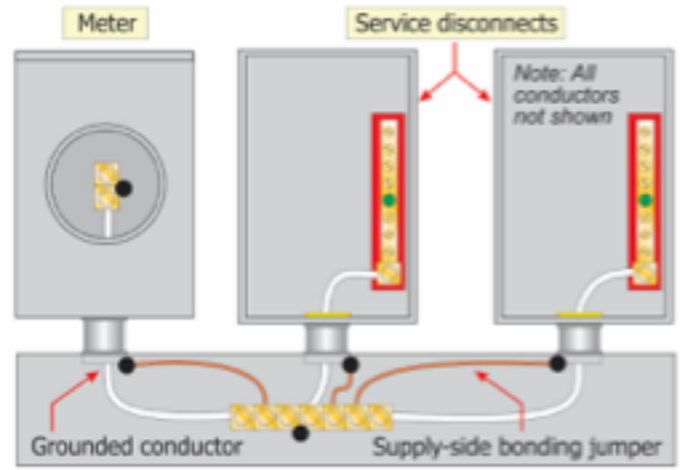
250.92(A) Bonding Service Equipment Enclosures

The normally non–current-carrying metal parts of service equipment required to be bonded together include:



Bond together in a method specified by 250.92(B) and size bonding jumpers per sizes in Table 250.102(C)(1)

Use of Grounded *(Neutral)* Conductor for Bonding *(Line Side of Service)*



Grounded conductor permitted to be used for grounding on the supply side of the service disconnect(s) in accordance with 250.142(A)(1)

Methods of Bonding at Service Equipment Enclosures

- Various methods for bonding at the service are addressed by the *Code*
- Bonding requirements are more restrictive at services than downstream from the service disconnect
- Service equipment and enclosures can be subject to heavy fault currents in the event of a line-to-ground fault
- Overcurrent protection is controlled by the serving utility
- See 250.92(B)

Methods of Bonding at Service Equipment Enclosures *(cont.)*

- Service conductors only have **short-circuit protection** provided by the overcurrent device on the line side of the utility transformer
- Only **overload protection** is provided at the load end of the service conductors by the service main overcurrent device
- One reason the *Code* limits the length of service conductors inside a building by requiring the service disconnecting means to be "nearest the point of entrance" of the service conductors *[see 230.70]*
- Various methods for bonding at the service are illustrated on the next few slides

250.92(B) Bonding Fittings

Bonding Locknut — Used where no concentric or eccentric knockouts remain
(Standard locknut permitted on opposite side)

Bonding Wedge — Use with bonding jumper around concentric or eccentric knockouts; with or without bonding jumper where no concentric or eccentric knockouts
(Standard locknut permitted on opposite side)

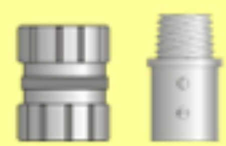
Bonding Locknut Suitable for Service Bonding

Courtesy of Thomas and Betts

Bonding Wedge Suitable for Service Bonding

Courtesy of Thomas and Betts

250.92(B) Methods of Bonding Service Equipment



Threadless couplings and connectors made up tight for rigid metal conduit, intermediate metal conduit, and electrical metallic tubing

Conduit hub furnished in many trade conduit sizes as accessory by equipment manufacturer
(Install according to manufacturer's instructions)

Threaded couplings or bosses on enclosures made up wrenchtight


DANGER


Courtesy of Thomas and Bett

Methods of Bonding at Service *[250.92(B)]*

- Listed lugs, pressure connectors, other listed means *(250.8)*
- Threaded couplings and connectors or threaded hubs on enclosures where made up wrenchtight
- Threadless couplings and connectors if made up tight for metal raceways or metal-clad cables
- Other listed devices, such as bonding-type locknuts, bushings, or bushings with bonding jumpers
- Standard locknuts are not permitted for the bonding required by this section
- Bonding jumpers are required to be used around impaired concentric or eccentric knockouts
- Connections cannot depend on solder *[250.148(E)]*

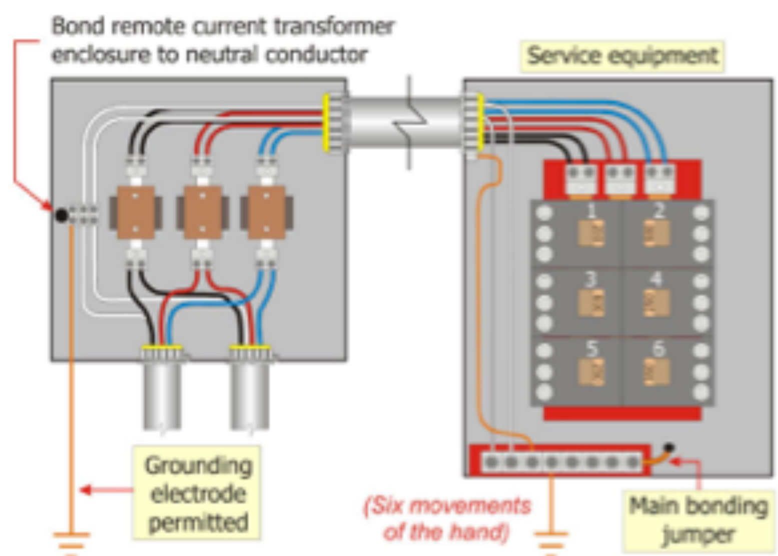
Grounding and Bonding of Remote Metering

- All metallic equipment containing service conductors required to be bonded together and to the **grounded service conductor** *[see 250.92(A)]*
- This includes remote *(from the service equipment)* meter cabinets and meter socket enclosures, current transformer cabinets, raceways, and auxiliary gutters
- Grounding and bonding of equipment to the **grounded service conductor** at locations on the line side of and remote from the service disconnecting means increases safety

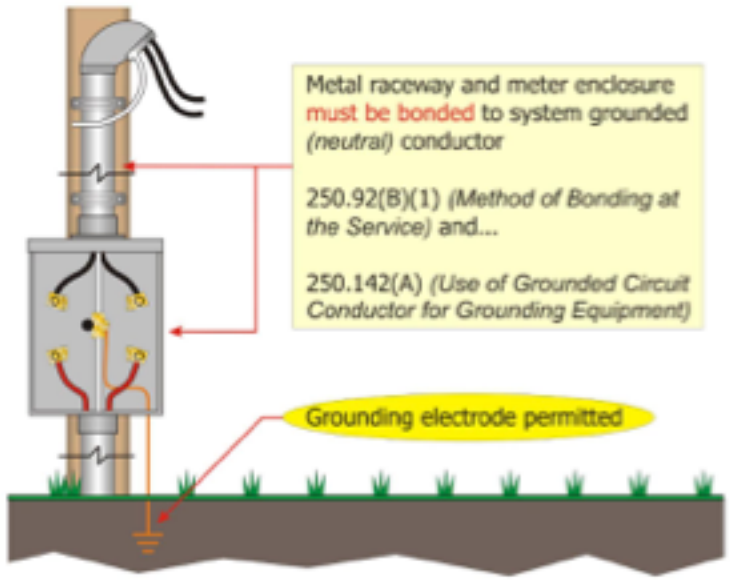
Grounding and Bonding of Remote Metering *(cont.)*

- Remote equipment should never be grounded only to a grounding electrode *(such as a ground rod)*
- If a ground fault occurred on the line-side of remote equipment *(and not bonded as required)*, only means for clearing ground fault would be through the grounding electrodes and earth *(high impedance path)*
- No overcurrent device will open or operate, leaving the equipment enclosure(s) at a dangerous voltage-to-ground potential
- Any person or animal that contacts the enclosure can be shocked or electrocuted

Grounding and Bonding of Remote Metering



Bonding Remote Meter Loop

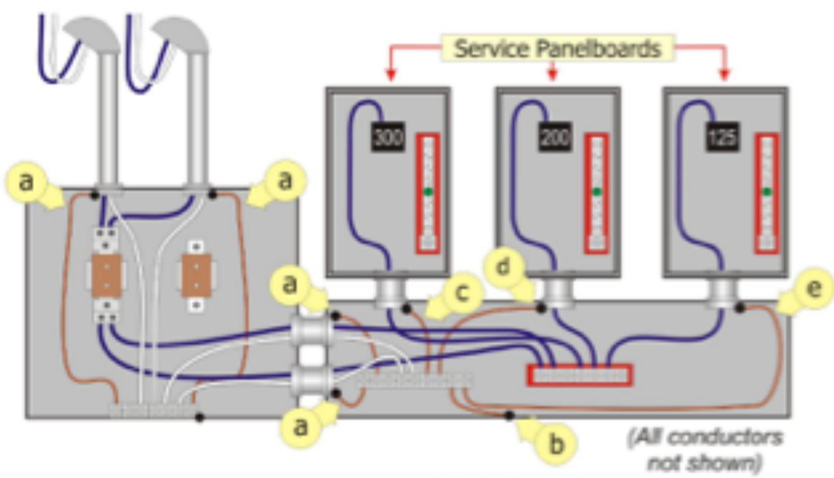


Bonding of Multiple Service Disconnecting Means

- Installation of multiple services permitted by 230.2(A) through (D)
- Installations of services that have multiple disconnecting means can take several forms
- Basic rule for sizing the supply-side bonding jumper for bonding these various configurations is found at 250.102(C)
- Supply-side bonding jumpers on the line side of each service and the main bonding jumper sized from Table 250.102(C)(1)
- Size of supply-side bonding jumper for each raceway based on the size of service-entrance conductors in that raceway

Bonding of Multiple Service Disconnecting Means

Size supply-side bonding jumpers in accordance with 250.102(C)



Note: See next slide for legend

Sizing Supply-Side Bonding Jumpers

- The appropriate size of supply-side bonding jumpers for the installation in Figure 5-16 with the assumed size of conductors is as follows: *(all sizes copper)*
  - **(a)** 500 kcmil in service mast and nipple has a supply-side bonding jumper of 1/0 AWG
  - **(b)** 1000 kcmil in wireway has a supply-side bonding jumper of 2/0 AWG
  - **(c)** 300 kcmil to 300-ampere service has a supply-side bonding jumper of 2 AWG
  - **(d)** 3/0 AWG to 200-ampere service has a supply-side bonding jumper of 4 AWG
  - **(e)** 2 AWG to 125-ampere service has a supply-side bonding jumper of 8 AWG

Chapter Six:
The Grounding Electrode System

- Definitions and general requirements for grounding electrodes
- Grounding electrode system to be used
- Sizing interconnecting bonding jumpers for the grounding electrode system
- Description and installation of grounding electrodes
- Common grounding electrode
- Objectionable current flow and resistance of grounding electrodes

The Grounding Electrode System

- Grounding electrodes provide essential function of connecting the electrical system and electrical equipment to the earth
- The earth is considered to be at zero potential
- Grounding electrode(s) serves and is used to:
  - Ground the electrical system to earth
  - Connect non-current-carrying metallic portions of electrical equipment to the earth
- Primary purpose of the grounding electrode(s) is to maintain the electrical equipment at the earth potential present where the grounding electrode(s) is located

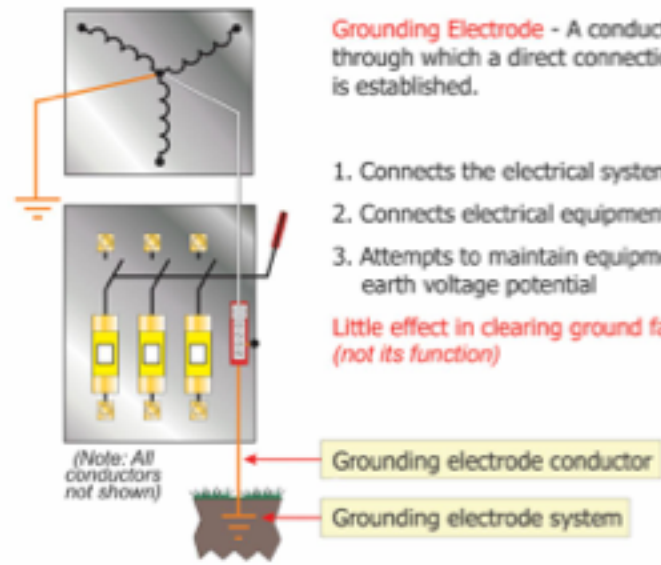
The Grounding Electrode System *(cont.)*

- Grounding electrode(s) serves the function of dissipating overvoltages into the earth
- Overvoltages can be caused by high-voltage conductors being accidentally connected to the lower-voltage system such as by a failure in a transformer or by an overhead conductor dropping on the lower-voltage conductor
- Overvoltages can also be caused from lightning

Definition

- ***Grounding Electrode:*** A conducting object through which a direct connection to earth is established.
- See Article 100
- The details and descriptions of the various grounding electrodes acceptable for grounding are contained in 250.52(A)
- The definition of ***grounding electrode*** is intended to work cooperatively with the list of electrodes identified in 250.52(A)

Functions of Grounding Electrode

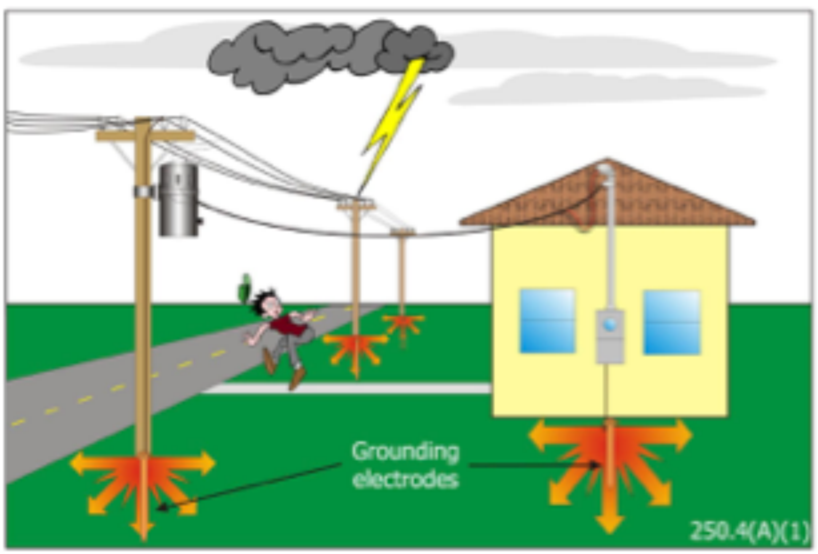


Grounding Electrode - A conducting object through which a direct connection to earth is established.

1. Connects the electrical system to earth
2. Connects electrical equipment to earth
3. Attempts to maintain equipment at the earth voltage potential

Little effect in clearing ground faults
(not its function)

Dissipation of Over-Voltages

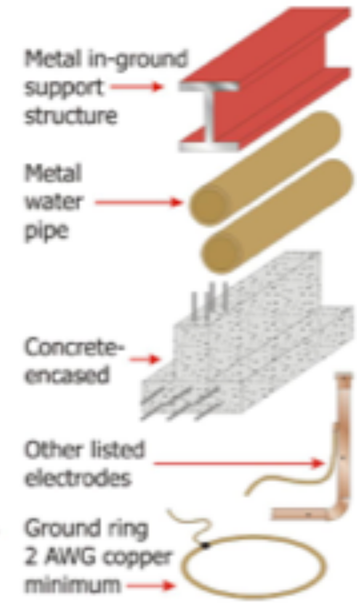


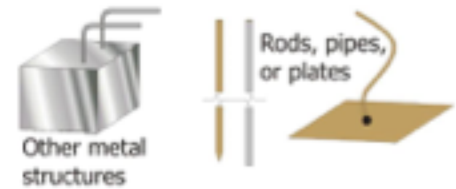
Grounding Electrode System

- All grounding electrodes **that are present** at each building or structure served are required to be bonded together to form the grounding electrode system *(see 250.50)*
- Where **metallic water piping** [250.52(A)(1)], **metallic in-ground support structure** [250.52(A)(2)], or a **concrete-encased electrode** [250.52(A)(3)] is part of the construction of the building or structure it is required to be used as a grounding electrode for the electrical system
- None of these three items are required to be installed, only used where they are installed as part of the construction of the building or structure
- Exception to 250.50 has provisions for existing buildings or structures

250.50 Grounding Electrode System

- Where present, grounding electrodes required to be used to form the grounding electrode system
- Includes electrodes that are an inherent component of the building construction *(metal in-ground support structure, etc.)*
- By exception, existing concrete-encased electrodes not required to be used where doing so involves disturbing concrete footings of existing structures or buildings





Grounding Electrodes for Grounding

- Section 250.52(A) includes the details and descriptions of grounding electrodes that are **required to be used** for the grounding electrical systems ***(when present)***
- Section 250.52(B) includes items that are **not permitted** to be used as grounding electrodes for electrical systems and equipment
- Installation provisions for the electrodes described in 250.52(A) are provided in 250.53 titled "Grounding Electrode System Installation"

Grounding Electrodes for Grounding

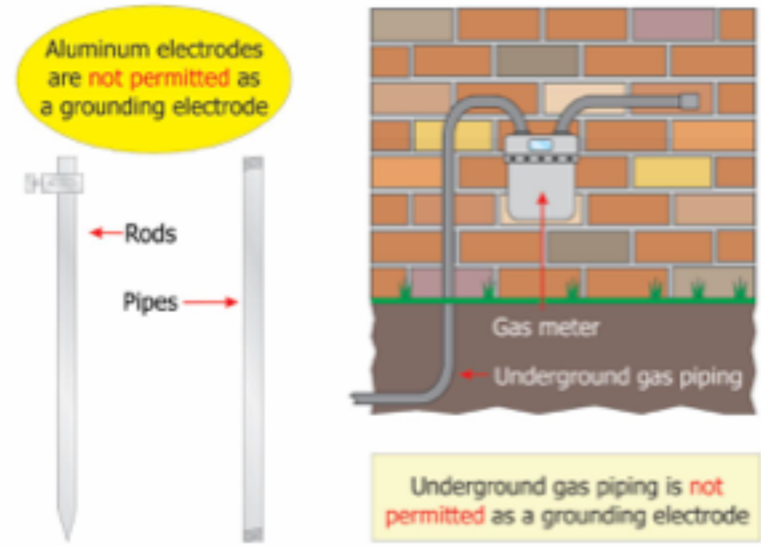
- Section 250.52(A) includes the details and descriptions of grounding electrodes that are **required to be used** for the grounding electrical systems *(where present)*:

  (A)(1) Metal underground water pipe
  (A)(2) Metal in-ground support structure
  (A)(3) Concrete-encased electrode
  (A)(4) Ground ring
  (A)(5) Rod and pipe electrode
  (A)(6) Other listed electrodes
  (A)(7) Plate electrodes
  (A)(8) Other local metal underground systems or structures

The Grounding Electrode System *(cont.)*

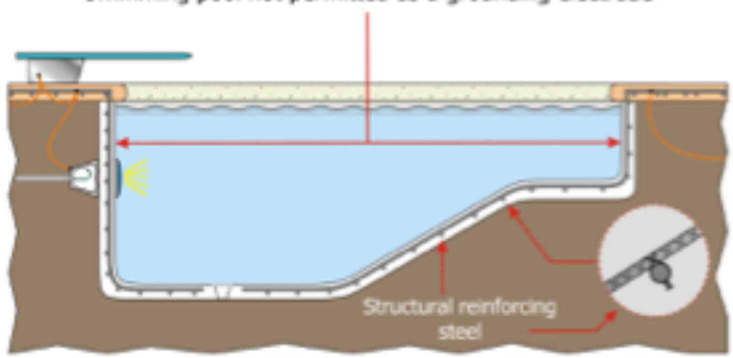
- Section 250.52(B) lists (3) items **NOT permitted** to be used as part of the grounding electrode system:
  - (1) Metal underground gas piping systems
  - (2) An aluminum electrode *(such as an aluminum ground rod)*
  - (3) Structural reinforcing steel for a permanently installed swimming pool

250.52(B) Not Permitted as Grounding Electrodes



250.52(B) Not Permitted as Grounding Electrodes

Structural reinforcing steel *(rebar forming shell)* of an in-ground swimming pool not permitted as a grounding electrode



Not permitted as grounding electrodes:
- aluminum electrodes
- underground gas piping
- structural reinforcing steel of in-ground swimming pools

Metal Underground Water Piping Systems

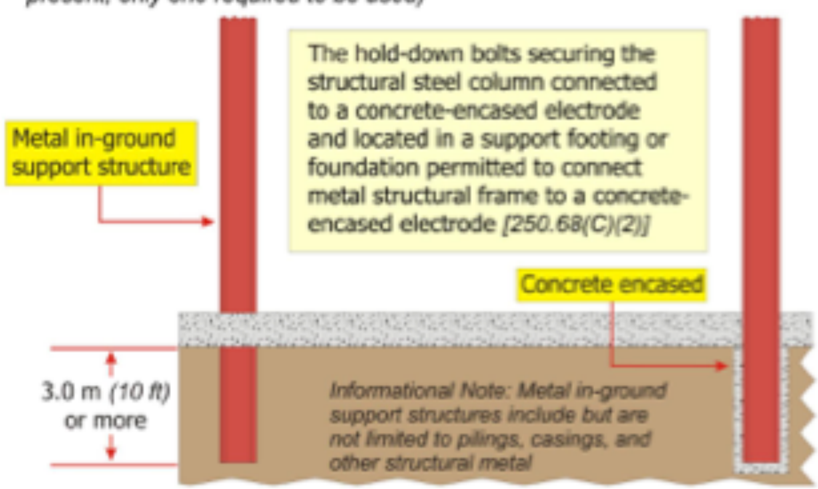
- Section 250.52(A)(1) requires **metal underground water piping systems** to be used for the grounding electrical systems *(where present)*
- Must be in direct contact with the earth for 3.0 m **(10 ft) or more** and electrically continuous
- Includes any metal well casing bonded to the pipe
- Can be made electrically continuous by bonding around insulating joints or insulating pipe
- Must not be coated or otherwise insulated from direct contact with the earth

Metal In-Ground Support Structure(s)

- Section 250.52(A)(2) requires a **metal in-ground support structure** to be used for the grounding electrical systems *(where present and qualifies)*
- Must be in direct contact with the earth vertically for **3.0 m (10 ft) or more** *(with or without concrete encasement)*
- If multiple metal in-ground support structures are present, **permitted to bond only one** into the grounding electrode system
- Could include *(but are not limited to)* pilings, casing, and other structural metal

250.52(A)(2) Metal In-Ground Support Structures

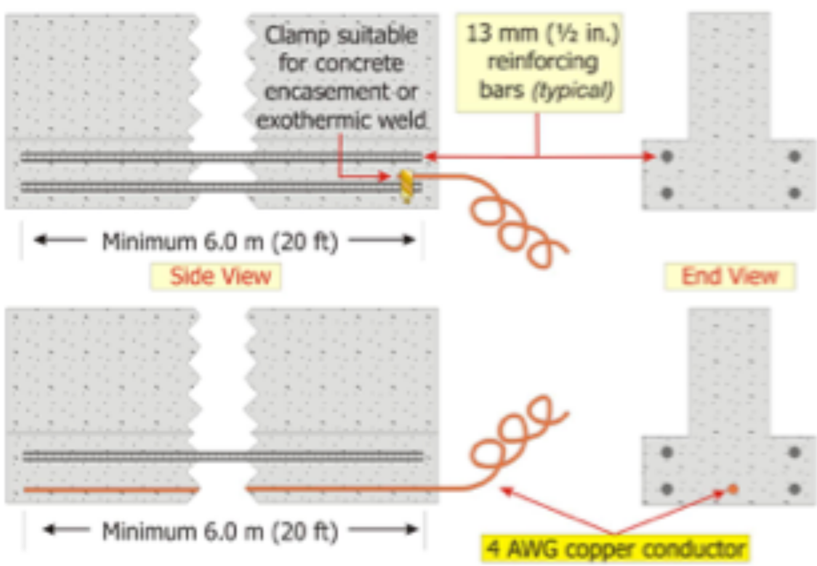
One or more structural metal in-ground support structure(s) in direct contact with the earth vertically for 3.0 m (10 ft) or more *(with or without concrete encasement)* qualifies as a grounding electrode *(if multiple are present, only one required to be used)*



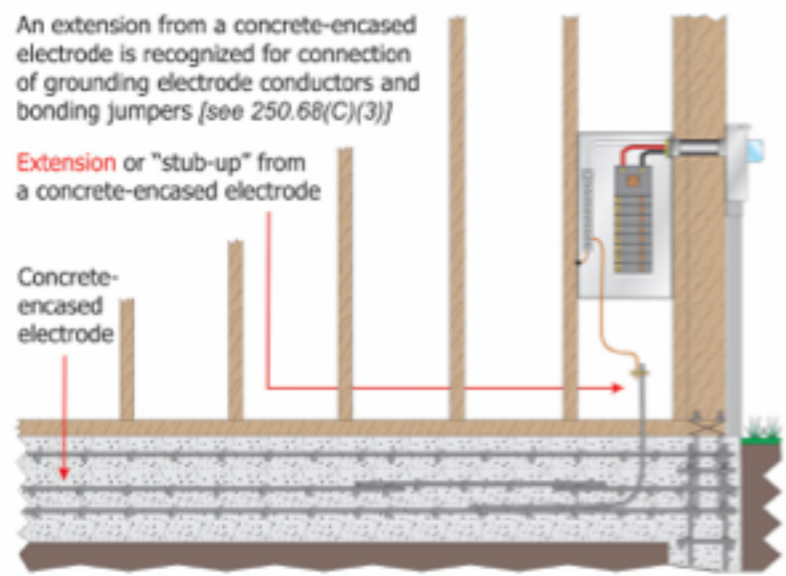
Concrete-Encased Electrode

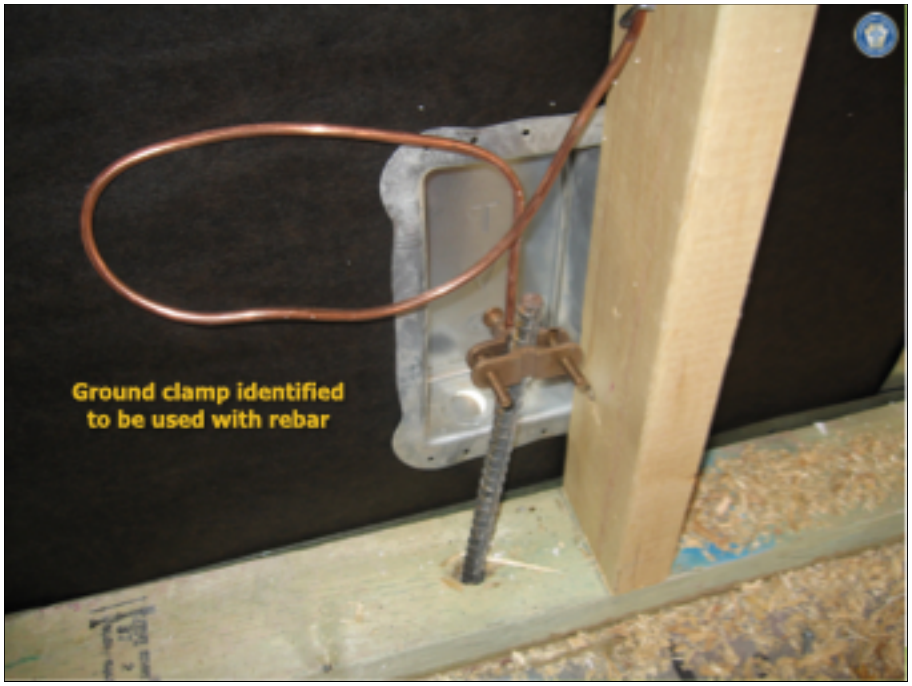
- Section 250.52(A)(3) requires concrete-encased electrodes to consist of:
  - At least **6.0 m (20 ft)** of **bare copper conductor not smaller than 4 AWG** or one or more bare or electrically conductive coated steel reinforcing bars or rods of not less than **13 mm (½ in.) in diameter**
  - Installed in **one continuous 6.0 m (20 ft) length**, or multiple pieces connected together by the usual steel tie wires, exothermic welding, welding, etc. to create a 6.0 m (20 ft) or greater length
  - Metallic components encased by at least **50 mm (2 in.) of concrete**
  - Located **horizontally** within portions of a concrete foundation or footing in direct contact with the earth or within **vertical** structural components in direct contact with the earth

250.52(A)(3) Concrete-Encased Electrode



Concrete-Encased Electrode Extension



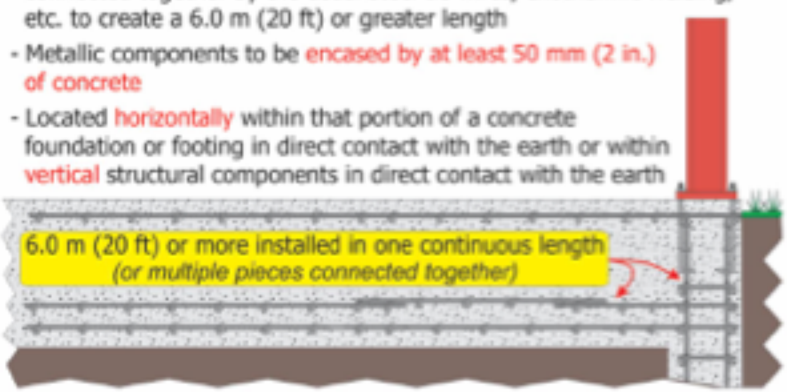


Concrete-Encased Electrode

250.52(A)(3) Concrete-Encased Electrode

Concrete-encased electrode to consist of:

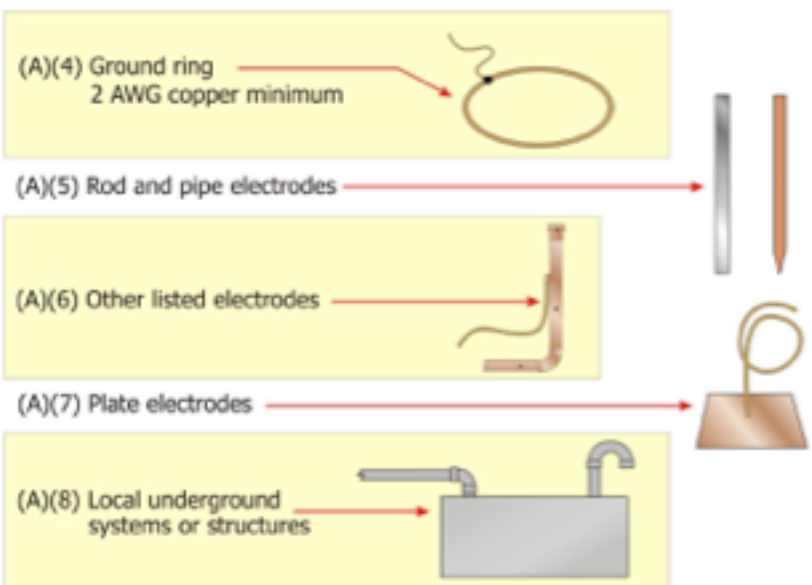
- At least 6.0 m (20 ft) of bare copper conductor not smaller than 4 AWG or one or more bare or electrically conductive coated steel reinforcing bars or rods, not less than 13 mm (½ in.) in diameter,
- Installed in one continuous 6.0 m (20 ft) length, or multiple pieces connected together by the usual steel tie wires, exothermic welding, etc. to create a 6.0 m (20 ft) or greater length
- Metallic components to be encased by at least 50 mm (2 in.) of concrete
- Located horizontally within that portion of a concrete foundation or footing in direct contact with the earth or within vertical structural components in direct contact with the earth



Grounding Electrode Required

- Where the grounding electrodes described in 250.52(A) are not present, a grounding electrode must be installed
- Where none of these grounding electrodes exist, one or more of the grounding electrodes specified in 250.52(A)(4) through (A)(8) shall be installed and used
- These "made" electrodes can consist of rod, pipe, and plate electrodes, or other listed electrodes, or local metal underground systems or structures
- See 250.50 and 250.52(A)(4) through (A)(8)

250.52(A) Installed Grounding Electrodes



Ground Ring

- The requirements or conditions a **ground ring** must meet to qualify as a grounding electrode are as follows:
  - Encircles the building or structure
  - Must be in direct contact with the earth
  - Consist of at least 6.0 m (20 ft) of bare copper conductor
  - Not smaller than 2 AWG
- See 250.52(A)(4)

Rod or Pipe Electrodes

- Requirements or conditions a **rod and pipe electrode** must meet to qualify as a grounding electrode are as follows:
  - Not be less than 2.44 m (8 ft) in length
  - **Pipe or conduit grounding electrodes** must consist of the following materials:
    - Not smaller than metric designator 21 (trade size ¾)
    - Where of steel, outer surface must be galvanized or otherwise metal-coated for corrosion protection
- See 250.52(A)(5)

Rod or Pipe Electrodes *(cont.)*

- Requirements or conditions a **rod and pipe electrode** must meet to qualify as a grounding electrode are as follows:
  - Not be less than 2.44 m (8 ft) in length
  - **Rod-type grounding electrodes** must consist of the following materials:
    - Stainless or copper or zinc coated steel
    - At least 15.87 mm (⅝ in.) in diameter, unless listed
- See 250.52(A)(5)

Plate Electrodes

- Requirements or conditions a **plate electrode** must meet to qualify as a grounding electrode are as follows:
  - Must expose not less than 0.186 m² (2 ft²) of surface to exterior soil *(1 ft sq. plate has two sides and would comply)*
  - Bare or electrically conductive coated iron or steel plates must be at least 6.4 mm (¼ in.) in thickness
  - Solid, uncoated electrodes of nonferrous metal shall be at least 1.5 mm (0.06 in.) in thickness
- See 250.52(A)(7)
- Required to be buried not less than **762 mm (2 ½ ft)** below the surface of the earth *[see 250.53(H)]*

Other Local Metal Underground Systems or Structures as Electrodes

- If none of the grounding electrodes described at 250.52(A)(1 through (A)(7) are present at the building or structure, "**other local metal underground systems or structures**" are permitted to be used in the grounding electrode system
- This could include such things as:
  - Piping systems
  - Underground tanks
  - Underground well casings that are not bonded to a metal water piping system(s)
- See 250.50 and 250.52(A)(8)

Supplemental Electrode

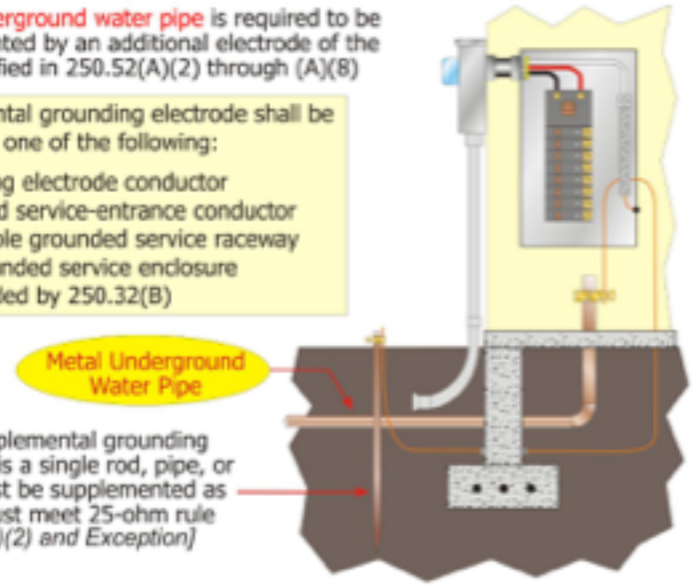
- An **underground metal water pipe** electrode is required to be supplemented by an additional grounding electrode
- Any of the electrodes described in 250.52(A)(2) through (A)(8) are permitted to be used *(not limited to just a ground rod)*
- If the supplemental electrodes are of the rod, pipe, or plate types, these must be supplemented as well or must meet the 25 ohm rule at 250.53(A)(2), Exception
- See 250.53(D)(2)

250.53(D)(2) Supplemental Electrode Connection

Metal underground water pipe is required to be supplemented by an additional electrode of the type specified in 250.52(A)(2) through (A)(8)

Supplemental grounding electrode shall be bonded to one of the following:

- Grounding electrode conductor
- Grounded service-entrance conductor
- Nonflexible grounded service raceway
- Any grounded service enclosure
- As provided by 250.32(B)



If the supplemental grounding electrode is a single rod, pipe, or plate, must be supplemented as well or must meet 25-ohm rule *[250.53(A)(2) and Exception]*

Size of Bonding Jumper for Grounding Electrode System

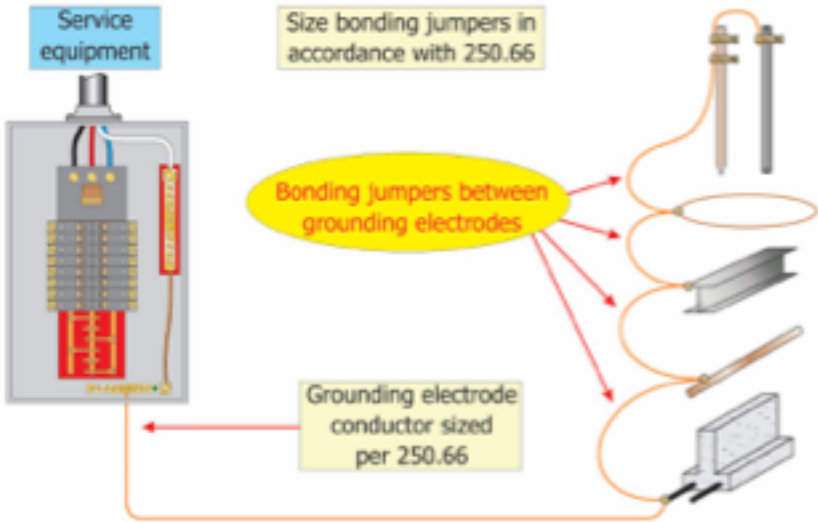
- **Bonding jumper(s)** used to connect grounding electrodes of the grounding electrode system together required to be installed in accordance with the requirements of 250.64(A), (B), and (E)
- Bonding jumper(s) used to bond grounding electrodes together required to be sized in accordance with 250.66
- Sizes based on the size of ungrounded service-entrance conductors
- Connections to be made in a manner specified in 250.70
- See 250.53(C)

Size of Bonding Jumper for Grounding Electrode System *(cont.)*

- Conductor(s) connecting grounding electrodes together is a **bonding conductor** *(not a grounding electrode conductor)*
- These bonding conductors not required to be installed in "one continuous length" *(as per grounding electrode conductors)*
- Conditions for sizing the grounding electrode conductor at **250.66(A), (B), and (C)** apply for sizing of these bonding jumpers

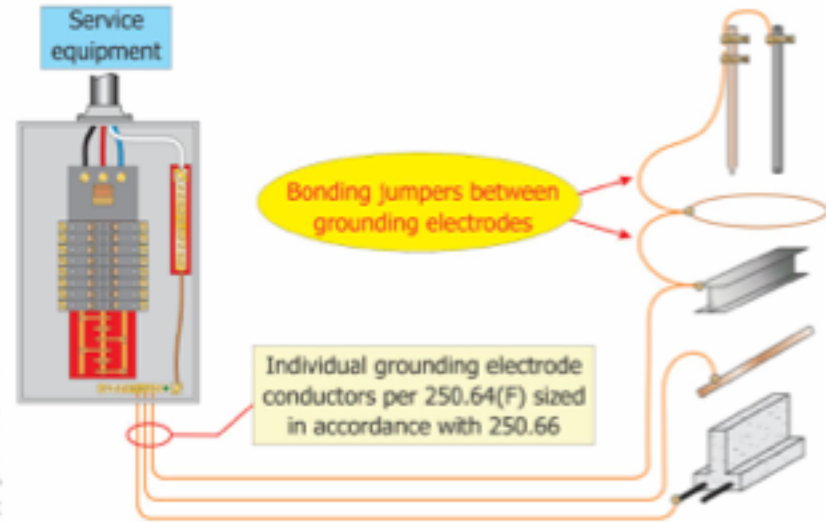
Bonding Jumper(s) for Grounding Electrode System

Grounding electrodes connected together with bonding jumpers that are installed in accordance with 250.64(A), (B), and (E)



Individual Grounding Electrode

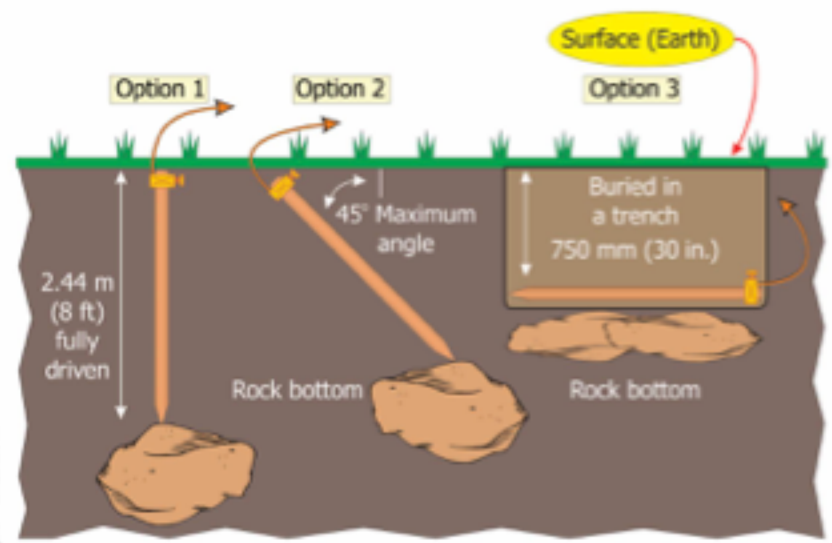
Individual grounding electrode conductor(s) are permitted to be run to any convenient grounding electrode in the grounding electrode system



Installation of Rod and Pipe Electrodes

- **Rod and pipe electrodes** required to be installed with least **2.44 m (8 ft)** is in contact with the soil
- Required to be **driven vertically** unless rock bottom is encountered
- If rock bottom is encountered *(preventing rod or pipe from being driven 2.44 m (8 ft) vertically)*, rod or pipe permitted to be installed at an **oblique angle** of not more than **45 degrees** from vertical
- Where driven at an angle cannot be achieved, only then can the rod or pipe be **buried in a trench** that is at least **750 mm (30 in.)** deep
- See 250.53(G)

Installation of Rod or Pipe Electrodes

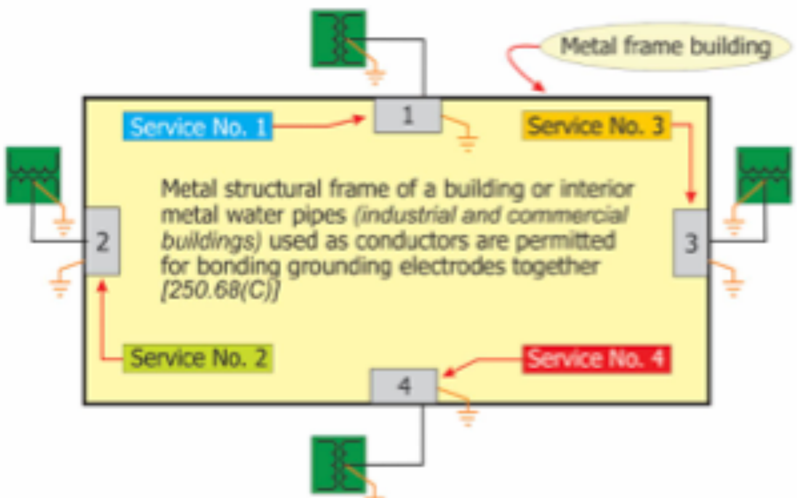


250.53(G)

Common Grounding Electrode

- Where more than one service supplies a building or structure, often there are more than one utility transformer or source *(which can have differences of potential between them)*
- Where more than one service are installed in the same building or structure, they must use the same grounding electrode system
- **Common grounding electrode** required to be used for all ac system grounding in or at a building or structure
- Where two or more grounding electrodes are bonded together, considered to be a **single grounding electrode system**
- See 250.58 and 250.50

250.58 Common Grounding Electrode

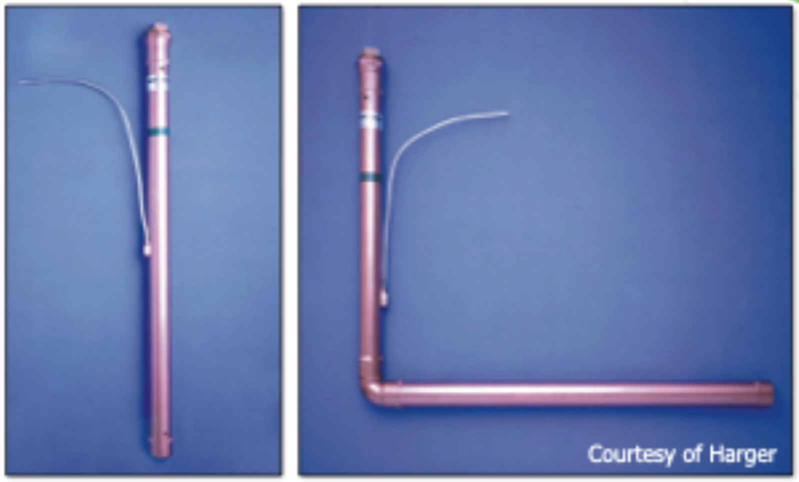


The same grounding electrode(s) must be used for all services, feeders, and branch circuits. Two or more electrodes bonded together are considered one grounding electrode system [250.58]

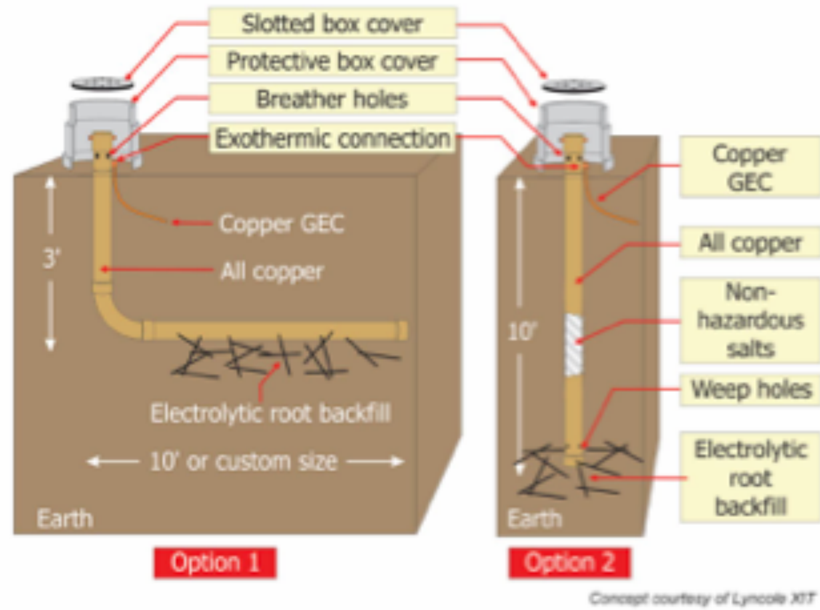
Enhanced Grounding Electrodes

- Minimum requirements for grounding electrodes for use in grounding services, systems, and equipment are covered in Part III of Article 250
- Ever-increasing installations using **information technology equipment** and **sensitive electronics** sometimes drive the need to exceed the minimum requirements established for safety of persons and property
- Installing electrodes or electrode systems that are extensive in nature and designed to establish and maintain a **lower level of resistance** to earth through the electrode or electrode system can accomplish this need
- Listed products are available to accomplish this additional grounding when desired for the electrical system
- Provisions for **other listed electrodes** are addressed at 250.52(A)(6)

Enhanced Grounding Electrodes



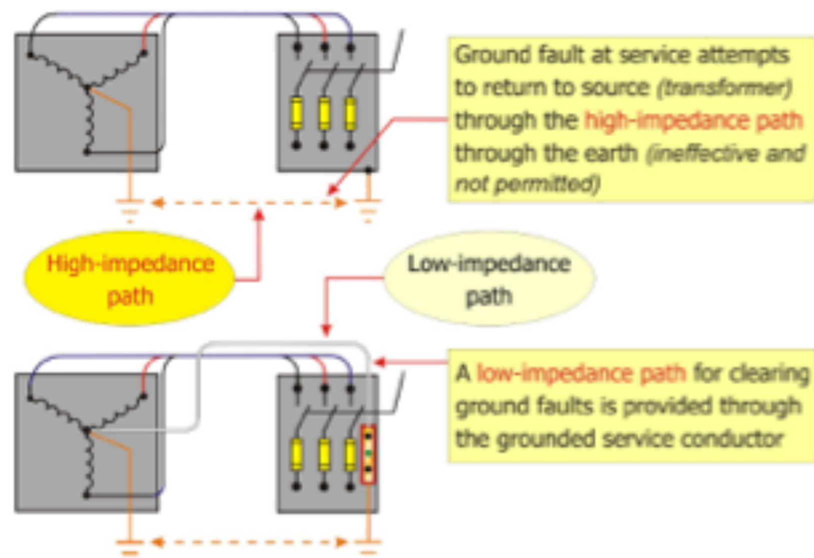
Enhanced Grounding Electrode - Anatomy



Earth Prohibited as Return Path

- In discussing grounding electrodes, notice that no mention is made for providing a low-resistance, low-impedance common grounding electrode path for clearing ground faults
- The high impedance of the earth makes it an **ineffective path** for the levels of current common to power systems
- The earth should never be used as a ground fault current path, as it is a very poor conductor
- See 250.4(A)(5)

250.4(A)(5) Earth Return Prohibited



Resistance of Grounding Electrodes

- No requirement in the *Code* that all grounding electrodes meet any maximum resistance to ground
- It is expected that the grounding electrode system will have a resistance to ground of **25 ohms or less**
- The *Code* specifies a resistance of 25 ohms or less *only* for single rod, pipe, or plate electrode(s)
- Where the resistance of a single rod, pipe, or plate electrode exceeds 25 ohms, required to be **supplemented** by an additional electrode *(other than a metallic water pipe electrode)*

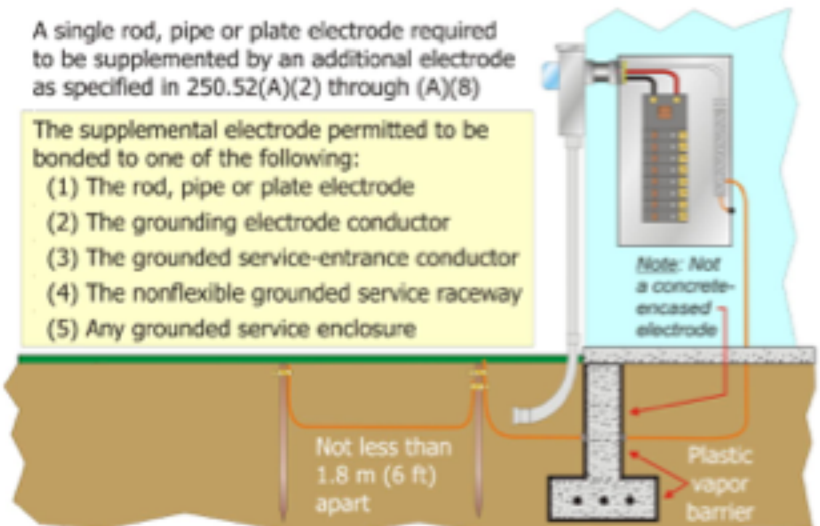
Resistance of Grounding Electrodes *(cont.)*

- Rod, pipe and plate electrodes must be **supplemented** by additional electrode *[250.53(A)(2)]*
- Exception provides that where a single rod, pipe, or plate electrode has a resistance to ground of **25 ohms or less** then no supplemental electrode is required
- Where driven ground rods are installed, two ground rods would be the maximum required under any condition
- No requirement that additional electrodes *(such as ground rods or plates)* be installed until the 25 ohms-to-ground resistance is obtained

250.53(A) Rod, Pipe, and Plate Electrodes

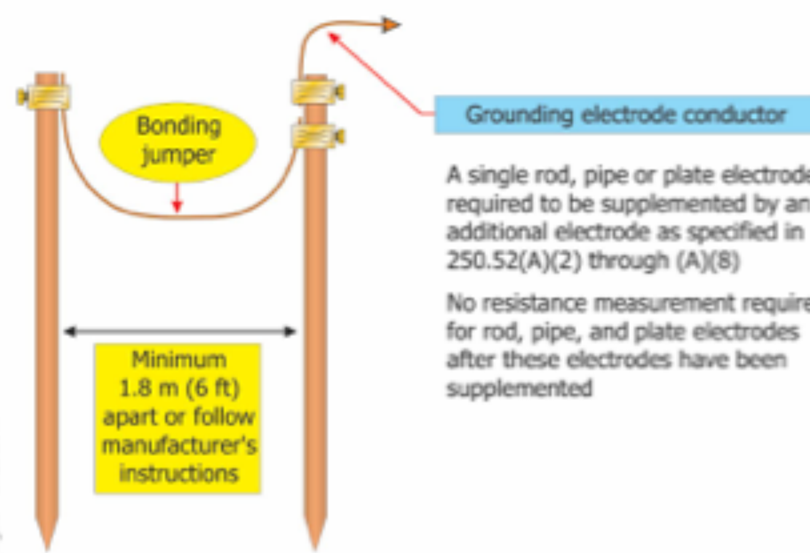
A single rod, pipe or plate electrode required to be supplemented by an additional electrode as specified in 250.52(A)(2) through (A)(8)

The supplemental electrode permitted to be bonded to one of the following:
(1) The rod, pipe or plate electrode
(2) The grounding electrode conductor
(3) The grounded service-entrance conductor
(4) The nonflexible grounded service raceway
(5) Any grounded service enclosure



Exception: *If a single rod, pipe, or plate grounding electrode has a resistance to earth of* ***25 ohms or less****, the supplemental electrode shall not be required*

Resistance of Rod, Pipe, and Plate Electrodes



A single rod, pipe or plate electrode required to be supplemented by an additional electrode as specified in 250.52(A)(2) through (A)(8)

No resistance measurement required for rod, pipe, and plate electrodes after these electrodes have been supplemented

Resistance of Rod, Pipe, and Plate Electrodes

A single rod, pipe or plate electrode required to be supplemented by an additional electrode as specified in 250.52(A)(2) through (A)(8)

Exception: *If a single rod, pipe, or plate grounding electrode has a resistance to earth of* ***25 ohms or less****, the supplemental electrode shall not be required*

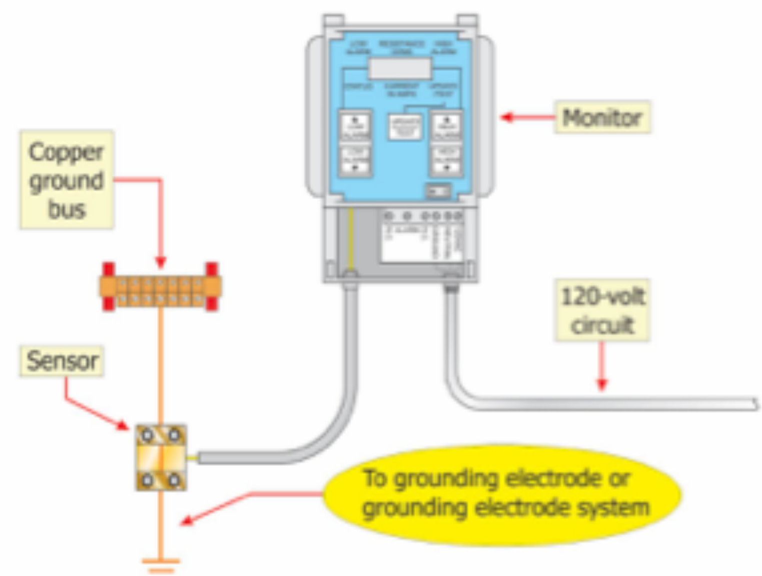
Ground Electrode System Monitoring

- **Grounding electrode system monitoring** has become common where **information technology equipment** and other **sensitive electronic equipment** are utilized
- Not required by the *Code*
- Often desired as an **essential performance option** for data centers and similar facilities
- Measures grounding system performance on an ongoing basis
- Provides an early warning of ground system degradation or loss of integrity so remedial action can be taken
- Grounding is an integral part of safety as well as center of lightning protection and surge suppression systems

Ground Electrode System Monitoring *(cont.)*

- Features of **grounding electrode system monitoring systems** include but are not limited to:
  - Ongoing monitoring of ground system resistance and current
  - Remote reading and control capability
  - Local audible alarm
  - High and low alarm values
  - Adjustable sampling rate

Ground Resistance Monitor System

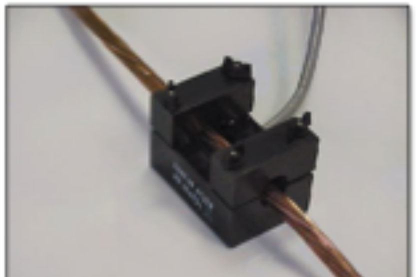


Concept courtesy of Lyncole XIT

Ground Electrode System Monitoring

Monitor

Sensor



Courtesy of Lyncole XIT

Ground Electrode Resistance

- Grounding electrodes maintain a reference potential for:
  - Instrument safety
  - Protect against static electricity,
  - Limit the system-to-frame voltage for operator safety
- Ground resistance should be zero ohms *(ideally)*
- Low ground resistance is essential to meet *NEC*, OSHA, and other electrical safety standards

Ground Electrode Resistance *(cont.)*

- Resistance of the electrode has the following components:
  - Resistance of the metal and that of the connection to it
  - Contact resistance of the surrounding earth to the electrode
  - Resistance in the surrounding earth to current *(earth resistivity)*, which is often the most significant factor

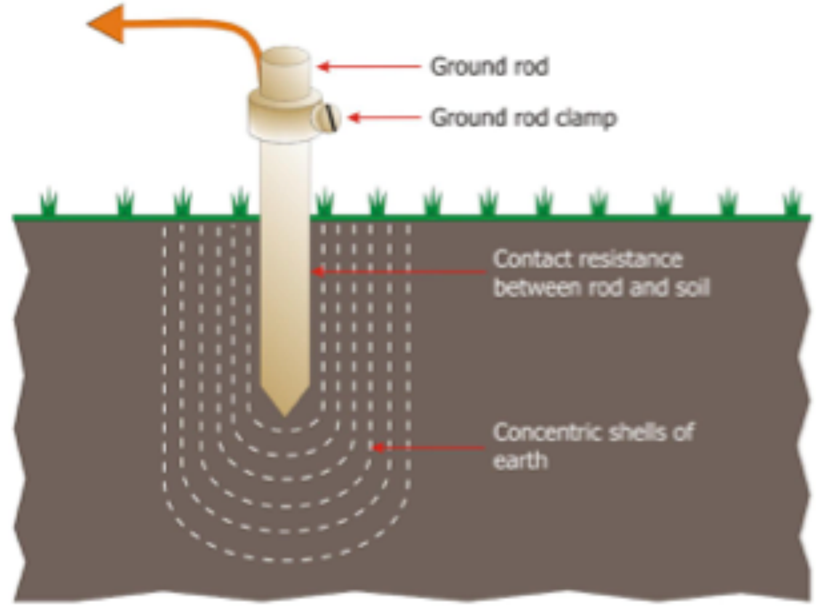
Ground Electrode Resistance *(cont.)*

- Grounding electrodes are usually made of very conductive material with adequate cross sections so overall resistance is negligible
  - Copper, copper clad, or zinc plated *(galvanized)*
- NIST *(National Institute of Standards and Technology)* has demonstrated that resistance between the surrounding earth and the electrode is negligible if electrode is:
  - Free of paint, grease or other coating and…
  - Earth is firmly packed

Ground Electrode Resistance (cont.)

- The electrode can be thought of as being surrounded by **concentric shells of earth** or soil, all of the same thickness
- Closer the shell is to the electrode, the smaller its surface ***(greater its resistance)***
- Farther away the shells are from the electrode, the greater the surface of the shell ***(lower the resistance)***

Ground Rod Resistance

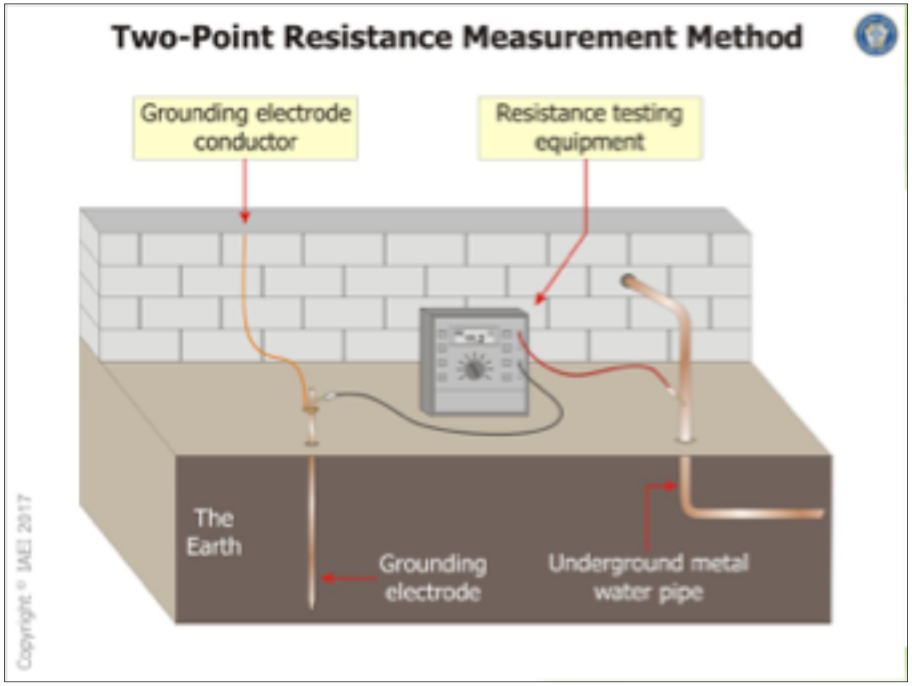


Maximum Resistance of Grounding Electrodes

- No maximum resistance for a grounding electrode system
- Maximum **25 ohms** for single electrodes of the rod, pipe, or plate types when not supplemented *[250.53(A)(2), Ex.]*
- Rod, pipe, or plate electrode required to be supplemented by an additional electrode
- When supplemented, no maximum earth resistance for the rod, pipe, or plate electrode(s) *(no 25 ohms rule)*

Grounding Electrode Resistance Testing

- Measurement of ground resistances can only be accomplished with specially designed test equipment
- Most ground resistances instruments use the **fall-of-potential principle** of alternating current (ac) circulating between an auxiliary electrode and the grounding electrode under test
- Reading will be given in ohms
- Ohms represent the resistance of the ground electrode to the surrounding earth
- Some manufacturers of earth resistance testing instruments have recently introduced clamp-on ground resistance testers


Two-Point Resistance Measurement Method
Grounding electrode conductor
Resistance testing equipment
The Earth
Grounding electrode
Underground metal water pipe
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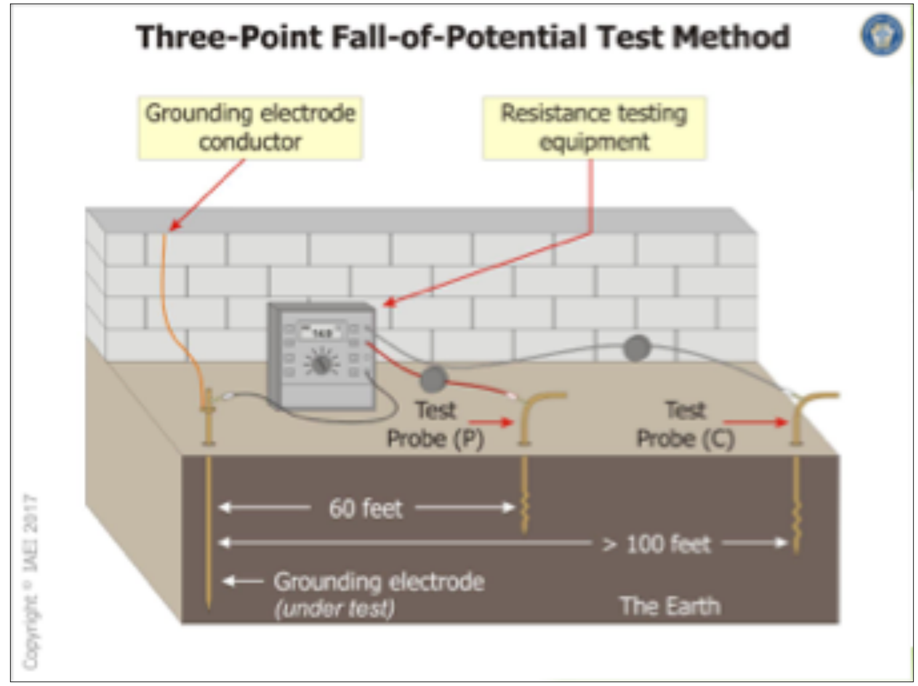
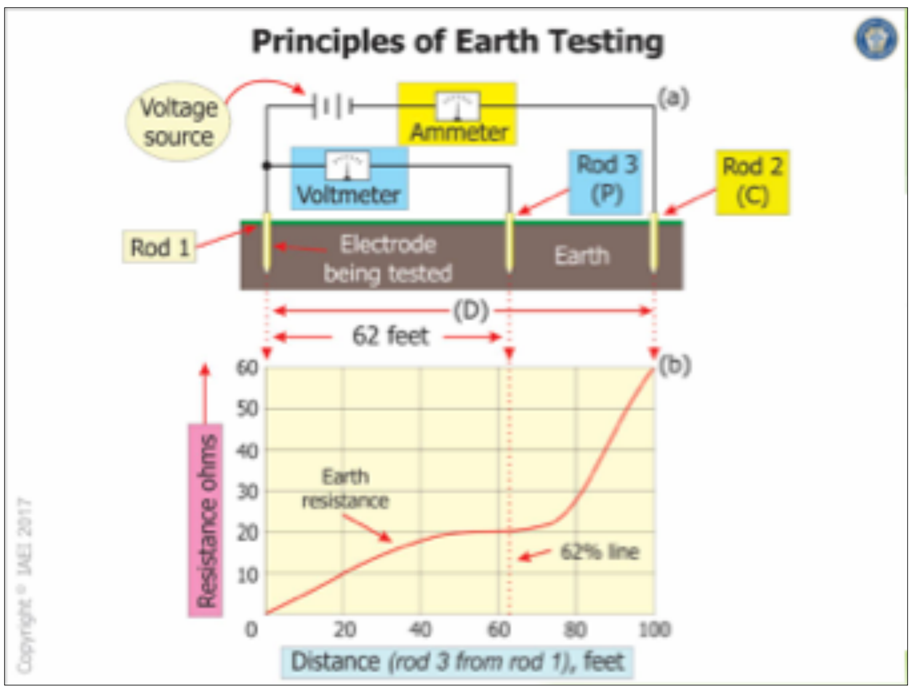

Three-Point Fall-of-Potential Test Method
Grounding electrode conductor
Resistance testing equipment
Test Probe (P)
Test Probe (C)
60 feet
> 100 feet
Grounding electrode (under test)
The Earth
Copyright © IAEI 2017


Principles of Earth Testing
Voltage source
Ammeter
Voltmeter
(a)
Rod 3 (P)
Rod 2 (C)
Rod 1
Electrode being tested
Earth
(D)
62 feet
(b)
Resistance ohms
60
50
40
30
20
10
0
Earth resistance
62% line
20
40
60
80
100
Distance (rod 3 from rod 1), feet
Copyright © IAEI 2017


Ground Resistance Clamp-on Tester
Digital earth test clamp
Courtesy of Megger
Megger
Copyright © IAEI 2017

Objectionable Currents

- The term ***objectionable current*** is not defined
- Steps permitted to correct objectionable currents:
  - Due to multiple grounding connections, abandon one or more, but not all
  - Change location of grounding connection
  - Interrupt continuity of grounding conductor or conductive path causing the objectionable current
  - Other means acceptable to the authority having jurisdiction
- See 250.6

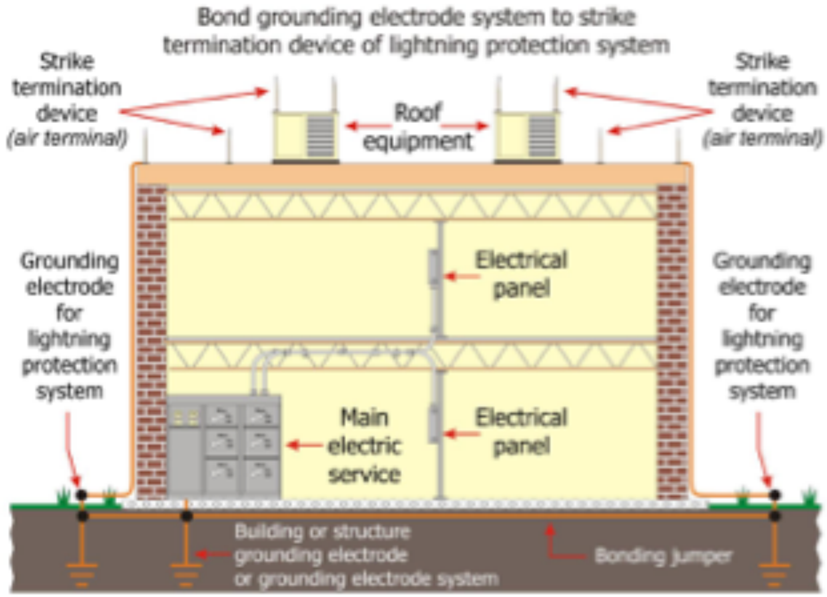
Lightning Protection System

- Lightning protection systems should be installed in accordance with **NFPA-780, *Standard for the Installation of Lightning Protection Systems***
- The *Code* prohibits the use of driven pipes, rods, or other electrodes installed for connection of the lightning protection conductors and strike termination devices in place of the grounding electrodes required for a wiring system and for equipment
- See 250.60

Lightning Protection System *(cont.)*

- Note that where two grounding electrodes are installed, they are required to be bonded together
- Lightning protection grounding electrode system *required* be bonded to the building or structure power grounding electrode system
- See 250.106

Bonding of Grounding Systems Together



Chapter Seven: Grounding Electrode Conductors

- General requirements and definitions for grounding electrode conductors
- Functions of the grounding electrode conductor
- Sizing grounding electrode conductors
- Grounding electrode conductor installation
- Grounding electrode conductor connections
- Material and protection for grounding electrode conductors

Grounding Electrode Conductors

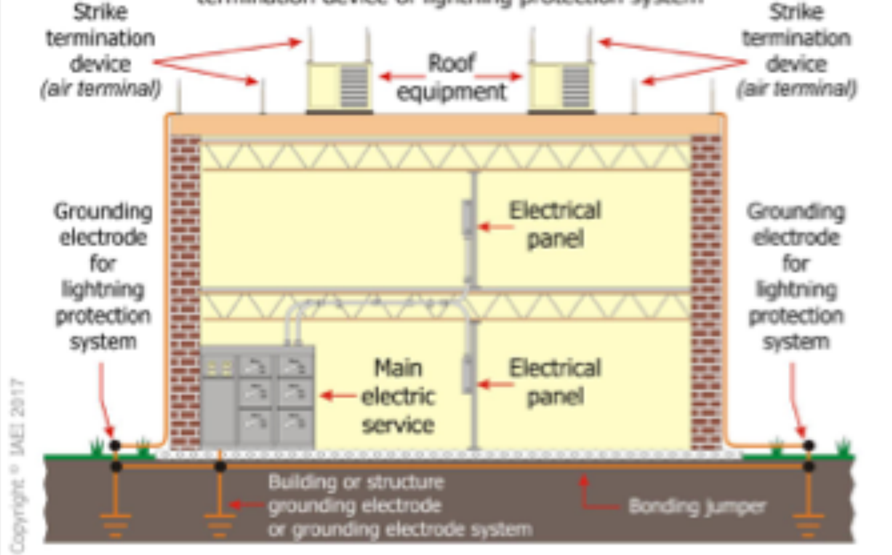
- ***Grounding electrode conductors*** used to connect the following to a grounding electrode or a point on grounding electrode system:
  - Electrical system grounded conductor
  - Equipment grounding conductor
  - or both,
- Required to be sized per Table 250.66 based on size of the service-entrance conductors or largest derived ungrounded conductors of a separately derived system
- Not required to exceed **3/0 AWG copper** or **250-kcmil aluminum** or copper-clad aluminum

Grounding Electrode Conductors *(cont.)*

- Specific requirements for ***grounding electrode conductors*** given regarding:
  - Conductor material
  - Installation procedures
  - Protection from physical damage
  - Connection procedures

Bonding of Grounding Systems Together

Bond grounding electrode system to strike termination device of lightning protection system



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Grounding Electrode Conductors

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Grounding Electrode Conductors *(cont.)*

- Specific requirements for ***grounding electrode conductors*** given regarding:
  - Conductor material
  - Installation procedures
  - Protection from physical damage
  - Connection procedures

Definitions

- ***Grounding Electrode Conductor:*** A conductor used to connect the system grounded conductor or the equipment to a grounding electrode or to a point on the grounding electrode system.

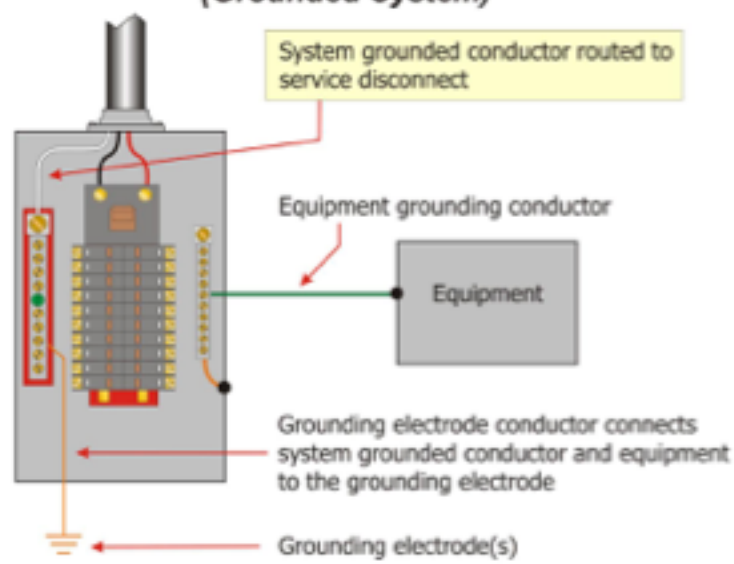
Function of Grounding Electrode Conductor

- In a **grounded system**, GEC is the sole connection from the grounding electrode to the grounded system conductor *(may be a neutral)* and the equipment grounding conductor(s)
- For an **ungrounded system**, sole connection from the grounding electrode to the service equipment or building disconnect enclosure and to the equipment grounding conductor(s)
- See 250.24(A), (D), and (E)

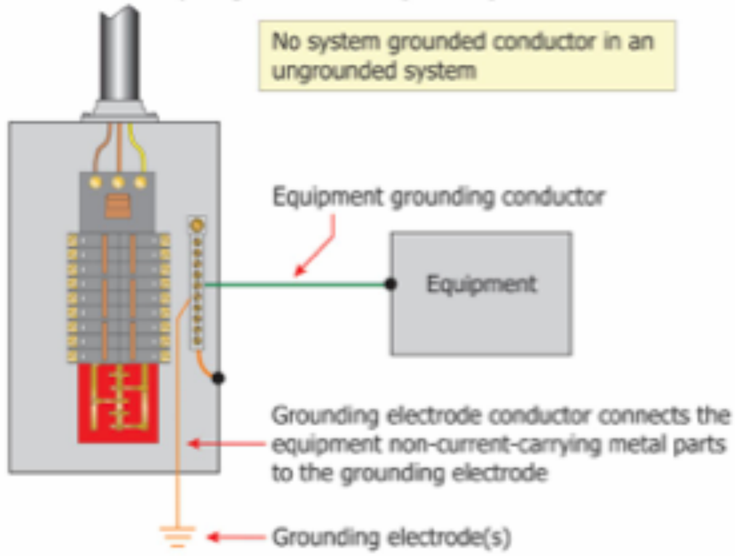
Function of Grounding Electrode Conductor *(cont.)*

- A **single grounding electrode conductor** is required to connect both the system grounded conductor and the equipment grounding conductor
- Example: one grounding electrode conductor cannot be used to ground the system grounded conductor and a second grounding electrode conductor be used to ground the equipment grounding conductor *(even though both grounding electrode conductors are connected to the same grounding electrode)*

Grounding Electrode Conductor *(Grounded System)*



Grounding Electrode Conductor
(Ungrounded System)



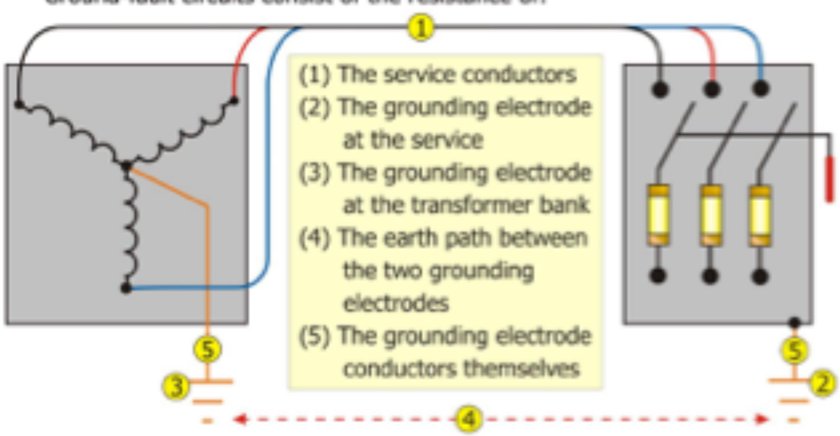
Current in Grounding Electrode Conductor

- The maximum amount of current in a grounding electrode conductor is directly related to the **impedance** in the ground return path to the source
- Dependent on the sum of **resistance** in ground return path:
  - Grounding electrode conductor *(service) plus*
  - Grounding electrode *(service) plus*
  - Earth *plus*
  - Grounding electrode *(source) plus*
  - Grounding electrode conductor *(source)*
- GEC has little or no effect in clearing ground faults

High Impedance Earth Return

Maximum current of ground fault is limited by the high-impedance series circuit through grounding electrodes and the earth

Ground-fault circuits consist of the resistance of:



Higher impedance in the path results in a lower amount of current over that particular path back to the source

Sizing Grounding Electrode Conductors

- The minimum size of the grounding electrode conductor is based on the largest ungrounded service-entrance conductor or derived phase conductor from a separately derived system
- Refer to 250.66 and Table 250.66
- Scan down left column and find the size of the service-entrance conductor being installed
- Scan across the row to find the size of copper, aluminum, or copper-clad aluminum grounding electrode conductor

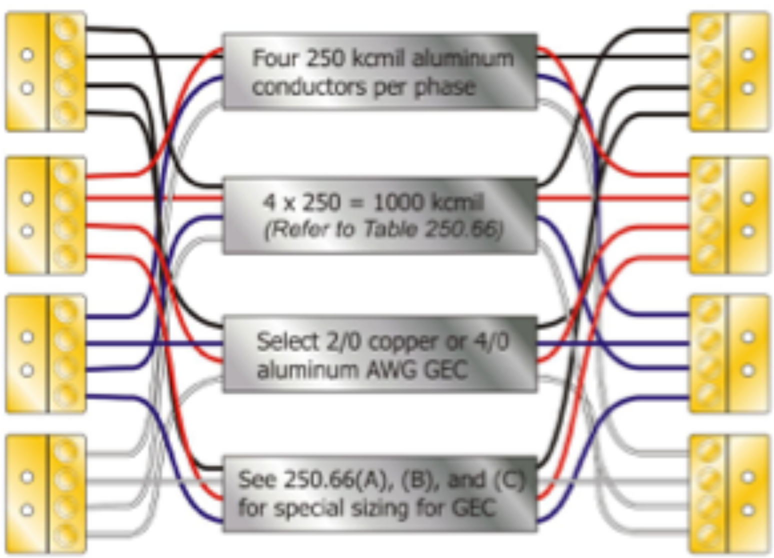
Table 250.66 Grounding Electrode Conductor for Alternating-Current Systems

Size of Largest Ungrounded Service-Entrance Conductor or Equivalent Area for Parallel Conductors (AWG/kcmil)		Size of Grounding Electrode Conductor (AWG/kcmil)	
Copper	Aluminum or Copper-Clad Aluminum	Copper	Aluminum or Copper-Clad Aluminum
2 or smaller	1/0 or smaller	8	6
1 or 1/0	2/0 or 3/0	6	4
2/0 or 3/0	4/0 or 250	4	2
Over 3/0 through 350	Over 250 through 500	2	1/0
Over 350 through 600	Over 500 through 900	1/0	3/0
Over 600 through 1100	Over 900 through 1750	2/0	4/0
Over 1100	Over 1750	3/0	250

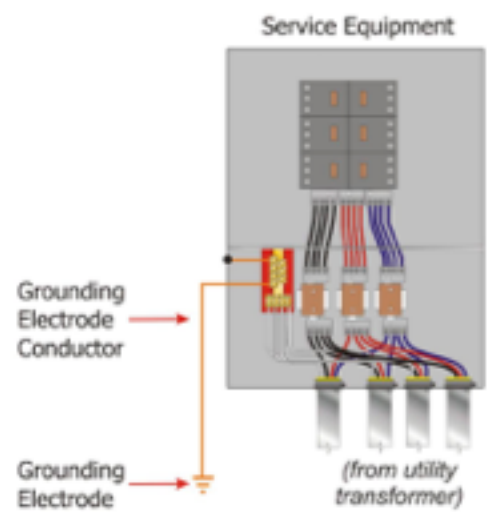
Sizing Grounding Electrode Conductors

- Where service-entrance **conductors are installed in parallel** as allowed by 310.10(H), the circular mil area of one set of parallel conductors is added together and treated as a single conductor for purposes of sizing GEC
- **Example:** Four 250-kcmil aluminum service-entrance conductors installed in parallel are considered to be a single 1000-kcmil aluminum conductor
- Reference Table 250.66 for sizing of GEC for this set of service-entrance conductors

Grounding Electrode Conductor for Parallel Service-Entrance Conductors



Grounding Electrode Conductor for Parallel Service-Entrance Conductors



4- 250 Kcmil aluminum conductors per phase

4 X 250= 1000 Kcmil *(refer to Table 250.66)*

Select 2/0 copper or 4/0 aluminum AWG grounding electrode conductor *(GEC)*

See 250.66(A),(B) or (C) for special sizing requirments for GEC

Sizing Grounding Electrode Conductors

- Grounding electrode conductors are generally required to be not smaller than the values in Table 250.66
- Grounding electrode conductor or bonding jumper may be sized as follows where not extended on to other types of electrodes that require a larger size conductor:
  - Not required to be larger than 6 AWG copper or 4 AWG aluminum to **rod, pipe, or plate** type grounding electrodes *[250.66(A)]*
  - Not required to be larger than 4 AWG copper to **concrete-encased electrode** *[250.66(B)]*
  - Not larger than the **ground ring** conductor *[250.66(C)]*

Sizing Grounding Electrode Conductors (cont.)

- Bare aluminum conductors are not permitted where installed in direct contact with masonry or earth, or where subject to corrosive conditions *[250.64(A)]*
- Aluminum grounding electrode conductor terminations are not allowed within 450 mm (18 in.) of the earth *[250.64(A)]*

Sizing at Multiple Service Disconnects

- Three methods permitted by the *NEC* for connections of grounding electrode conductor taps to a **common grounding electrode conductor** where multiple service disconnects are installed [250.64(D)(1), (2), and (3)]
  - Taps to common grounding electrode conductor
  - Individual conductors to grounding electrode(s)
  - Connection at common location

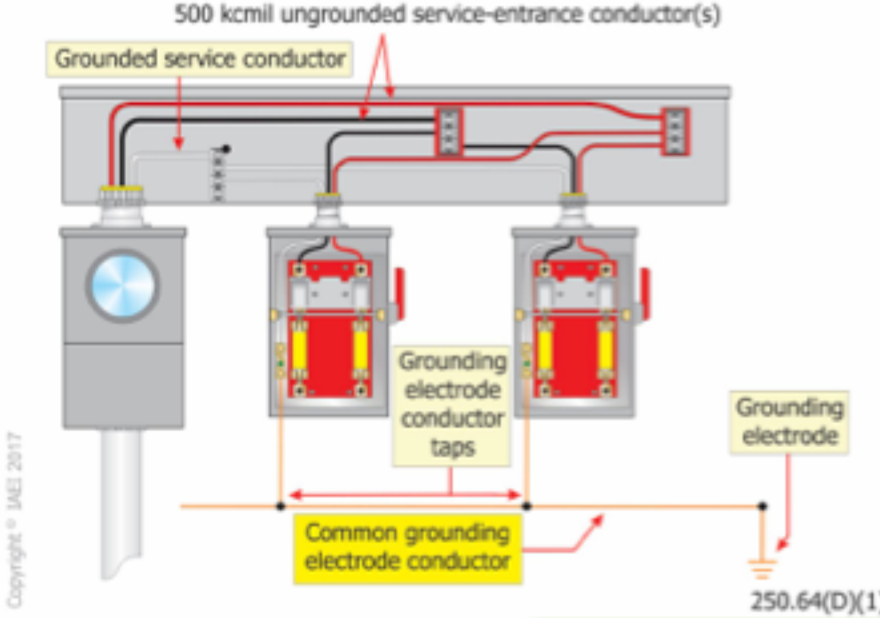
Sizing Common Grounding Electrode Conductor and Taps

- Single GEC permitted to serve separate enclosures
- Common GEC sized based on main service-entrance conductors
- Tap conductors sized based on individual service-entrance conductors supplying each service disconnect *(connected from each service disconnect to the common grounding electrode)*
- See 250.64(D)(1)

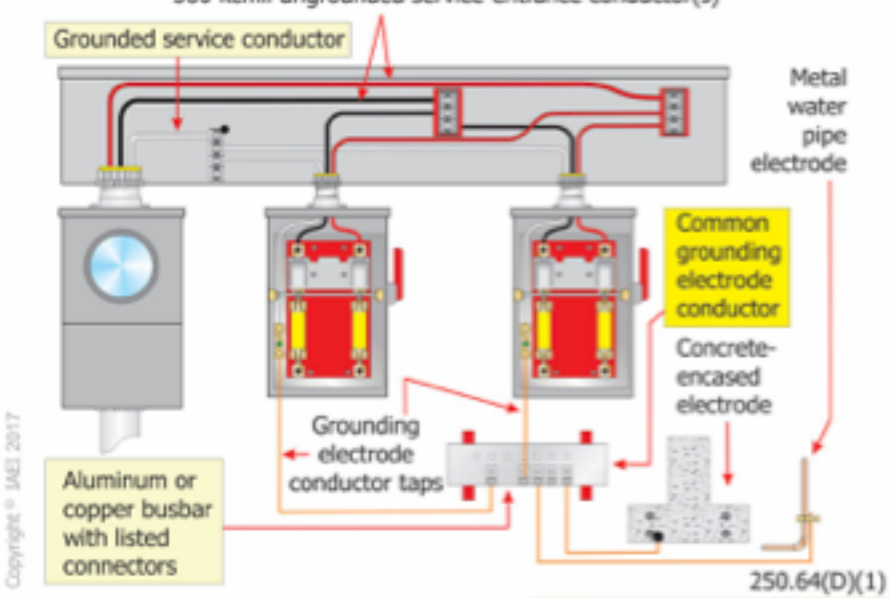
Sizing Common Grounding Electrode Conductor and Taps *(cont.)*

- Important to understand alternative provided at 250.64(D)(1) addresses two conductors;
  - **Common grounding electrode conductor**
    - Required to be installed without a splice or joint *(generally)*
  - **Grounding electrode conductor tap(s)**
    - Permitted to be connected to the common grounding electrode conductor

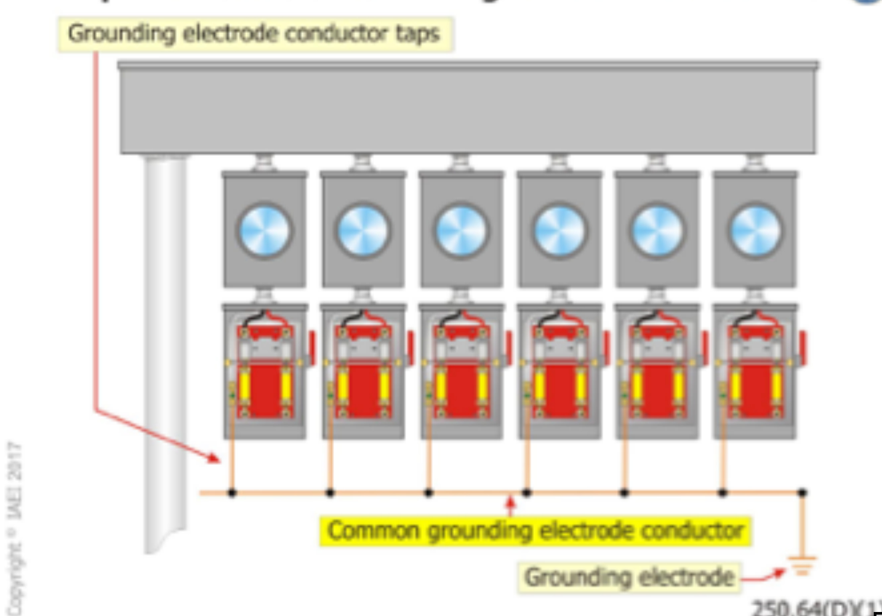
Taps to Common Grounding Electrode Conductor



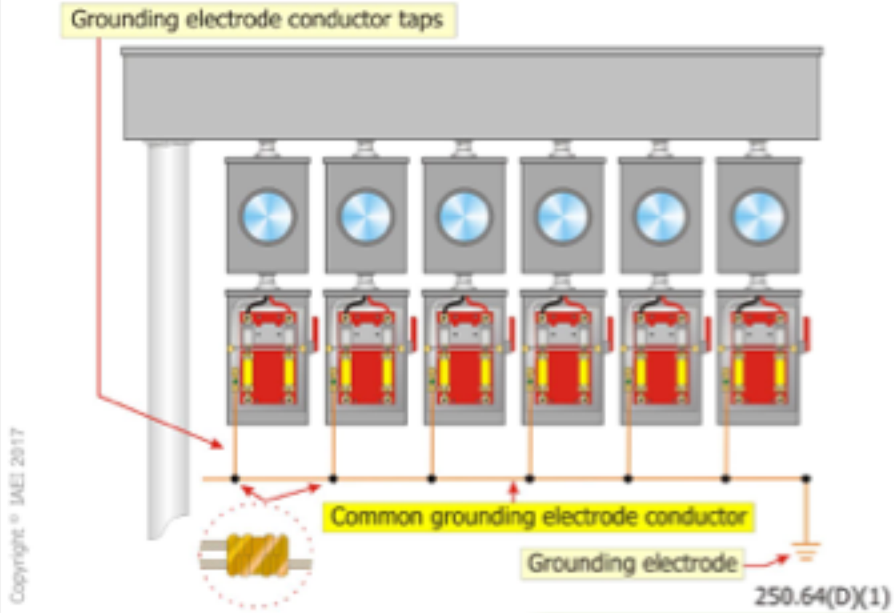
Taps to Common Grounding Electrode Conductor



Taps to Common Grounding Electrode Conductor



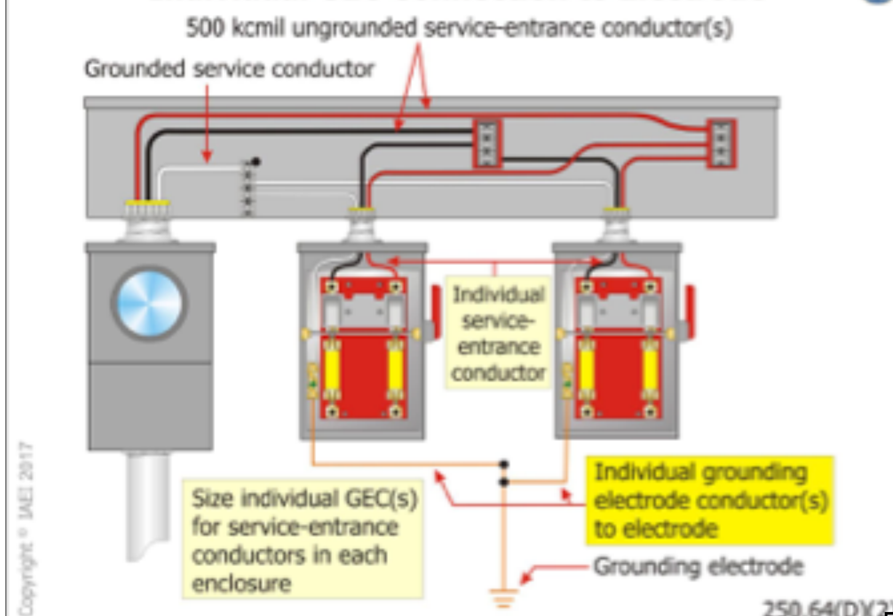
Taps to Common Grounding Electrode Conductor



Sizing Individual Grounding Electrode Conductors

- Permitted to install grounding electrode conductor from **individual service disconnects** to grounding electrode *(rather than being tapped to the common grounding electrode conductor)*
- Grounding electrode conductor sized for the service-entrance conductor serving each individual enclosure
- See 250.64(D)(2)

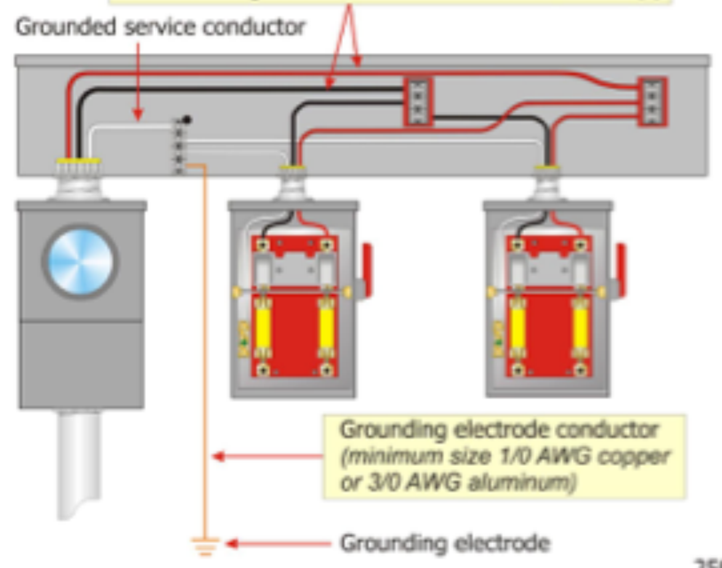
Individual GEC Connection to Electrode



Sizing at Common Location

- Permitted to install a **single grounding electrode conductor** to wireway or other **common location** to all connected individual service entrance conductors
- Example:
  - 500-kcmil copper service-entrance conductors with grounded conductor grounded inside the wireway
  - GEC to a water pipe or metal in-ground building steel electrode required to be 1/0 AWG copper or 3/0 AWG aluminum *(Table 250.66)*
- See 250.64(D)(3)

GEC Connection in Common Location *(Wireway)*



Grounding Electrode Conductor Connections

- The *Code* generally requires that the point of connection of grounding electrode conductors and bonding jumpers to grounding electrodes be made **accessible** *[see 250.68(A)]*
  - **Two exceptions** to this accessibility rule
- GEC connection must be made in a manner that will ensure a permanent and effective grounding path

Grounding Electrode Conductor Connections *(cont.)*

- All mechanical elements used to terminate a grounding electrode conductor or bonding jumper to a grounding electrode are generally required to be accessible
- An **encased or buried connection** to a concrete-encased, driven, or buried grounding electrode is **not required to be accessible** by 250.68(A) Ex. No. 1

Grounding Electrode Conductor Connections

Photo shows two different ground clamps that are permitted to be buried or concrete-encased *(not accessible)* as allowed by 250.68(A) Ex. No. 1

Grounding Electrode Conductor Connections *(cont.)*

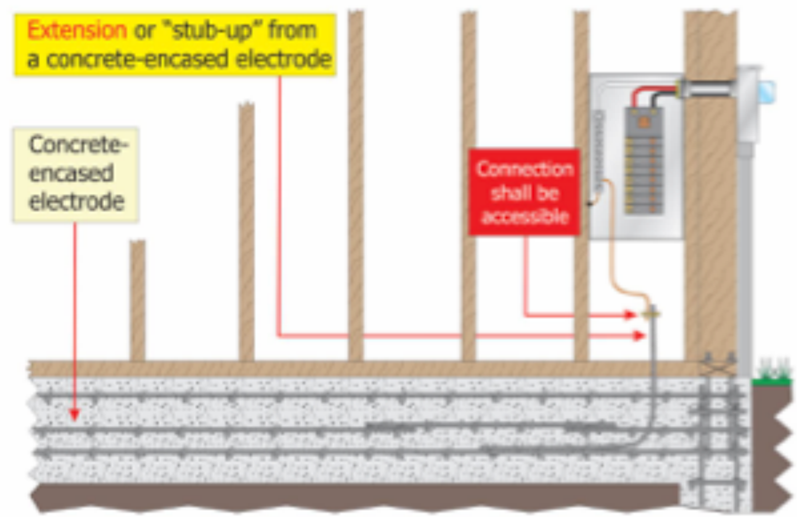
- All mechanical elements used to terminate a grounding electrode conductor or bonding jumper to a grounding electrode are generally required to be accessible
- **Exothermic or irreversible compression connections** used at terminations, together with the mechanical means used to attach such terminations to **fireproofed structural metal** whether or not the mechanical means is reversible, is **not required to be accessible** by 250.68(A) Ex. No. 2

GEC Connections from Extension at Concrete-Encased Electrode

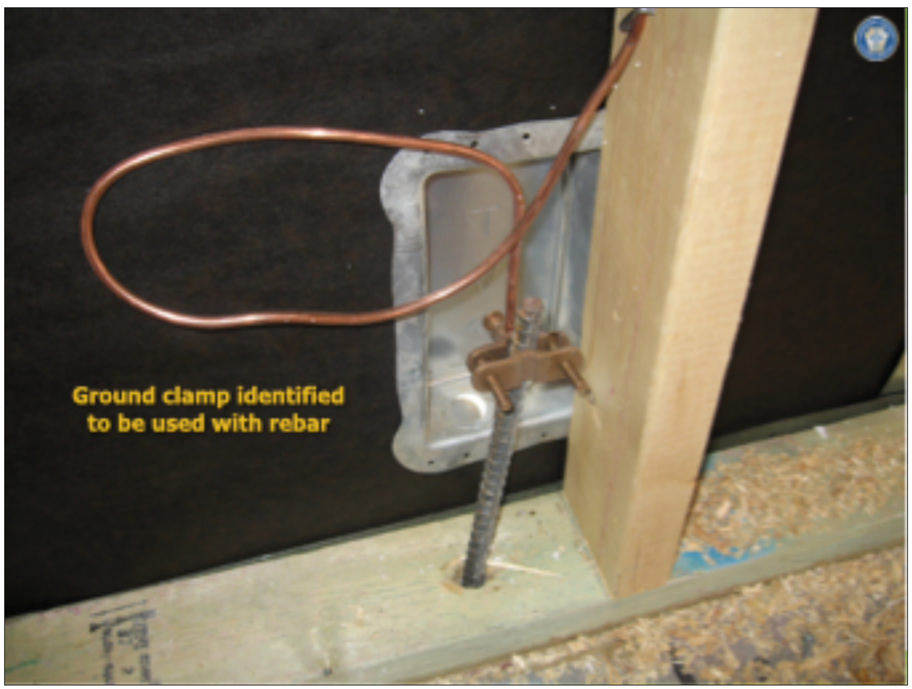
- Common practice to extend a rebar-type concrete-encased electrode out of the footing or foundation before the slab or foundation is poured
- Typically accomplished by using another piece of rebar connected to the concrete-encased electrode and **"stubbed-up"** out of the poured concrete to provide an accessible connection point above the slab
- GEC connection can be made after the foundation has been poured and cured
- Extension or "stub-up" is not part of the concrete-encased electrode
- Permitted by 250.68(C)(3)

Concrete-Encased Electrode Extension

A rebar extension from a concrete-encased electrode is recognized for connection to the grounding electrode

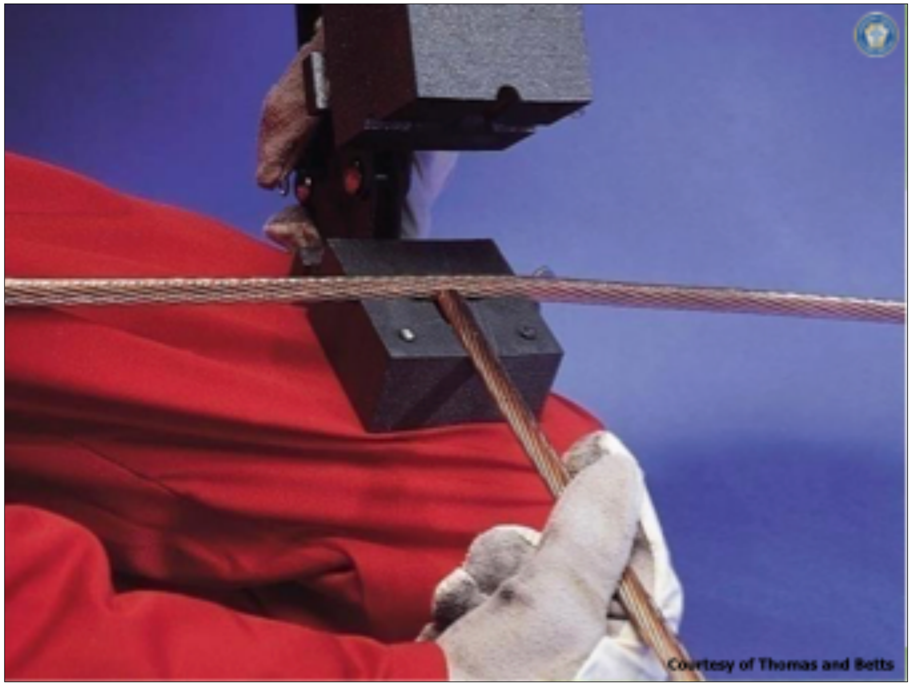


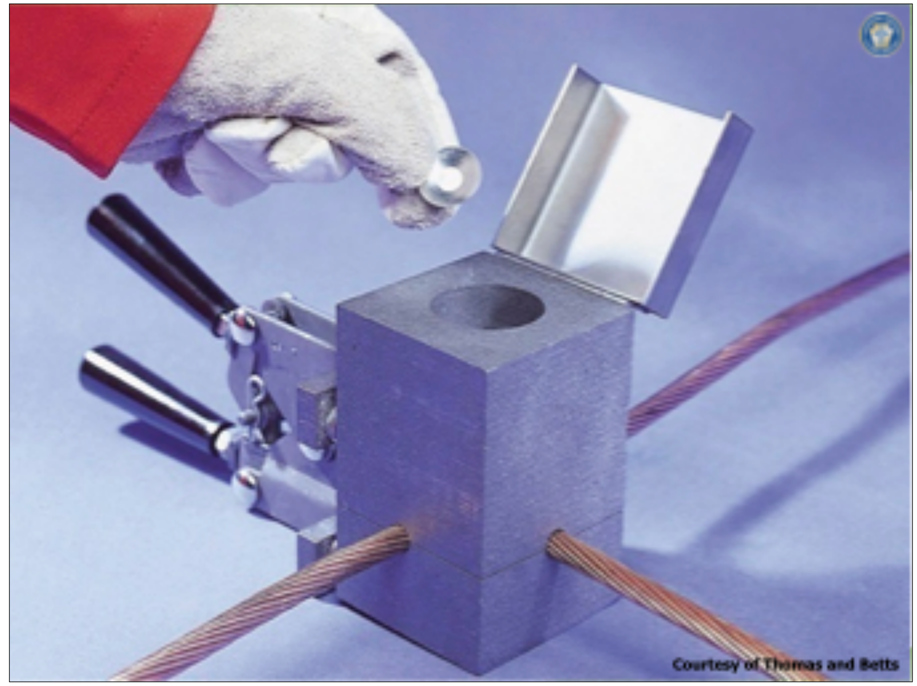
250.68(C)(3)



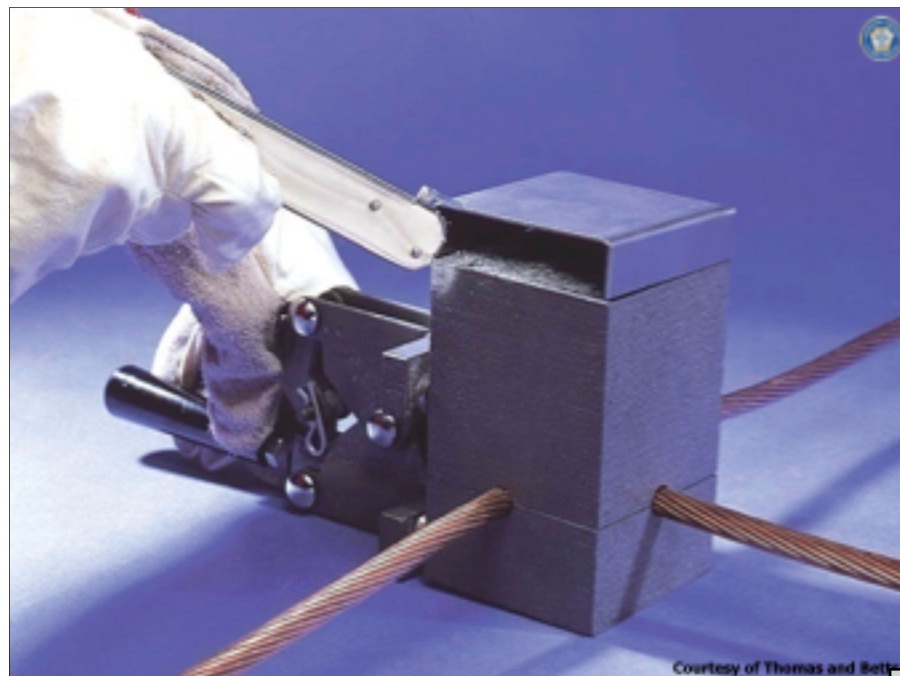
GEC Connections Using Exothermic Welding

- Specific rules for connections of GEC and bonding conductor to grounding electrodes are found at **250.70**
- Connections required to be made by:
  - Exothermic welding
  - Listed lugs
  - Listed pressure connectors
  - Listed clamps
  - Other listed means
- Only connection means not required to be listed are those made by **exothermic welding** *(listed exothermic weld connections are available)*


Courtesy of Thomas and Betts


Courtesy of Thomas and Betts


Courtesy of Thomas and Betts


Courtesy of Thomas and Betts

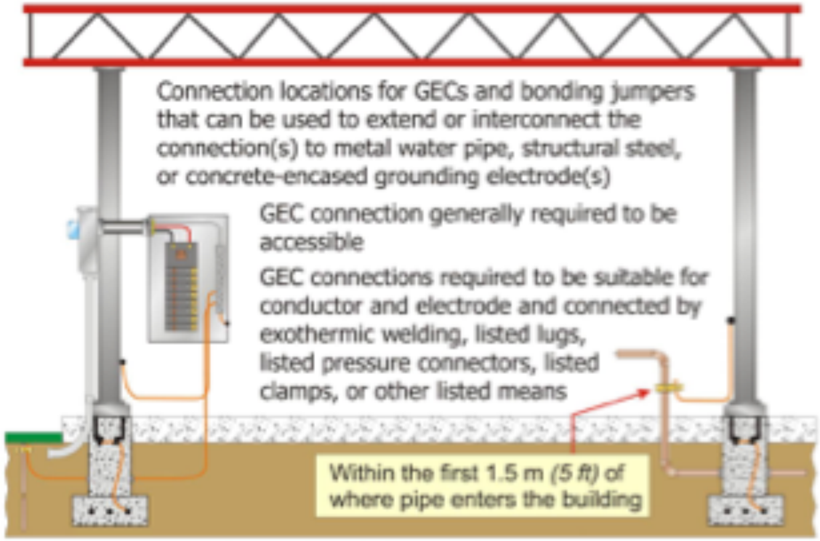
Grounding Electrode Conductor Connections *(cont.)*

- Grounding electrode conductors and bonding jumpers permitted to be connected at the following locations and used to extend the connection to an electrode(s):
  - **Interior metal water piping** located **not more than 1.52 m (5 ft)** from the point of entrance to the building
    - *See 250.68(C)(1)*
  - ***Exception*** *for industrial, commercial, and institutional buildings or structures beyond the first 1.52 m (5 ft) from the point of entrance to the building*
    - *See complete exception for details*

Grounding Electrode Conductor Connections *(cont.)*

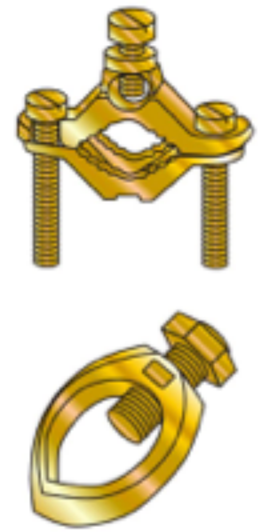
- Grounding electrode conductors and bonding jumpers permitted to be connected at the following locations and used to extend the connection to an electrode(s):
  - The **metal structural frame of a building**
    - *See 250.68(C)(2)*
  - A **concrete-encased electrode** of the rebar-type **extended from its location** within the concrete to an accessible location above the concrete
    - *See 250.68(C)(3)*

250.68 GEC and Bonding Jumpers Connections

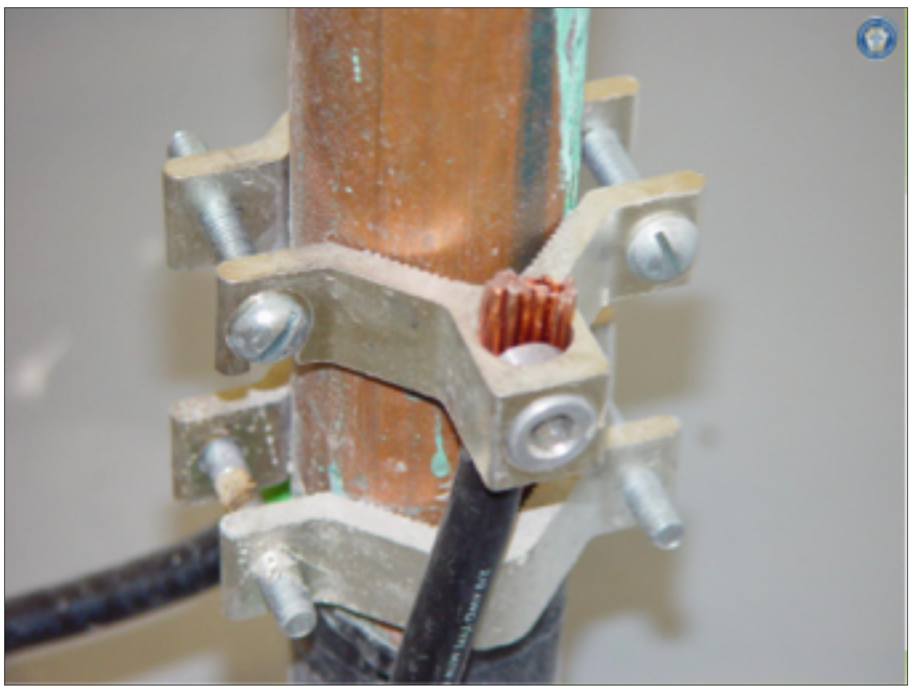


Structural metal frame of a building permitted as a bonding conductor to interconnect electrodes or as GEC

Ground Clamps Listed for Application



- Grounding electrode conductor connected to grounding electrode by exothermic welding, listed lugs, listed pressure connectors, listed clamps or other listed means
- Connection devices shall be listed for materials of the grounding electrode and grounding electrode conductor
- Shall be listed for direct burial where used on pipe, rod or other buried or concrete encased electrodes
- See 250.70



Courtesy of Thomas and Betts

Courtesy of Galvin Industries

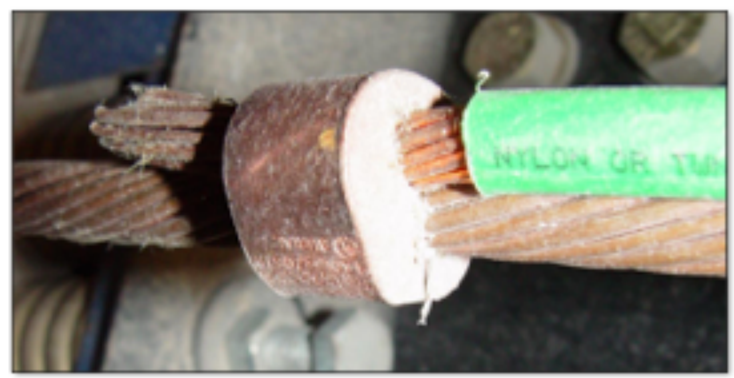
Courtesy of Thomas and Betts

Grounding Electrode Conductor Material

- Copper, aluminum, or copper-clad aluminum *[or the items as permitted in 250.68(C)]*
- Conductors of the wire type shall be:
  - Solid or stranded
  - Insulated, covered, or bare
- Aluminum and copper-clad aluminum grounding electrode conductors are not permitted to be terminated within 450 mm (18 in.) of the earth
- See 250.62 and 250.64(A)

Grounding Electrode Conductor Material *(cont.)*

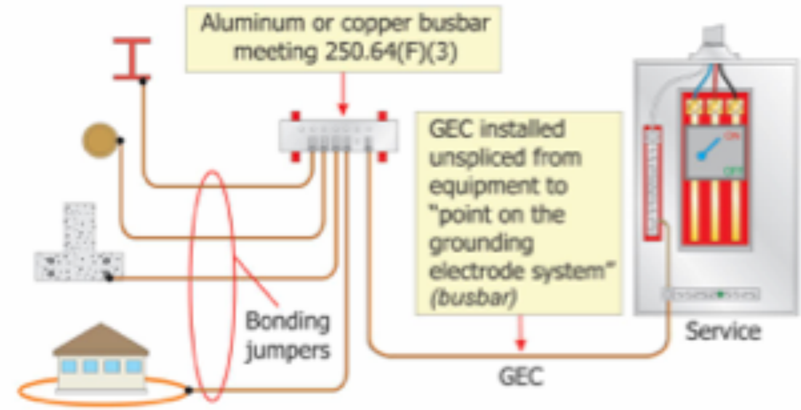
- **No specific color identification** for grounding electrode conductors but 250.119 permits the color **green** to be used for grounding and bonding conductors



Grounding Electrode Conductor Installation

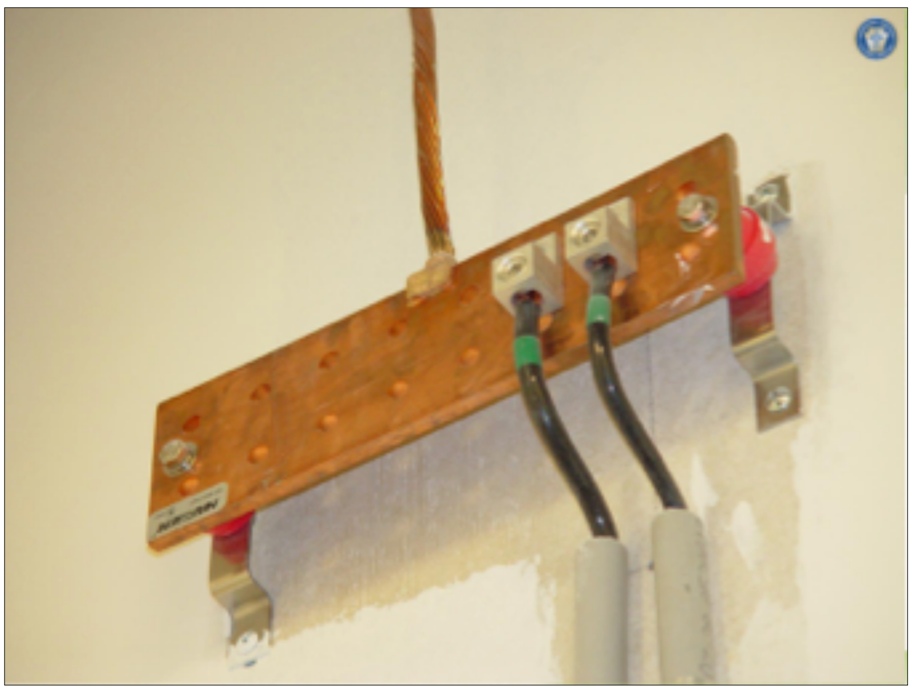
- Where grounding of systems, equipment or both are required, grounding electrode conductors are installed and connected to the grounding electrode system
- *Code* provides **installation requirements** for grounding electrode conductors where installed for services, separately derived systems, or for buildings or structures supplied by a feeder(s) or branch circuit(s)
- See 250.64

250.64(F) Installation to Electrode(s)



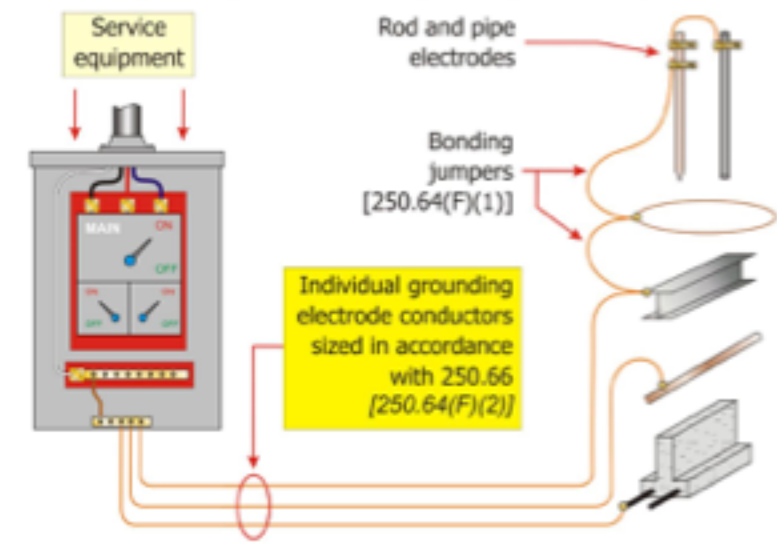
Bonding jumper(s) from grounding electrodes and grounding electrode conductors are permitted to be connected to copper or aluminum busbars to form the grounding electrode system

Connection to be made by a listed connector or by the exothermic welding process



Individual Grounding Electrode Conductor(s)

Individual grounding electrode conductor(s) are permitted to be run to any convenient grounding electrode in the grounding electrode system



GEC - Securing and Protection from Damage

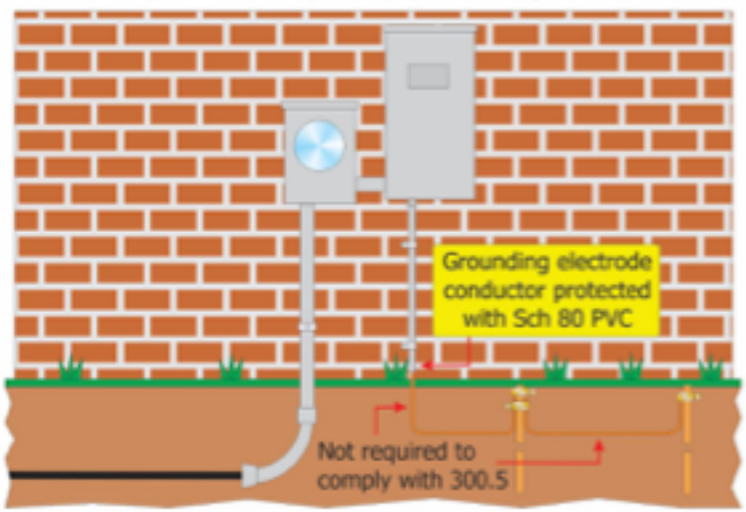
- When exposed, grounding electrode conductor(s) or enclosure(s) are required to be **securely fastened to surface**
- Grounding electrode conductors are permitted to be installed on or through framing members
- Where **not exposed to physical damage**, 6 AWG or larger permitted to run along the surface of the building without protection or metal covering
- Where **exposed to physical damage**, 6 AWG or larger required to be protected by installation in cable armor or raceway *(RMC, IMC, PVC, etc.)*
- Sizes **smaller than 6 AWG** required to be protected from physical damage by installation in cable armor or raceway

GEC - Securing and Protection from Damage *(cont.)*

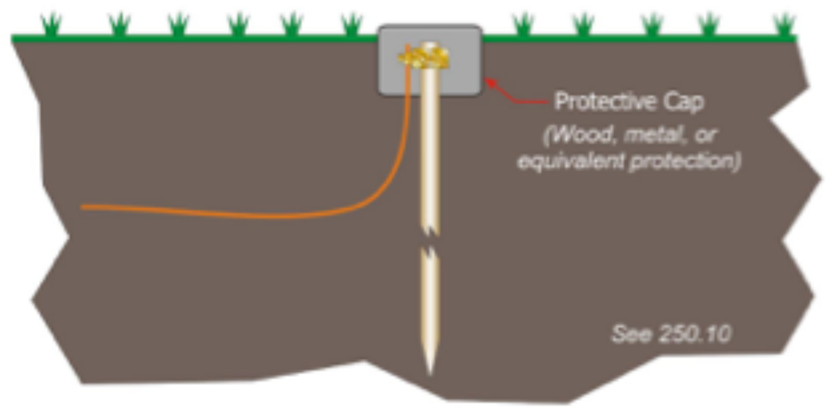
- Grounding electrode conductors and grounding electrode bonding jumpers in contact with the earth are **not required to comply with *300.5*** *(minimum burial depth requirements)*
- Must be buried or otherwise protected if subject to physical damage
- See 250.64(B)(4)

250.64(B)(4) GEC Installation

Grounding electrode conductors and GE bonding jumpers in contact with the earth not required to comply with 300.5, but shall be buried or otherwise protected if subject to physical damage



Protection of Ground Clamp Attachment



Ground clamp to be approved for general use without protection or be protected from physical damage as follows:
- (1) installed where they are not likely to be damaged or
- (2) enclosed in metal, wood, or equivalent protective covering

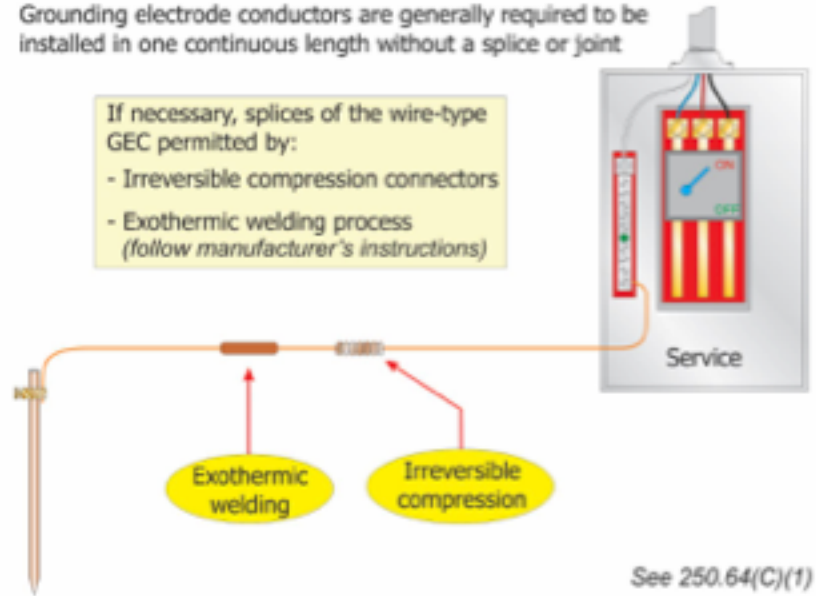
Splicing Grounding Electrode Conductors

- Grounding electrode conductors generally required to be installed in **one continuous length without a splice** or joint
- If necessary, splices or connections shall be made as permitted in (1) through (4):
  - (1) Splicing of the wire-type GEC permitted only by **irreversible compression-type connectors** listed as grounding and bonding equipment or by the **exothermic welding process**

Splicing Grounding Electrode Conductors

Grounding electrode conductors are generally required to be installed in one continuous length without a splice or joint

If necessary, splices of the wire-type GEC permitted by:
- Irreversible compression connectors
- Exothermic welding process *(follow manufacturer's instructions)*



See 250.64(C)(1)

Splicing Grounding Electrode Conductors *(cont.)*

- Grounding electrode conductors generally required to be installed in **one continuous length without a splice** or joint
- If necessary, splices or connections shall be made as permitted in (1) through (4):
  - (2) Sections of **busbars** shall be permitted to be connected together to form a grounding electrode conductor

Splicing Grounding Electrode Conductors *(cont.)*

- Grounding electrode conductors generally required to be installed in **one continuous length without a splice** or joint
- If necessary, splices or connections shall be made as permitted in (1) through (4):
  - (3) Bolted, riveted, or welded connections of **structural metal frames of buildings** or structures
  - (4) Threaded, welded, brazed, soldered or bolted-flange connections of **metal water piping**

Protection from Magnetic Field

- Where **ferrous metal raceways** or enclosures are provided for **protection of the grounding electrode conductor**, special procedures must be followed
- Ferrous metal conduits must be **bonded at both ends** of the grounding electrode conductor to form a **parallel circuit** with the grounding electrode conductor
- Lack of observation, results in **doubling the impedance** of the grounding electrode conductor
- Where the impedance increased, the effectiveness of the grounding electrode conductor is reduced
- See 250.64(E)

Protection from Magnetic Field *(cont.)*

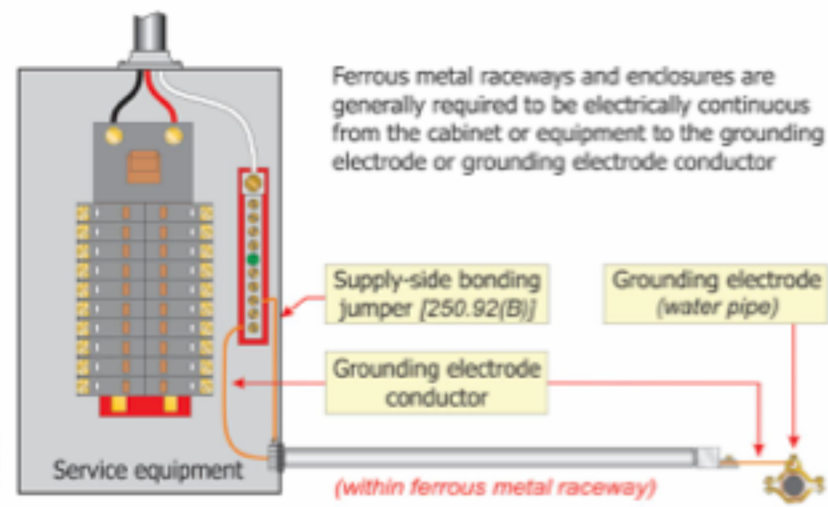
- Ferrous metal conduit must be **electrically continuous** from the point of attachment at the cabinet or equipment to the grounding electrode
- Ferrous metal conduit is required to be **securely fastened** to clamp or fitting
- Nonferrous metal enclosures *(PVC)* are not required to be electrically continuous

Protection from Magnetic Field *(cont.)*

- Ferrous metal conduit not physically continuous from the cabinet or equipment to the grounding electrode is required to be made electrically continuous by **bonding each end of the conduit** to the grounding electrode conductor
- This bonding is required at each end and to all intervening ferrous metal raceways, boxes, and enclosures between the service equipment and the grounding electrode

Protection from Magnetic Field

Ferrous metal raceways and enclosures are generally required to be electrically continuous from the cabinet or equipment to the grounding electrode or grounding electrode conductor

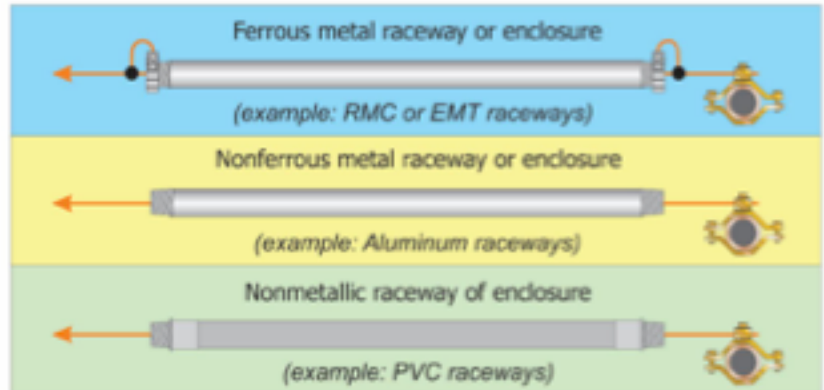


See 250.64(E)

Protection from Magnetic field

Bonding required at grounding electrode conductor to both ends of ferrous metal raceways and enclosures that are not electrically continuous from cabinet or enclosure to grounding electrode or grounding electrode conductor

Note: Bonding jumper is required to be the same size as the grounding electrode conductor



Grounding Electrode Conductor Connections

Grounding electrode conductor enclosed in armor cable and bonded to clamp and grounding electrode *(must be protected from magnetic field)*

Grounding and ElectroMagnetic Interference (GEMI) Research

Steel Tube Institute OF NORTH AMERICA

www.steeltubeinstitute.org

Division of Current in Both Paths (Conductor vs Raceway)

Conductor	Conduit Size	Total Amperes	Current in Conductor	Current on Conduit
6	½	100	3	97
6	½	300	5	295
2	¾	90	7	83
2	¾	350	10	340
2/0	1	150	15	135
2/0	1	590	5	585
4/0	1¼	225	15	210
4/0	1¼	885	15	870

The above test data confirms that, for all practical purposes, the impedance of a conductor enclosed in steel conduit *(when the conduit is bonded at both ends)* is approximately equal to the impedance of the conduit

**Data from Grounding ElectroMagnetic Interference (GEMI) analysis software*

Design Considerations for Grounding Electrode Conductor Length

- Short-time rating of copper grounding electrode conductor related to I^2t rating *(current x current x time)*
- Five-second rating is approximately 1 ampere for every 42.25 circular mil conductor area
- Voltage drop for grounding electrode conductors over 30 m (100 ft) should not exceed 40 volts
- The *NEC* does not currently limit the length or require larger grounding electrode conductors for long runs, but it should be a design consideration

Design Considerations for Grounding Electrode Conductor Length

- **Example:** 1/0 AWG copper service-entrance conductors, GEC is 6 AWG copper *(Table 250.66)*, length is 45 m (150 ft)
- 6 AWG has 26,240 circular mils, resulting in a short-time rating of 621 amperes, and a dc resistance of 0.0737 ohms for 45 m (150 ft.) (0.491 ohms/k ft.)
- Voltage drop would be 621 x 0.0737 or 46 volts
- Voltage drop for GECs over 30 m (100 ft) should not exceed 40 volts
- Next larger-sized GEC (4 AWG) has resistance of 0.0462 ohms for 45 m (150 ft) (0.308 ohms/k ft.)
- Voltage drop would be 621 x 0.0462 or 28.7 volts
- 4 AWG copper GEC is the proper size

Grounding Electrode Conductors for Direct-Current Circuits

- For direct-current **(dc) circuits**, size of the grounding electrode conductor is specified in **250.166**
- Size can be larger than would be required for the same size alternating-current (ac) circuit
- **Resistance** only factor in determining current in a dc circuit
- Grounding electrode conductor for dc systems does not have to be larger than **3/0 copper** or **250 kcmil aluminum**

Chapter Eight:
Bonding Enclosures and Equipment

- The purpose of bonding
- Requirements for maintaining continuity and conductivity
- Bonding of systems over 250 volts to ground
- Bonding multiple raceway systems
- Bonding of grounding-type receptacles
- Bonding of metal water piping systems
- Bonding of other metal piping systems
- Bonding of interconnected exposed structural metal framing

Bonding Enclosures and Equipment

- Bonding is an **ongoing process** in any electrical system from the point of service delivery to final outlet on the system
- Bonding metal parts or enclosures of electrical components and conductors **connects them together** electrically and mechanically, establishing **electrical continuity and conductivity**
- Bonding has a very important function electrically for both grounded and ungrounded systems
- Bonding metallic parts together puts parts at the **same potential**
- Bonding connection to the grounding electrode at the service or source of separately derived system puts parts at the **ground (earth) potential**

Definitions

- ***Bonded (Bonding):*** "Connected to establish electrical continuity and conductivity."
- ***Bonding Conductor or Jumper:*** "A reliable conductor to ensure the required electrical conductivity between metal parts required to be electrically connected."
- ***Bonding Jumper, Equipment:*** "The connection between two or more portions of the equipment grounding conductor."
- ***Bonding Jumper, Main:*** "The connection between the grounded circuit conductor and the equipment grounding conductor at the service."

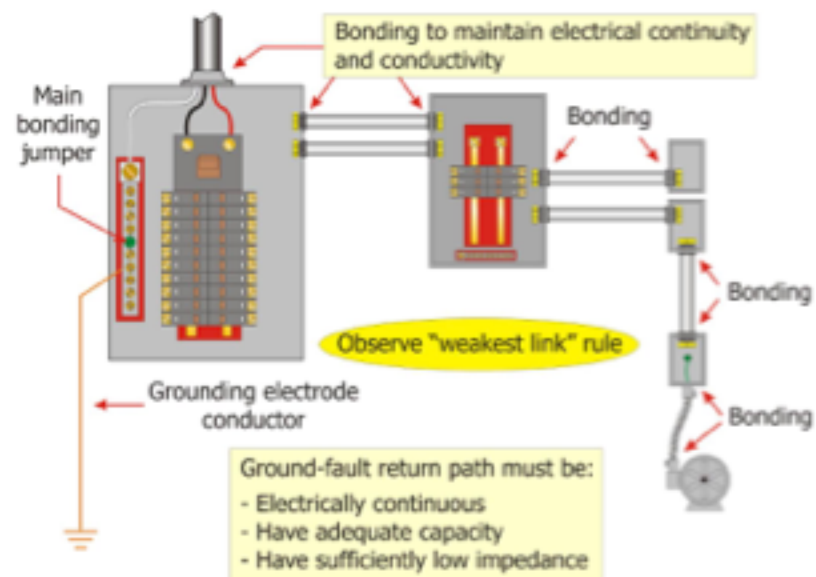
Maintaining Continuity

- Effective bonding is necessary to assure electrical continuity and capacity to safely conduct any fault current likely to be imposed
- Any nonconductive paint, enamel, or similar coating to be removed at threads, contact points, and contact surfaces or have equipment connected by means of fittings designed so as to make such removal unnecessary
- See 250.96(A)

Maintaining Continuity *(cont.)*

- "**Weakest link**" rule applies to the ground-fault return path
- To provide adequate safety, the effective ground-fault current path is required to:
  - Be **electrically continuous**
  - Have **adequate capacity** to conduct safely any fault current likely to be imposed on it
  - Have sufficiently **low impedance** to limit the voltage to ground and to facilitate the operation of the circuit-protective devices
- See 250.4(A)(5) and 250.4(B)(4)

Observe the "Weakest Link" Concept



Clean Surfaces

- Nonconductive coatings such as paint, lacquer and enamel must be removed from threads and other contact surfaces of equipment to be grounded, unless…
- Connected by means of fittings designed to make such removal unnecessary
- Nonconductive coatings could restrict equipment grounding and impair ground-fault return path
- See 250.96(A) and 250.12

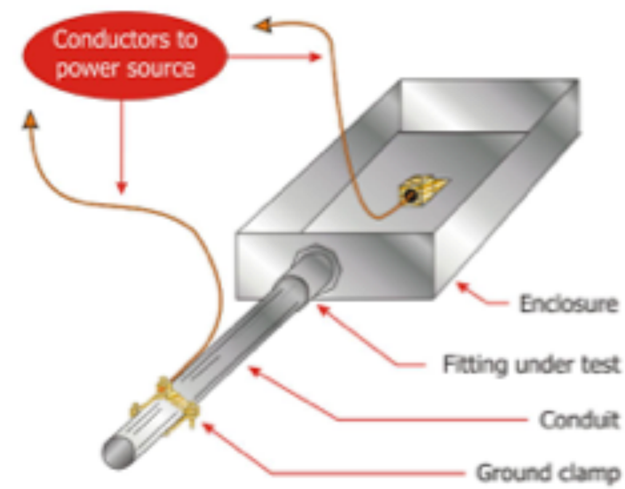
Testing of Conduit Fittings

- The importance of removing paint from enclosures where the conduit or raceway is intended to serve as the fault-current path is further emphasized in a report titled "***Conduit Fitting Ground-Fault Current Withstand Capability***," issued by Underwriters Laboratories on June 1, 1992
- The following slides illustrate the testing performed by UL on various conduit and tubing fittings to determine suitability during ground-fault conditions

Testing of Conduit Fittings *(cont.)*

- Over 300 conduit-fitting assemblies from ten different manufacturers were subjected to a current test to simulate performance under ground-fault conditions
- A sample assembly consisted of a conduit fitting secured to one end of a two-foot length of conduit and attached to a metal enclosure
- Some of the enclosures were bare metal or galvanized, and others were painted with enamel coating typical of construction of enclosures in the 1990s
- Seven of the more than 300 assemblies tested sustained damage
- A visual examination of sample assemblies that failed showed that melting of the die-cast zinc locknuts occurred as a result of the fault current

Conduit and Tubing Fitting Test Model



"Conduit Fitting Ground-Fault Current Withstand Capability" issued by Underwriters Laboratories on June 1, 1992

Conduit and Tubing Fitting Test Model

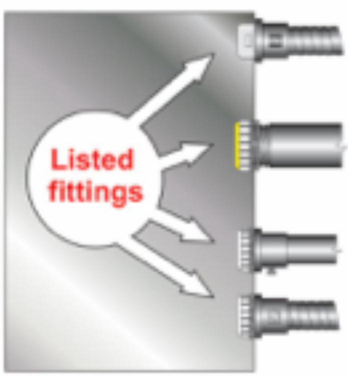
"Conduit Fitting Ground-Fault Current Withstand Capability" issued by Underwriters Laboratories on June 1, 1992

Conclusions on Fittings Testing

- 1. Over 300 conduit fitting assemblies from 10 manufacturers were tested…seven assemblies failed
- 2. Failures probably due to high resistance between fitting and enclosure as fitting locknut did not penetrate the paint
- 3. Some fittings that did not fail showed signs of arcing and welding
- 4. Most fitting temperatures matched conduit temperatures
- 5. Flexible metal conduit temperature was much higher than the temperature of the fittings
- 6. Fittings providing good electrical contact to both conduit and enclosure will provide **suitable path for fault current**

Bonding for Circuits Over 250 Volts

For circuits exceeding 250 volts to ground, the electrical continuity of metal raceways and metal-sheathed cables that are not used for service-conductors must also be ensured by specific methods such as:



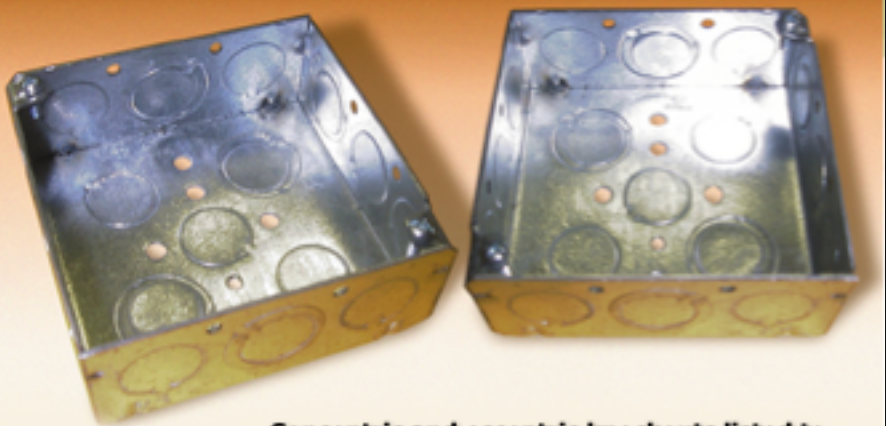
See 250.97

- Threadless couplings and connectors for cables with metal sheaths
- Two locknuts, on rigid metal conduit or IMC, one inside and one outside
- Fittings with shoulders that seat firmly against the box or enclosure such as for EMT, flexible metal conduit and cable connectors with one locknut inside
- Listed fittings

Also permitted:
- Threaded couplings and hubs
- Threadless couplings and connectors
- Bonding jumpers
- Bonding locknuts, bushings, and wedges

Bonding for Over 250 Volts

- All listed device outlet boxes are specially designed and tested so knockouts perform satisfactorily for over 250-volt-to-ground applications
- Also, see UL ProductSpec for the guide card information under category code QCIT for listing details on these device boxes



Concentric and eccentric knockouts listed to meet the bonding requirements for over 250 volts at 250.97

Concentric or Eccentric Knockouts

- Caution needs to be exercised in the use of equipment that has concentric or eccentric knockouts
- Ability to carry fault current must be of concern
- Common to find nibs of adjacent rings damaged during removal of the desired knockout
- Leaves less material available for carrying fault current
- Safest practice is to install bonding bushings around concentric and eccentric knockouts where there is any question about their integrity

Concentric or Eccentric Knockouts *(cont.)*

- Concentric and eccentric knockouts in equipment *(such as cabinets, enclosed switches, junction and pull boxes, auxiliary gutters and wireways)* **not tested or certified** by an electrical products testing laboratory for their current-carrying ability
- Specific methods provided for in **250.97** must be used if those enclosures have eccentric or concentric knockouts

Concentric and Eccentric Knockouts

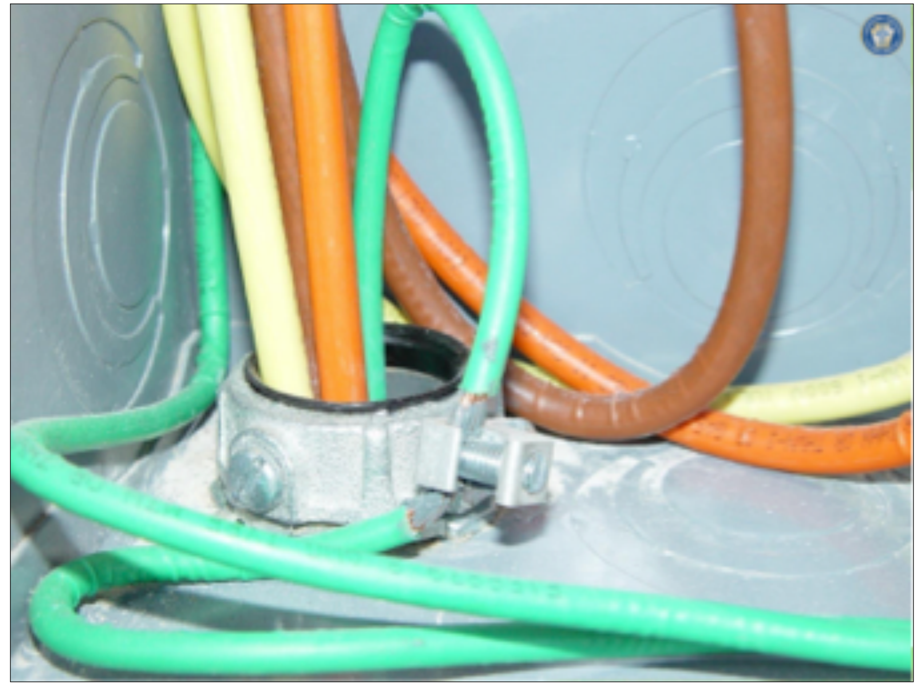
Concentric knockouts

It may be necessary to bond around concentric knockouts at enclosures such as disconnects and panelboards to ensure current-carrying capacity

Bonding jumpers required around impaired connections such as reducing washers, concentric or eccentric knockouts

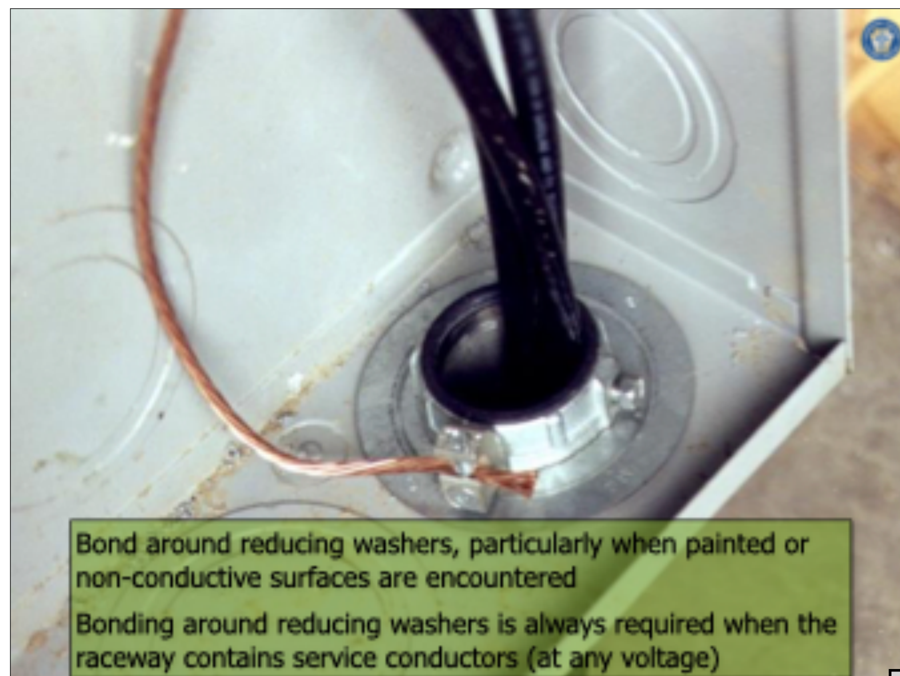
Eccentric knockouts

Eccentric rings present the same obstacle to carrying fault current as do concentric knockouts



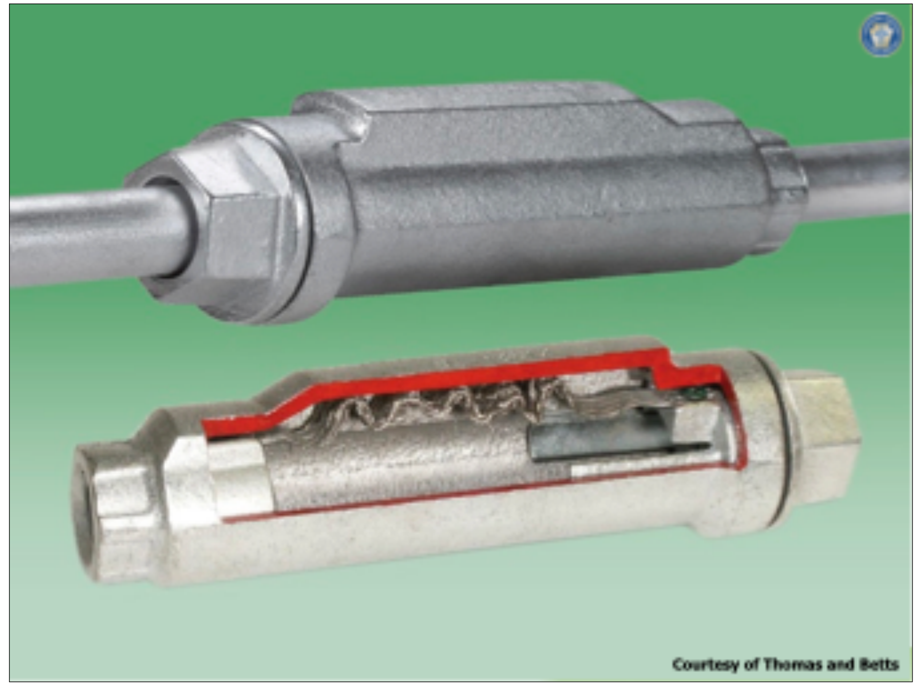
Reducing Washers

- Reducing washers are evaluated and listed for bonding over and under 250 volts for other than raceways used for service conductors *(see UL ProductSpec, category QCRV)*
- Bonding around reducer washers at raceways containing service conductors is required by 250.92(B)
- Where painted or coated enclosures are encountered and the paint or coating under the washer is not removed, one should always bond around to provide an adequate fault-return path
- Use reducing washers only where all the rings of concentric or eccentric knockouts are removed



Bonding Loosely Jointed Metal Raceways

- Expansion fittings and telescoping sections of metal raceways are required be made **electrically continuous** by equipment bonding jumpers or other means
- Bonding is required around these types of fittings unless the fitting is listed for providing bonding around the expansion feature of the fitting
- See 250.98



Attaching Bonding Jumpers

- Good electrical contact must be maintained
- Where used between grounding electrodes or around water meters and similar equipment, good electrical contact must be maintained
- The arrangement of bonding jumpers must be such that the disconnection or removal of equipment will not interfere with or interrupt the grounding and bonding continuity of the jumper
- See 250.68(B)

Attaching Bonding Jumpers *(cont.)*

- Bonding jumper and equipment grounding conductor connections are required to be made using one or more of the following methods:
  - (1) Listed pressure connectors
  - (2) Terminal bars
  - (3) Pressure connectors listed as grounding and bonding equipment
  - (4) Exothermic welding process
  - (5) Machine screw-type fasteners that engage not less than two threads or are secured with a nut

Attaching Bonding Jumpers *(cont.)*

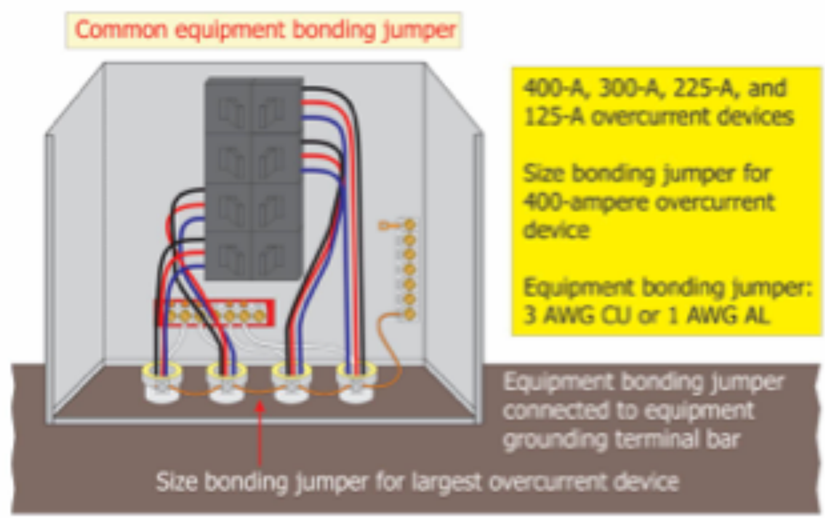
- Bonding jumper and equipment grounding conductor connections are required to be made using one or more of the following methods:
  - (6) Thread-forming machine screws that engage not less than two threads in the enclosure
  - (7) Connections that are part of a listed assembly
  - (8) Other listed means
- Connection that depends on solder is not acceptable
- See 250.8

Bonding Multiple Raceway Systems *(Load Side)*

- Permitted to use **single equipment bonding jumper** to bond one or **several raceways**
- Size single equipment bonding jumper based on largest overcurrent device ahead of conductors in raceways
- Also permitted to connect **individual equipment bonding jumpers** to **each raceway** individually
- Size individual bonding jumpers in accordance with 250.122 and the individual overcurrent devices
- See 250.102(D)

Bonding Multiple Raceways *(Load Side)*

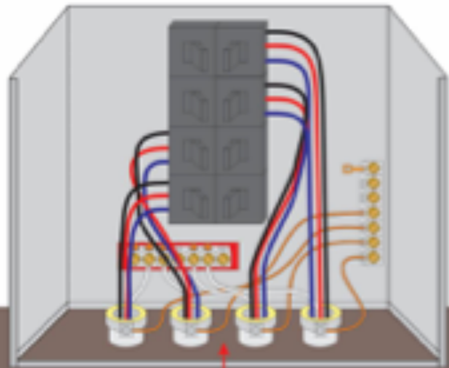
Open-bottom switchboard or motor control center



Bonding Multiple Raceways *(Load Side)*

Open-bottom switchboard or motor control center

Individual equipment bonding jumper(s)



	CU	AL
400 A =	3 AWG,	1 AWG
300 A =	4 AWG,	2 AWG
225 A =	4 AWG,	2 AWG
125 A =	6 AWG,	4 AWG

Equipment bonding jumper connected to equipment grounding terminal bar

Size bonding jumper(s) for individual overcurrent devices

Bonding of Grounding-Type Receptacles

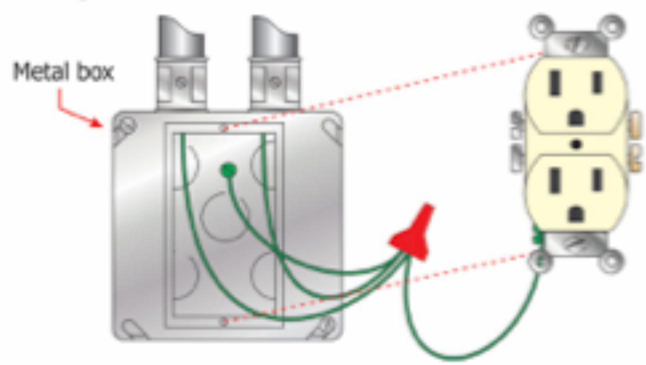
- An equipment bonding jumper is required to be used to connect the grounding terminal of a grounding-type receptacle to a grounded box unless grounded as in 250.146(A) through (D):
  - (A) Surface-mounted boxes
  - (B) Contact devices or yokes
  - (C) Floor boxes
  - (D) Isolated ground receptacles
- Size equipment bonding jumper in accordance with Table 250.122 based on the rating of the overcurrent device protecting the circuit conductors
- See 250.146

Continuity and Attachment of EGC to Boxes

- **All equipment grounding conductors** associated with any and all circuits in the box must be connected together and to the box *(not just EGCs of each associated circuit)*
- Exception gives relief to EGCs of an **isolated ground circuit** *(isolated ground receptacle not required to be connected to the other EGCs or to the box)*
- Reference **250.8** *(Connection of Grounding and Bonding Equipment)* for guidance on terminating an EGC or bonding jumper to a metal box or enclosure
- See 250.148

Bonding of Grounding-Type Receptacles

Splice or join all equipment grounding conductors and bonding jumpers together inside box using suitable devices



Connect bonding jumper to grounding terminal of grounding receptacle unless:
(A) Boxes mounted on surface *(Metal-to-metal contact)*
(B) Contact devices listed as self-grounding type
(C) Floor boxes listed for grounding
(D) Isolated equipment grounding terminal

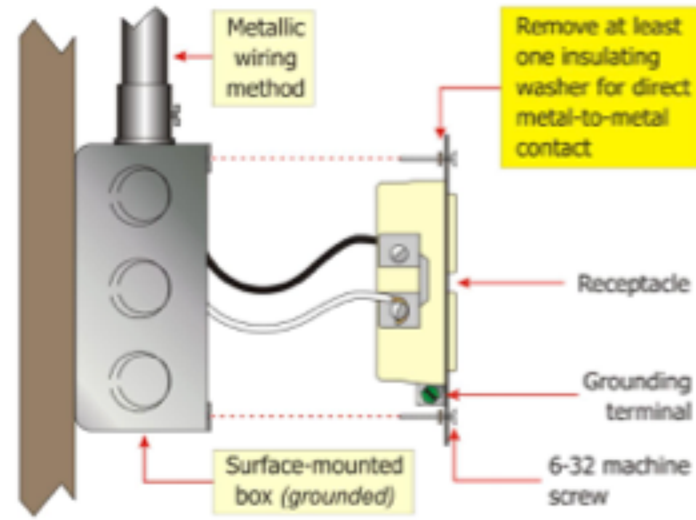
See 250.146 and 250.148

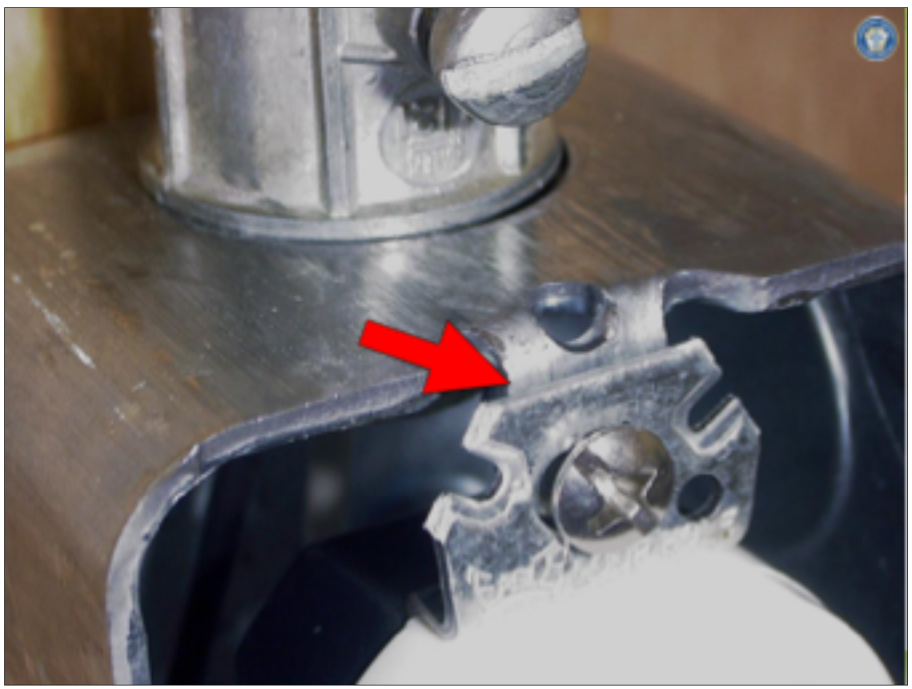
Bonding of Grounding-Type Receptacles *(cont.)*

- Surface-Mounted Boxes [250.146(A)]
  - Mounted on surface only
  - Direct metal-to-metal contact
  - Box permitted to ground receptacle
  - At least one insulating washer *(holding screws)* is required to be removed from the receptacle
  - Raised-cover mounted receptacles permitted for grounding and bonding of receptacle

250.146(A) Surface-Mounted Box

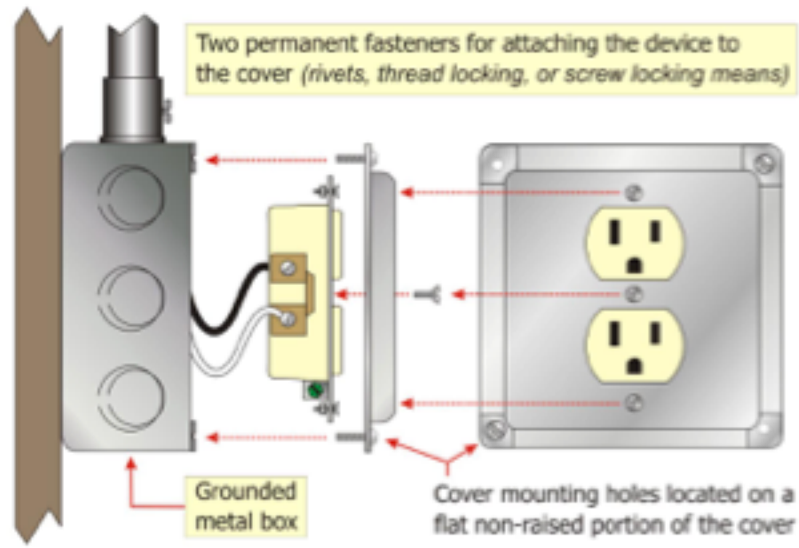
Direct metal-to-metal contact from metal mounting yoke to surface-mounted metal box permitted for grounding of receptacle





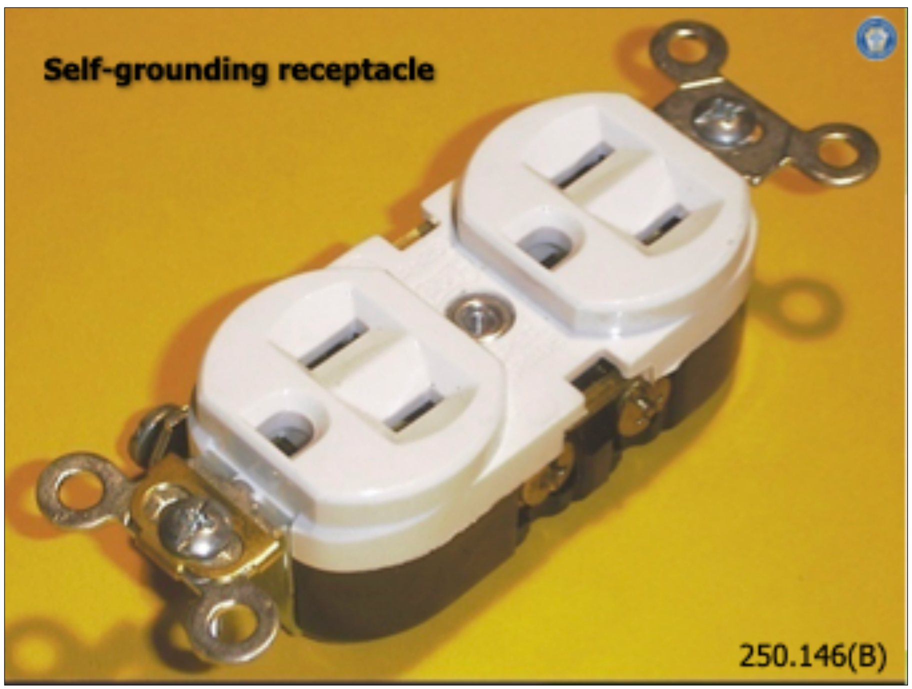
250.146(A) Surface-Mounted Box

Listed exposed work cover is permitted as the grounding and bonding means



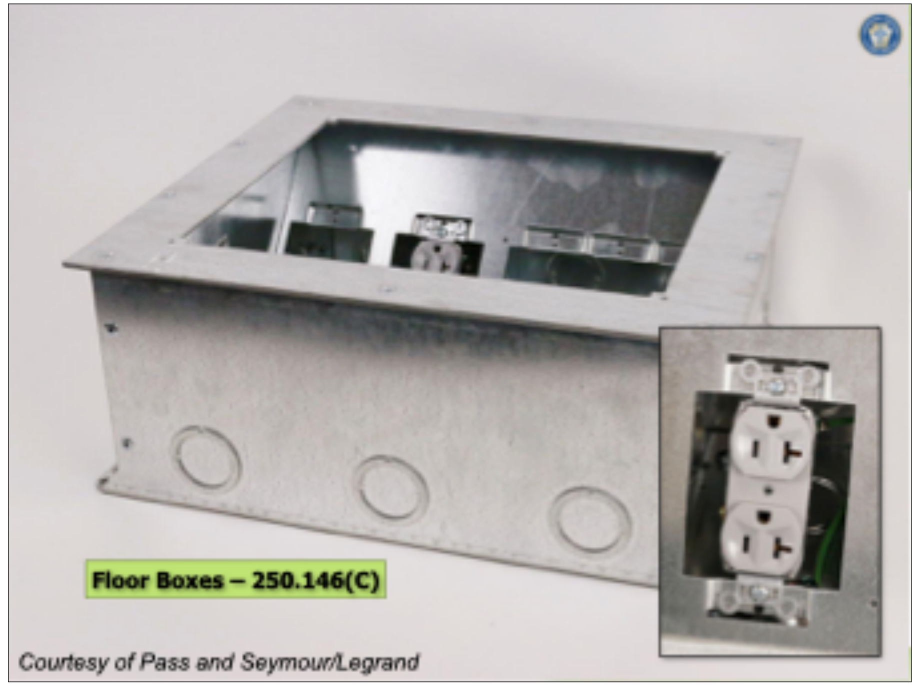
Bonding of Grounding-Type Receptacles *(cont.)*

- Contact Devices or Yokes [250.146(B)]
  - Contact devices or yokes designed and listed as **self-grounding** are permitted in conjunction with the supporting screws to establish the equipment bonding means between the receptacle device yoke and flush-type boxes
  - The use of a self-grounding receptacle is not permitted to be the means to ground the metal box *[see 250.148(B) and (C)]*



Bonding of Grounding-Type Receptacles *(cont.)*

- Floor Boxes [250.146(C)]
  - **Floor boxes** designed for and listed as providing satisfactory ground continuity between the box and the receptacle device are permitted as a grounding/bonding means between the receptacle device yoke and the floor box

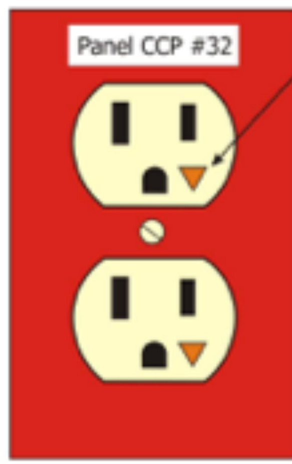


Courtesy of Pass and Seymour/Legrand

Bonding of Grounding-Type Receptacles *(cont.)*

- Isolated Receptacles [250.146(D)]
  - Where installed for the reduction of electrical noise *(electromagnetic interference)* on the grounding circuit, a **isolated ground receptacle** is permitted
  - Grounding terminal is **purposely insulated** from the receptacle mounting means but is connected to an insulated EGC run with the circuit conductors
  - IG EGC permitted to pass through one or more panelboards without a connection to the panelboard grounding terminal bar
  - IG EGC permitted to pass through boxes, wireways, or other enclosures without being connected to enclosures

406.3(D) Isolated Ground Receptacles



- Isolated ground receptacles to be identified by orange triangle on face *[406.3(D)]*
- To be used only with isolated equipment grounding conductors *[406.3(D)(1)]*
- Isolated ground receptacles installed in nonmetallic boxes shall be covered with a nonmetallic faceplate unless the box has a feature or accessory for grounding the faceplate *[406.3(D)2)]*
- Isolated equipment grounding conductor for isolated ground receptacles permitted to pass through panelboards, boxes, wireways, and other enclosures *[250.146(D)]*

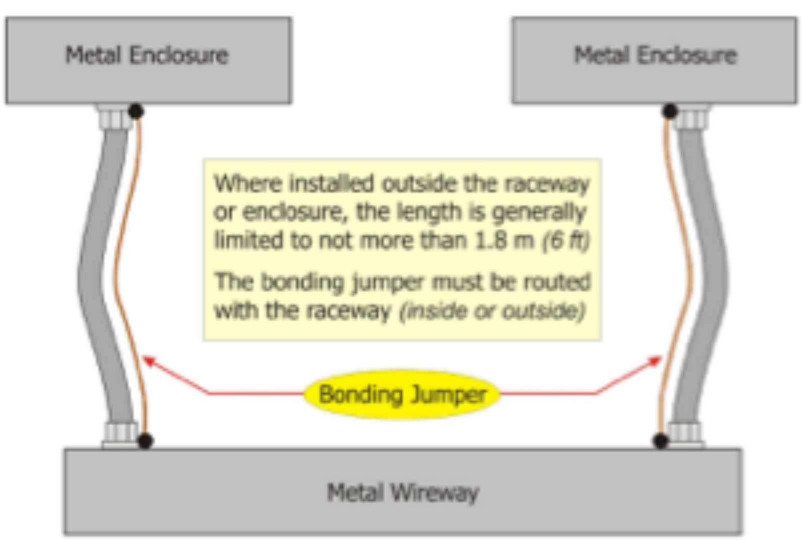
Installation of Bonding Jumpers

- **Equipment bonding jumper** is defined in Article 100 as "The connection between two or more portions of the equipment grounding conductor."
- Definition describes the installation of equipment bonding jumpers on the **load side** of overcurrent protective devices
- On the **line side** *(supply side)*, such as at the service or source of separately derived system, this jumper is a **supply-side bonding jumper** *[see 250.102(C) and 250.30(A)(2)]*

Installation of Bonding Jumpers *(cont.)*

- Bonding jumpers or conductors and equipment bonding jumpers are permitted to be installed **inside or outside** of a raceway or an enclosure
- If installed **inside** a raceway, it must comply with the requirements of 250.119 *(ID of an EGC)* and 250.148 *(Continuity and attachment of EGC to boxes)*
- If installed on the **outside**, the length of conductor shall not exceed 1.8 m (6 ft) and must be routed with the raceway or enclosure *(see exception for outside pole locations)*
- See 250.102(E)

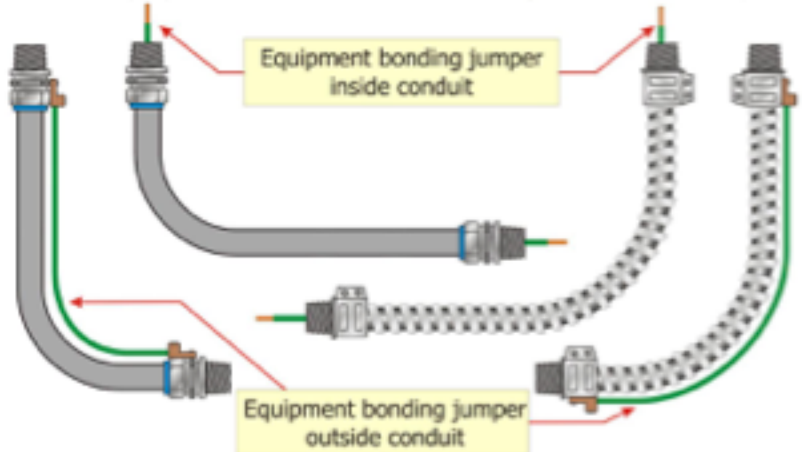
Bonding Jumper Installed Outside of Raceway



See 250.102(D) and (E)

Equipment Bonding Jumper Installation

Flexible metal conduit and liquidtight flexible metal conduit in lengths longer than 1.8 m *(6 ft)* shall not be used as an effective ground-fault current path



Where equipment bonding jumpers *(internal or external)* are installed, they shall comply with 250.102 *(installation of bonding jumpers, etc.)*

Bonding of Piping Systems

- Metal water piping and other metal piping systems installed within or attached to buildings or structures required to be bonded
- Bonding requirement is not to be confused with metal underground water piping used as a grounding electrode *[see 250.52(A)(1)]*
- Some bonding requirements change depending upon whether the piping is metal water piping or other metal piping systems
- See 250.104 for bonding of metal piping systems

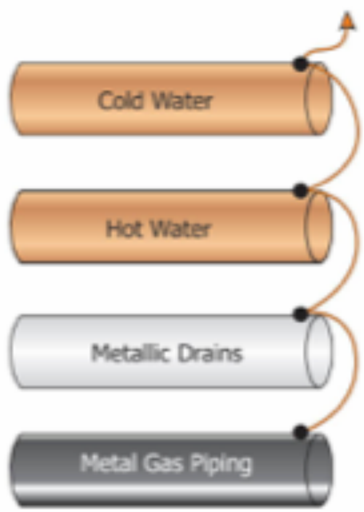
Bonding Metal Piping Systems

Applies to interior as well as exterior metal piping systems

Metal water piping system: Bonding jumper to be sized in accordance with Table 250.102(C)(1) based on the cm area of the service-entrance conductors

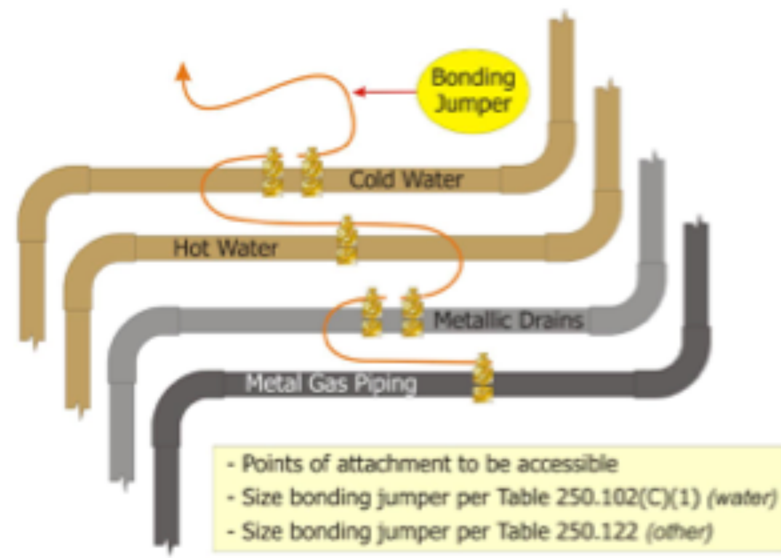
Other metal piping: Bonding jumper to be sized based on Table 250.122 for the circuit that is likely to energize the other metal piping system(s)

Note: Points of attachment of the bonding jumper(s) to be accessible



See 250.104(A) and (B)

Bonding Jumper Connection to be Accessible



See 250.104(A) and (B)

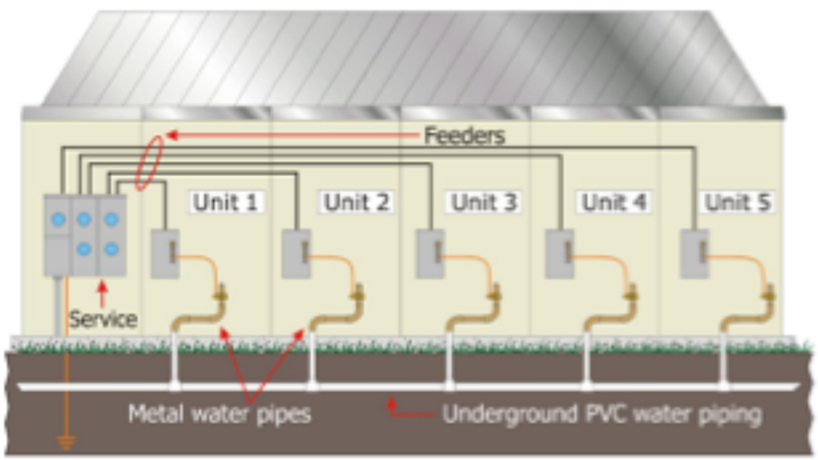
Bonding of Metal Water Piping Systems

- Metal water piping system(s) installed in or attached to a building or structure must be bonded per 250.104(A)
- Size bonding jumper per 250.102
- Attachment of bonding jumper to be accessible
- Attach bonding jumper to:
  - Service equipment enclosure
  - Grounded conductor at the service
  - Grounding electrode conductor if of sufficient size
  - One or more grounding electrodes used *(GEC or bonding jumper to be of sufficient size)*

Bonding of Metal Water Piping (Multiple Occupancies)

- Metal water piping system(s) allowed to be bonded to the panelboard or switchboard enclosure *(other than service equipment)* under specific conditions:
  - Building is multiple occupancy, and…
  - Metallic water piping is isolated from all other occupancies by nonmetallic water piping (*nonmetallic means or individual isolation)*
- Bonding jumper sized in accordance with Table 250.122, based on the rating of the overcurrent protective device for the circuit supplying the occupancy
- See 250.104(A)(2)

Metal Water Piping Bonding Alternative



Metal interior water pipes permitted to be bonded to panelboard in multiple occupancy buildings under the conditions provided in 250.104(A)(2)

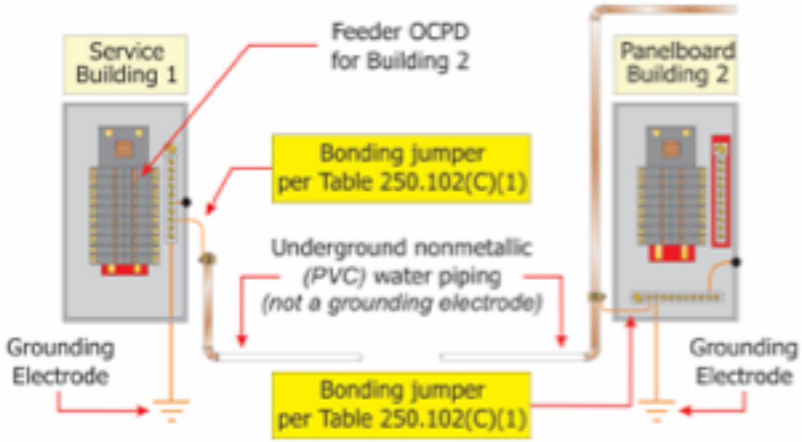
Size bonding jumper(s) in accordance with 250.122 based on the rating of the feeder OCPD

Bonding of Metal Water Piping (Multiple Buildings) *(cont.)*

- At **multiple buildings** or structures supplied by **feeder(s) or branch circuit(s)**, the metal water piping system(s) shall be bonded to one of the following:
  - Building or structure disconnecting means enclosure
  - EGC run with the supply conductors
  - One or more grounding electrodes used
- Size bonding jumper(s) 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
- The bonding jumper is not required to be larger than the largest feeder or branch circuit supplying the building
- See 250.104(A)(3)

Metal Water Pipe Bonding Jumper Size

Multiple Buildings or Structures Supplied by a Feeder(s) or Branch Circuit(s)



Bonding jumper sized from Table 250.102(C)(1) based on the size of feeder or branch circuit conductors that supply additional building(s) or structure(s)

See 250.104(A)(3)

Bonding of Other Metal Piping Systems

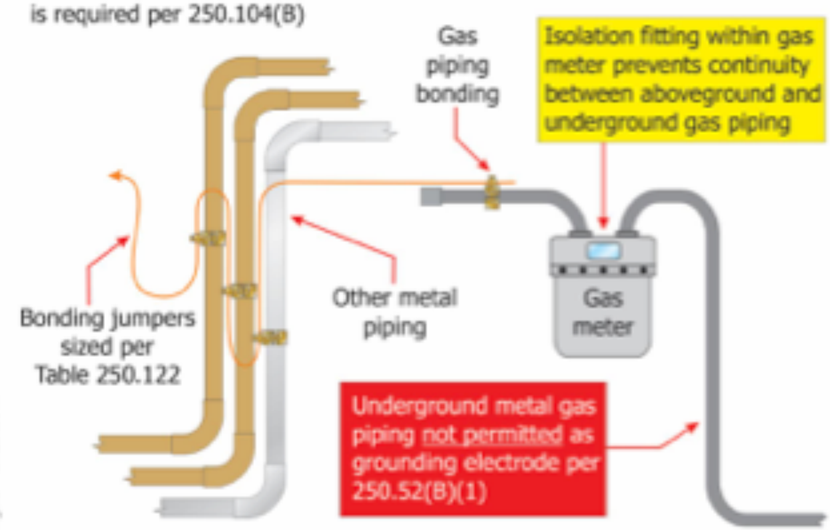
- If installed in or attached to a building or structure, metal piping system(s) ***(including gas piping)*** that is **likely to become energized** shall be bonded to any of the following:
  - EGC for the circuit that is **likely to energize the piping system**
  - Service equipment enclosure
  - Grounded conductor at the service
  - Grounding electrode conductor *(if of sufficient size)*
  - One or more grounding electrodes used *(GEC or bonding jumper to be of sufficient size)*

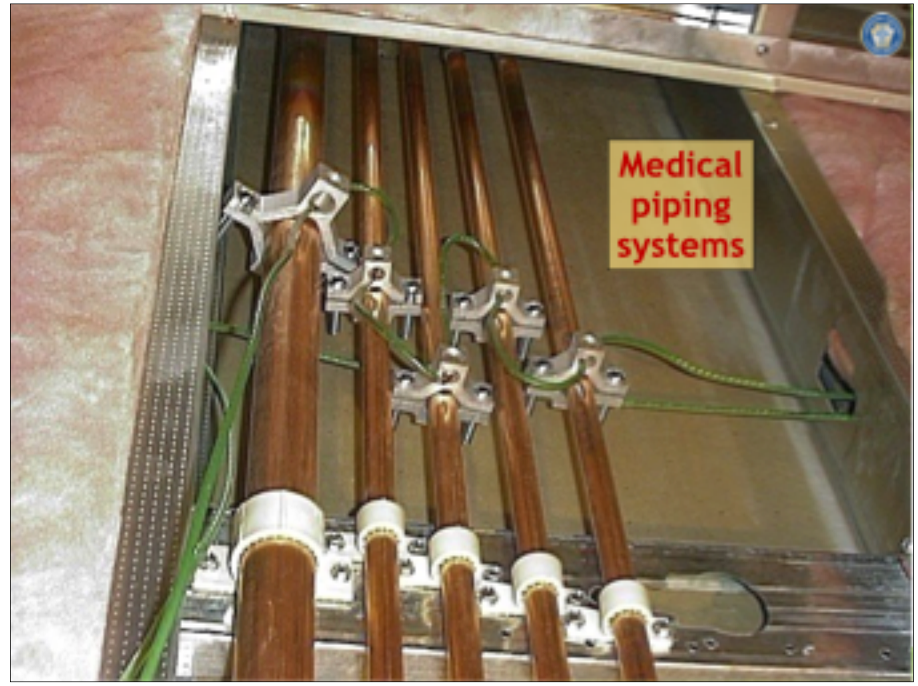
Bonding of Other Metal Piping Systems *(cont.)*

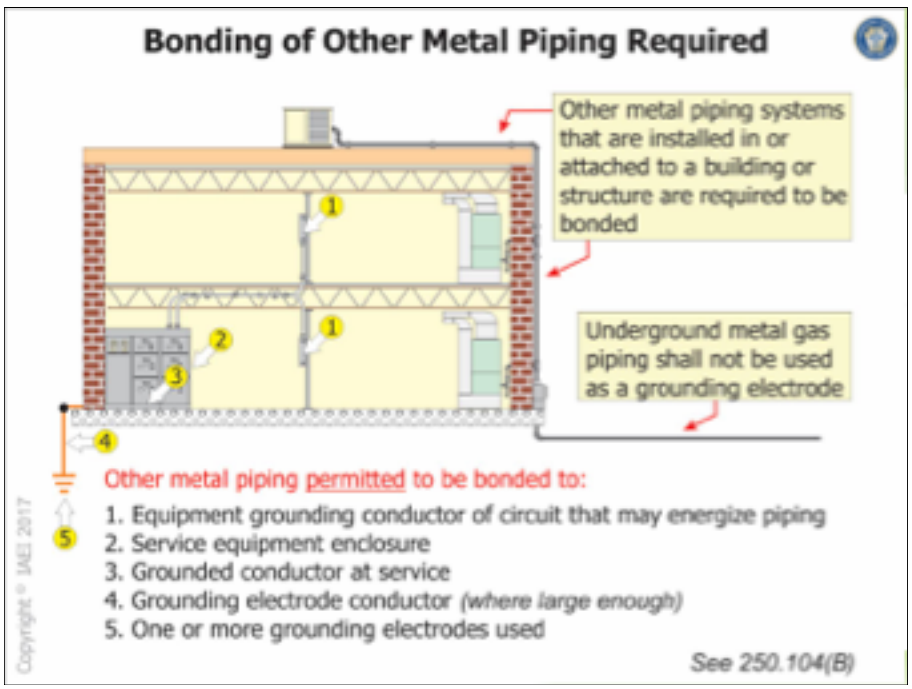
- Minimum size bonding jumper per **250.122** based on the **circuit likely to energize the piping system**
- Equipment grounding conductor of supply circuit may be used as bonding means
- NFPA 54 *(National Fuel Gas Code)* also requires metal gas piping system(s) to be bonded, which correlates with the requirements of the *NEC*
- See 250.104(B)

Bonding of Other Metal Piping Required

Bonding of other metal piping systems *(including metal gas piping systems)* is required per 250.104(B)

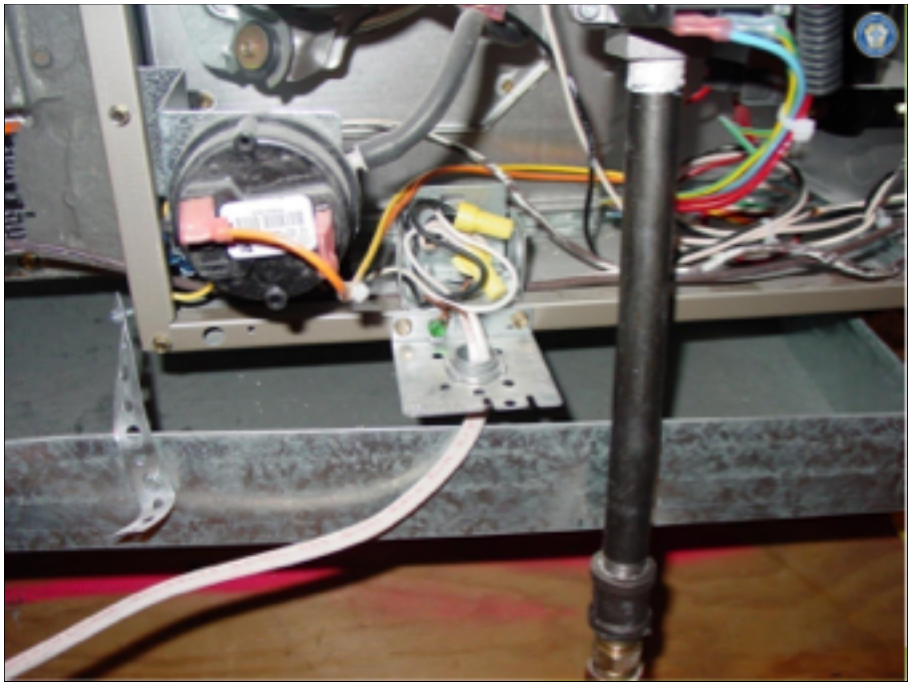


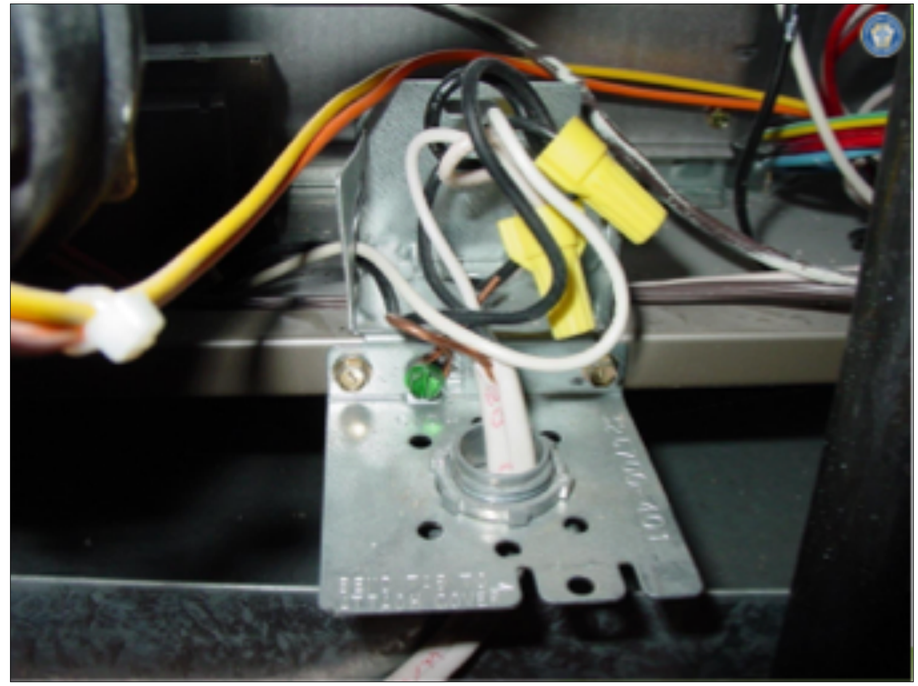




Bonding of Other Metal Piping Systems (cont.)

- **Bonding of Gas Piping:**
  - If installed in or attached to a building or structure, metal gas piping that is likely to become energized shall be bonded
  - The **equipment grounding conductor** for the circuit that is likely to energize the piping system can be used for **bonding** of the gas piping
- See 250.104(B)





Bonding Structural Steel

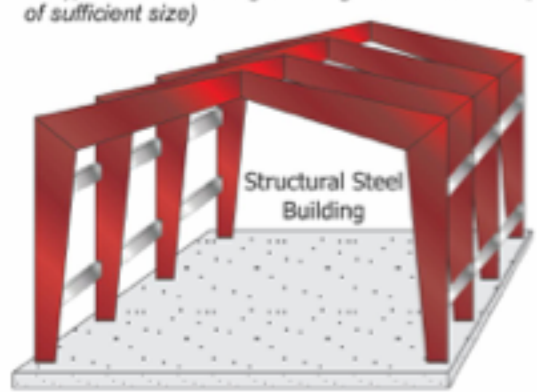
- **Exposed structural metal** interconnected to form a steel building frame *(not intentionally grounded)* and is likely to become energized is **required to be bonded**
- Bonding connection required to be made to:
  - Service equipment enclosure
  - Grounded conductor at the service
  - Disconnecting means for buildings or structures supplied by a feeder or branch circuit
  - Grounding electrode conductor *(of sufficient size)*
  - One or more grounding electrodes used *(if GEC or bonding jumper is of sufficient size)*

Bonding Structural Steel *(cont.)*

- Applicable to interior or exterior structural framing members of buildings or structures
- Bonding jumper required to be sized in accordance with Table 250.102(C)(1) and installed in accordance with the rules in 250.64(A), (B) and (E)
- The points of attachment of the bonding jumper to the structural steel are required to be accessible *(unless installed in compliance with 250.68(A) Exception No. 2)*
- See 250.104(C)

250.104(C) Bonding Structural Steel

- Exposed structural metal framing *(not intentionally grounded)* and likely to become energized shall be bonded
- Bond to the service equipment enclosure, grounded conductor at service, disconnecting means for building, grounding electrode conductor *(of sufficient size)*, or one or more grounding electrodes used *(if GEC or bonding jumper is of sufficient size)*



- Size bonding jumper per Table 250.102(C)(1)
- Install per 250.64(A), (B), and (E)
- Attachment point(s) of bonding jumper to be accessible *(unless installed per 250.68(A) Ex. No. 2)*

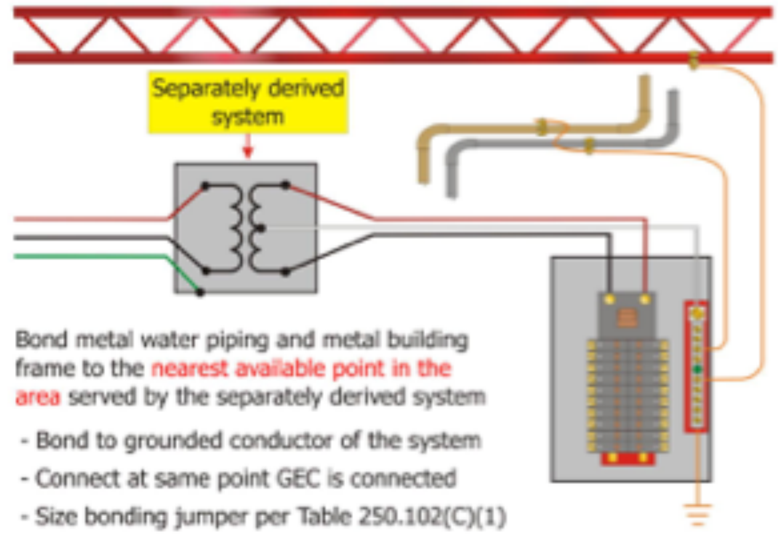
Bonding for Separately Derived Systems

- Metal water piping systems and structural metal building frame required to be bonded to separately derived systems in accordance with 250.104(D)(1) through (D)(3)
  - (D)(1) Metal Water Piping System(s)
  - (D)(2) Structural Steel
  - (D)(3) Common Grounding Electrode Conductor
- 250.30(A)(8) provides correlation between 250.104(D) and 250.30(A) *(grounding requirements for separately derived systems)*

Bonding for Separately Derived Systems (cont.)

- Bonding separately derived system is **necessary to establish a reference** to the metal water piping and structural metal in the area served by the separately derived system
- Area served can be determined by any equipment or outlets supplied from the separately derived system
- Bonding also provides a **fault-current path** in the event the metal water piping or structural metal becomes energized
- If a **common grounding electrode conductor** is used, it also must be bonded to the metal water piping and structural metal in the area

Separately Derived Systems-Bonding Structural Metal and Water Piping



Bond metal water piping and metal building frame to the nearest available point in the area served by the separately derived system

- Bond to grounded conductor of the system
- Connect at same point GEC is connected
- Size bonding jumper per Table 250.102(C)(1)

See 250.104(D)

Chapter Nine: Equipment Grounding Conductors

- General requirements for equipment grounding conductors on grounded and ungrounded systems
- Sizing requirements for equipment grounding conductors
- Rules applied to multiple raceways or cables
- Rules for flexible cords
- Use of building steel that is properly grounded by an equipment grounding conductor
- Grounding of equipment by the grounded conductor

File Attachments for Item:

ER-4 Western Section IAEI Special Meeting (IAEI Western)

All certifications (18.5 hours)

Staff Notes: The submitter has made it clear that, despite the way he filled out the application, this two-and-a-half-day meeting is not a multisession course. If approved, it will receive one course number.

ESIAC Recommendation:

Committee Recommendation:

APPLICATION FOR CONTINUING EDUCATION APPROVAL
COURSE CONDITIONS AND GUIDELINES

The Ohio Board of Building Standards is committed to the ongoing education and professional development of board-certified personnel through the delivery of high-quality, accurate and engaging professional continuing education content. To this end, the Board reviews and approves Continuing Education Courses for building department personnel.

Board approval is granted for course instruction on current codes and standards, including the OBC, OMC, OPC, and RCO, and any other content areas directly related to the responsibilities of the certification for which credit is being requested.

Promotion: Any person or organization promoting an approved course is required to make full and accurate disclosure regarding course title, course approval number, number of credit hours, categories for which the BBS has approved the class, and fees in promotion materials and advertising. ***The Board does not grant retroactive approval. It is recommended that courses be submitted for approval well in advance of any scheduling of classes and advertising***. Advertising may not falsely state BBS approval before approval is granted. Course providers may state that BBS approval is pending.

Application Submission: All Applications and associated materials shall be submitted by email in .pdf format. Instructions for completing the application are attached.

Certificate of Completion: Course providers shall provide participants a certificate of completion containing the following information:

- Name of participant
- Title of approved courses
- BBS approval #
- BBS approved certifications
- Date of the continuing education program
- Number of approved credit hours awarded, and
- Signature of authorized sponsor or instructor.

Any person or organization administering an approved course shall return a completed BBS Course Attendance form by email.

Participants: Participants must attend the complete course as presented by the instructor to receive credit hours approved by the Board. The organization or instructor of online courses shall plan and execute methods to verify the individual's attendance and completion of the course. No partial credit will be given to any participant who failed to complete the entire course as approved.

Board approval: All courses are approved for the calendar year in which application is made. Courses may be renewed so long as the referenced code is in effect, and the CEUs, certification and content remain unchanged. When the referenced code is updated, courses must be updated, and new approvals obtained.

Facility/training area: BBS Course may be delivered in person or online, or both, at the sponsor's option.
Course facilities shall include the following:

In Person Classes:
Sufficient seating capacity
ADA accessible facilities
Appropriate Audio/Visual devices for delivery
Writing surfaces for participants

Online Classes:
Web-accessible
ADA accessible delivery
Tech support available
Live and recorded courses permitted

In-person facilities shall comfortably and safely seat at least the number of attendees present in the room and shall be climate controlled, non-smoking, and sound controlled so that outside noise will not interfere with the training.

Ohio | Department of Commerce

Mike DeWine, Governor
Jon Husted, Lt. Governor

Sheryl Maxfield, Director

Board of Building Standards

Application for Continuing Education Course Approval

Provider Information:

Name: Thomas Moore

Organization: Western Section IAEI

Address: 3462 Brunk Road

E-mail: tmoore1767@gmail.com Telephone: (330) 289-7932

Website: http://IAEI-Western.org

Conference Sponsor (if applicable) Western Section IAEI Conference Email: tmoore1767@gmail.com

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

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

New Course Information:

Course title: Western Section IAEI Special Ohio Meeting

Course instructor: Thomas Moore (Multiple Presenters)

Course description: This will be a 2.5 day meeting. The educational presentation will consist of NEC 2023 Code Analysis 8.25 hrs.
Code panel question and answers by nationally recognized code expert's and code making panel members 3.75 hrs.
BBS & OCILB Reports by Regina Hanshaw and Carol Ross hrs. 1.5 - Ohio Required Instruction: Existing Buildings. 3 hrs.
Solar Photovoltaic and Electrical Storage Systems Wendall Whistler CMP member hrs. 2

Instructional hours per session: 18.5 Number of Sessions: 5

Course Date(s) and Location: April 23 - 26, 2023 Encore Hotel & Hall 4365 St. Route 39, Millersburg, Ohio 44654

Special Content:

Code Administration: XX
Existing Buildings: XX
Electrical Instruction: XX
Plumbing Instruction: ______

Conference Course: ____________________
Conference Name: Western Section IAEI Special Ohio Meeting
Conference location: Encore Hotel & Hall Millersburg, Ohio 44654

Course to be offered online? No **On Demand**_____ **Webinar**_______

Course Website: ____________________

Detail online course participation confirmation method (*i.e. test, quizlets, participant activity confirmation*):

____

Course applicable for the following certifications

Residential Certifications Only: ________ Commercial Certifications: XX
Administrative Course, All Certifications: ________

Application materials included:

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

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

Instructions for new Continuing Education Approval form

Provider Information

1. Please include all contact information.
2. If course is not part of a conference, leave conference sponsor and email blank.

Course Renewal

1. Indicate if the course is being submitted for renewal. Include prior approval letter and write in prior course number.
2. Certification approval for courses has now changed: all existing courses being renewed will be approved within the new classification system.
    a. Courses previously approved for only residential certifications will be approved for all residential certifications.
    b. Courses previously approved for at least on commercial certification will now be approved for all commercial certifications and all residential certifications.
    c. Courses on required instruction topics, Ohio Ethics, Code Administration and Existing Buildings, will be noted as Administrative Courses and be approved for all certifications.
3. Courses being renewed should skip the New Course information section and are not required to submit outline, agenda, slides or other instructional materials for review. Skip to Special Content, and mark any item that applies to the course.

New Course Information

1. Enter course title, name of instructor, and a brief description of the course content. Learning objectives may be substituted for course description, if desired.
2. Number of instructional hours per session is the length of instructional time.
3. Number of sessions: can be 1 or the number of sessions planned.
4. Course date(s) and location: not necessary at this time, enter if known.

Special Content

1. Indicate if the course will meet instructional time in Code Administration or Existing Buildings.
2. Indicate if the course is a plumbing or electrical course, for ESIAC review and trainee course tracking.
3. If the course is associated with a conference, indicate the conference name and location, as this will allow BBS to coordinate approvals with the conference provider.
4. If the course will be offered online, specify whether it will be on demand or offered as a virtual webinar, or both. Include website where the course will be provided.

Course applicable for the following certifications

This section represents a major change from previous BBS course approval forms.

1. If the course is only for residential certifications, check 'Residential Certifications Only'. The course, if approved, will be approved for all residential certifications.
2. If the course is appropriate for any commercial certifications, check Commercial Certifications. The course, if approved, will be approved for all commercial certification **AND** all residential certifications.
3. If the course is intended to meet required instruction in Code Administration (Chapter 1) or Existing Buildings (commercial or residential) check 'Administrative Course, All Certifications'.

Application Materials Included

This is a checklist for the course submitter's use, to be sure all materials necessary for review are included with the application. All materials should be submitted in .pdf format, along with the application, via email to Michael.Lane@com.ohio.gov or BBS@com.ohio.gov

Bret Johnston Bio
Journeyman Electrician since 1984
Master Electrician since 1994
Electrical Inspector for Sedgwick County (Wichita, Kansas) since 1992
Chief Building Inspector for Sedgwick County (Wichita, Kansas) since 2016
IAEI Member since 1993
Kansas Sunflower Chapter Secretary since 2012
Western Section President 2023

Christine Porter Bio
Intertek Testing Service Menlo Park CA
Christine Porter is a Field Evaluator – Conducting field evaluations of unlisted, modified, relocated, or used equipment for Intertek. She also provides Codes and Standards Training – Creating and providing classes and seminars for listing engineers, new field evaluators, as well as classes for Intertek clients, electrical & building trades associations, as well as code enforcement agencies on the applicable codes and standards. Christine taught in an electrical training/apprenticeship program for 32 years and earned Professor Emeritus from the Construction Industry Training College of Washington. Her duties included course development that involved creating training course material for electrical trainees and apprentices, as well as continuing education programs for certification purposes. She also earned recognition as a Subject Matter Expert (SME) from The National Center for Construction Education and Research (NCCER). She is a principal on CMP 5 covering the Grounding & Bonding requirements in NFPA 70, (NEC) National Electrical Code and a voting alternate on the Correlating Committee of NFPA 70 that correlates the requirements contained in NPFA 70, NFPA 70A, NFPA 70B, NFPA 70E, NFPA 73, NFPA 79, NFPA 110, NFPA 790, and NFPA 791. She is also an alternate on CMP 1 covering definitions and General Requirements in the NEC (NFPA 70). She serves as chair of NFPA 780 Standard for Installation of Lightning Protection Systems.

David Williams Bio
David Williams Electrical Inspector and Instructor, Delta Township, Michigan, and Lansing Community College. IAEI Code Panel 2008-2011-2014 CMP-5, Chair CMP-7 2017, 2020, 2023 CMP-10 and the NEC Correlating Committee. Master Electrician, Certifications: CEI-M, Certified Electrical Inspector-Master, IAEI, Electrical Inspector General and Electrical Inspector 1-2 Family. Dave serves on the UL Electrical Council and seven UL STP's. IAEI International Chairman of the Board of Directors 2022 and 2023. Secretary, IAEI-Michigan, Secretary NFPA Electrical Inspector Section.

Don Iverson Bio
Don Iverson is the Manager of Industry Codes & External Relations for Schneider Electric. His responsibilities are to support code adoptions on a national level as well as various roles within the business. Previously, Mr. Iverson was the Midwest Field Representative for the National Electrical Manufactures Association (NEMA). He has worked in the electrical field for over 22 years as a field electrician, apprenticeship instructor and, Electrical Inspector. He also holds a State of Michigan Electric masters & contractor's license and is a registered code official as an Electrical Inspector. Mr. Iverson is currently a member of NFPA 915, CMP 3 for the 2023 Representing Schneider Electric and past member of CMP 1 for the 2014, 2017 & 2020 NEC representing NEMA.

Gerald O'Connor Bio
Gerald has been with Eaton Corp. since August 2023 working in Electrical Codes & Standards. He was previously an electrical inspector with the City of Chicago for 6 years and is a part-time instructor with I.B.E.W. #134 technical institute in the greater Chicago area. He represented the IAEI on NFPA CMP-16 for the 2023 NEC and is waiting for approval as principal on CMP - 18. He also participates in NFPA 78 & 1078.

Jack Jamison Bio
Jack is the Chief Inspector with Jack E. Jamison, Jr. Inspections of Morgantown, WV. He holds a Bachelor of Science degree from Fairmont State University in Engineering Technology-Electrical Electronics. He is an ICC Master Code Professional, IAEI Certified Electrical Inspector Master, and a WV State Fire Marshall Class C Plans Examiner/Electrical Inspector. He is a founding member of the WV Chapter IAEI and currently serves as the Secretary and Education Committee. He has served as an IAEI Representative on the NFPA National Electric Code Making Panel for the last three code cycles on CMP 14, 18, and 11.

Joe Pavia Profile
Joe Pavia, P.E. is a Field Application Engineer with Eaton's Bussmann Business. He has over 30 years with Bussmann series solutions, specializing in training on the design and application of overcurrent protective devices and equipment in electrical distribution systems in accordance with the National Electrical Code® and equipment in accordance with the various product standards. He is a registered Professional Engineer for several States, serves on UL508C / UL61800-5-1 STP, NEMA SC07 committee and on Code Making Panel 11 for the National Electrical Code (NFPA 70). He also is active in various trade organizations including the Independent Electrical Contractors (IEC), International Association of Electrical Inspectors (IAEI), Institute of Electrical and Electronic Engineers (IEEE), National Electrical Manufacturer's Association (NEMA) and the National Fire Protection Association (NFPA).

Tim McClintock Bio
Tim McClintock has 36 years' experience in the electrical industry and is currently the National Electrical Manufacturers Association (NEMA) Midwest Technical Field Representative. In this role Tim serve NEMA members by promoting the use and adoption of the National Electrical Code® (NEC®) and by monitoring regional developments of importance to the electroindustry. Prior to joining NEMA, Tim was a Regional Electrical Code Specialist with the National Fire Protection Association (NFPA) providing support to state and local jurisdictions across 26 states with the adoption and use of the NEC® and other NFPA electrical codes and standards. Tim also served as the Chief Building Official and Electrical Inspector for the Wayne County Building Department in Wooster, Ohio for 16 years and prior to that, worked for nine years as an electrician for McClintock Electric Incorporated.
He served on Code Making Panel 12 for the 2008 and 2011 NEC code development cycle and also served as Chair of NFPA's Technical Committee on Electrical Equipment Evaluation, which is responsible for NFPA 790, Standard for Competency of Third-Party Field Evaluation Bodies and NFPA 791, Recommended Practice and Procedure for Unlabeled Electrical Equipment.
Tom Lichtenstein Bio
Tom Lichtenstein is a Sr. Regulatory Engineer and Distinguished Member of Technical Staff in the Codes and Regulatory Services Department at UL Solutions Northbrook Office. As an electrical engineer with UL for 33 years, Tom is UL's principal representative for NEC CMP-7 (formerly CMP-19) for seven code cycles and past alternate on CMP-1 for the 2011 NEC. In addition, was UL's representative for several

cycles on the Canadian Electrical Code (CEC), Part 1 committee and the Canadian Advisory Council on Electrical Safety (CACES) and is responsible for supporting the UL Mark for the Western Section of the International Association of Electrical Inspectors (IAEI) and providing technical presentations and support services for regulatory authorities.

Tom Moore Bio

Tom Moore, Akron Ohio, is past President of the IAEI Western Section, Ohio Chapter and Akron Division and past IAEI IO Board of Directors, Assistant Secretary/Treasurer of the Western Section IAEI' President and Membership Chair of the Akron Division IAEI.   He has been involved in the inspection industry since 1987 and the electrical industry for over 50 years. Tom retired as the the Assistant Building Commissioner with the City of Beachwood Ohio and presently back building and electrical inspector for the City Stow and Portage County.

Tom has represented the IAEI on NEC CMP 11 for the 2005, 2008, and 2011code cycles and previously CMP 5 for the 2002 Code Cycle, Chair of CMP 16 for the 2014, 2017 and 2020, and presently Chair of CMP 8 code cycles. Tom is presently Chair of CMP 8. Additionally, served on NFPA 915 Standard for **Remote Inspections.**

Wendell Whistler Bio

Wendell Whistler was born in Juneau, Alaska in 1960. He graduated from Juneau-Douglas High School in 1978 and served his electrical apprenticeship in Alaska and graduated from the A.J.E.A.T.T. program in 1984. Wendell has also attended University of Alaska and Oregon State University enrolled in the Electrical Engineering program. Over his 43-year career as an electrician he has worked on the Alaska Pipeline and Seafood canneries helped build or maintain several small Alaskan airports, worked on nuclear power plants in California and has been on construction crews in many different states. Wendell holds an Oregon Electrical Supervisors license, an Oregon OIC certificate, an Alaska Electrical Administrators license, Idaho Master Electricians License and Journeyman Electrical licenses in Alaska and Washington along with a NCSCB medium voltage cable splicers certificate. He is an approved instructor for both 10- and 30-hour OSHA courses and a MSHA above ground (24 hour) and under-ground (40 hour) instructor and an Extra class Amateur radio (HAM) license holder

Wendell started working as a follow-up services inspector for Intertek Testing in 2004 and then moved into doing field evaluations later that year. Became the team leader for the Western U.S.A. and coordinated 25 + field inspectors along with being a reviewer for the field reports. Most recently he worked for QPS America as a senior field inspector. Has numerous standards that he is competent is Such as UL 48, 1598, 73, 499, 61010-1, 508A, ISA 12.12.01

NFPA 70, 79, 99, 101.

Wendell began teaching apprenticeship and journeyman classes in 2000 and opened his own business, Whistler Consulting and Technical Services in 2002. Classes were approved in Alaska, Idaho, Oregon, and Washington.

Wendell is the former Apprenticeship Coordinator for the Central Electrical JATC and the former Training Coordinator for AJEATT in Fairbanks, AK.

Tom Lichtenstein Bio

Tom Lichtenstein is a Sr. Regulatory Engineer and Distinguished Member of Technical Staff in the Codes and Regulatory Services Department at UL Solutions Northbrook Office. As an electrical engineer with UL for 33 years, Tom is UL's principal representative for NEC CMP-7 (formerly CMP-19) for seven code cycles and past alternate on CMP-1 for the 2011 NEC. In addition, was UL's representative for several cycles on the Canadian Electrical Code (CEC), Part 1 committee and the Canadian Advisory Council on Electrical Safety (CACES) and is responsible for supporting the UL Mark for the Western Section of the International Association of Electrical Inspectors (IAEI) and providing technical presentations and support services for regulatory authorities.

THE WESTERN SECTION IAEI
2023 WESTERN SECTION SPECIAL OHIO MEETING
OUTLINE AND TIME SCHEDULE

Registration

Pre-Function Area - Registration

Sunday, April 23, 2023- 2:00 pm until 5:00 pm
Monday, April 24, 2023 - 7:00 am until 9:00 am

Please check the hotel event board for any room changes

Sunday April 23, 2023

12.00 pm – 5:00 pm - **Registration**

1:00 pm – 2:00 pm Secretaries, Membership &
Education Chair Meeting

2:00 pm - **Opening of Exhibits**

2:00 pm to 5:00 pm **Ohio Chapter Board of Directors Meeting**

5:00 pm- Exhibit Area Closed

6:30-8:30 pm- **Welcoming Reception**

Monday, April 24, 2023

NOTE: 1.85 CEU's (1.85 contact hours) will be awarded for attending the complete educational program registration forms must be signed and submitted at the proper time for CEU's to be awarded. NO PARTIAL CEU's WILL BE ISSUED.
IO CEU Credits 1.8
Ohio BBS all Certifications 18.5 hrs.
Ohio OCILB all disciplines 18.5 hrs.

7:00 am – 8:00 am **Registration & Visit Exhibit Displays**

1. Call to Order- Welcome
   -Bret Johnston, President-Western Section

2. Introduction of Color Guard -
   TBD -

3. Pledge of Allegiance–
Bob Sallaz

4. Invocation
Bob Sallaz

5. Welcome to Millersburg
- Dave Hall – Holmes County Commissioner

6. -Western Section President Address-
-Bret Johnston, Kansas

7. Ohio Appointment of Nominating Committee
- Karl Fredrick -Ohio Chapter President

8. Address of IAEI Chairman of the Board
- David Williams, Lansing, MI

9. IAEI President/ CEO Report
-Rudy Garza, Richardson, TX

10. NFPA Report NFPA Regional Electrical Specialist
- Tim McClintock

11. Western Section Secretary Report
-Tom Moore, Akron, OH

12. Introduction of Manufacturers/Exhibitors

9:00 am- **NFPA Correlating Committee Report** 1 hr.
- Larry Ayre, Chair Correlating Committee
- David Williams, Correlating Committee & CMP 10

10:00 am- Coffee, Rolls and Visit Displays

Refreshments Courtesy of:
TBD

10:15 IAEI NEC 2023 Analysis 1.75 hrs.
- Don Iverson Schneider, Electric CMP 3
- Tim McClintock, NFPA

12:00 Noon- Recess for Lunch & Visit Displays
General Member's Luncheon

1:00 pm – **Code Panel 1 Forum – Your questions Answered by NEC Code Panel Members** 2 hrs.

Moderator: OP Post – Previous Past Ohio Chapter President

-Brian Deacy, Atkore Manufacturing
CMP 3 & CMP 5
-Tom Moore, City of Stow
CMP 8
-Gerald O'Connor Eaton Corporation

CMP 16
-Wendall Whistler QPS America
CMP 4
-Borgia Noel, State of Wyoming
CMP 6
-Tom Lichtenstein, UL
CMP 7

3:00 pm- **Break and Visit Displays**
Refreshments Courtesy of:
TBD

3:15 pm – **IAEI NEC 2023 Analysis** 1.75 hrs**.**
- Don Iverson Schneider, Electric CMP 3
- Tim McClintock, NFPA

5:00 pm- Adjournment

--- On Your Own Dinner

TUESDAY, SEPTEMBER 20, 2023

7:00 am - Coffee, Rolls and Visit Displays
Refreshments Courtesy of:
TBD

8:00 am – **Code Panel 2 Forum – Your questions Answered by NEC Code Panel Members** 1.75 hrs.

Moderator: OP Post – Previous Past Ohio Chapter President
-Don Iverson - Schneider Electric
CMP 1 & CMP 3
-Christine Porter - Intertek
CMP 6
-Steve Froemming – City of Franklin, WI
CMP 13
-Jack Jamison - WV Chapter IAEI
CMP 11
-Bob Fahey – City of Janesville, WI
CMP 18
- Joe Pavia Bussmann
CMP 13:

9:45 am- Break and Visit Displays
Refreshments Courtesy of:
TBD

Note: Display booths will be closing at 3:15 pm

10:00am – **IAEI NEC 2023 Analysis** 2 hrs.
- Don Iverson Schneider, Electric CMP 3
- Tim McClintock, NFPA

12:00 Noon- Recess for Lunch & Visit Displays
-General Member’s Luncheon

Location TBD
-Ohio Board of Directors & Past Chapter &
Section President's Luncheon

1:00 pm- **Ohio Chapter Business Meetings**

1. Report of Board of Directors Meeting (Chapter Secretary)
2. Report of Nominating Committee
3. Election of Officers, Board of Directors Members
   (Voting by Ohio Chapter Members only)

1:30 pm – 2:15 pm BBS Report Regina Hanshaw .75 hrs.

2:15 pm – 3:00 pm OCILB Report Carol Ross .75 hrs.

3:00 pm - Break and Visit Displays
Refreshments Courtesy of:
TBD

3:15 pm – **IAEI NEC 2023 Analysis** 1.75 hrs.
- Don Iverson Schneider, Electric CMP 3
- Tim McClintock, NFPA

5:00 pm - Adjournment

6:00 pm - **Reception, Banquet, Dinner**
Installation of Officers, Door Prizes &
Entertainment

WEDNESDAY, SEPTEMBER 22, 2023

7:00 am – **Photovoltaic Systems & Energy Storage Systems** 2 hrs.
Wendall Whistler
NEC CMP 4

9:00 am - Break
Refreshments Courtesy of:
TBD

9:15am – **Ohio Required Instruction: Existing Buildings** 3 hrs.
- Jay Richards BBS
- Mike Thompson DIC

12:15 pm- Adjournment of the 2023 Western Section Meeting

Note: IAEI IO and Ohio BBS CEU Certificates for All Attendees Who Submitted the For CEU's will be Available following Wednesday Adjournment. OCILB hours will be entered directly into the OCILB database.

The Western Section IAEI thanks all the members of the Ohio Chapter for making this Annual Meeting a Success

Please join us for our 2023 Annual Western Section Meeting September 17 – 20, 2023 at Oglebay Resort in Beautiful Wheeling, WV.

Inspecting Solar Panel Installations

- NEC Article 690
- Plan Review
- PV Modules and Arrays
- Nameplate
- Mechanical Attachment
- PV System Components
- Off Grid Solar Components
- PV Labeling
- Solar PV Priorities
- PV Layout
- Grounding
- Overcurrent Protection
- Inverters & Micro-Inverters
- Markings
- Disconnects
    - Rapid Shutdown
- UL Standards
    - UL 6703 Electrical Connections
    - UL 1741 Inverters & Controllers
    - UL 1703 PV Modules
    - UL 4703 PV wire
    - UL 2703 Mounting Systems
        - Racking

eurofins | E&E

Inspecting Solar Panel Installations

Presented By:
Wendell Whistler

INTRODUCTION

Testing Services

- Product Safety
- EMC
- Wireless/OTA
- Environmental Simulation
- Field Evaluation

Field Evaluations

- Typically required by AHJs or end users
- Custom equipment
- Certified equipment that has been modified
- CE-marked equipment
- Unlisted equipment

Field Evaluation Services

- **We are a resource for AHJs and Contractors**
  - Standards consultation
  - Continuing education
- **Code making panels**
- **Very active in IAEI**

Contact Information

Wendell Whistler - Senior Field Engineer

wendell.whistler@metlabs.com

Cell: (971) 289-6652

Inspecting Solar Panel Installations

380

NEC Article 690

Solar Photovoltaic (PV) Systems

Part I General

Part II Circuit Requirements

Part III Disconnecting Means

Part IV Wiring Methods

Part V Grounding and Bonding

Part VI Marking

Part VII Connection to other Sources

Part VIII Energy Storage Systems

Plan Review

What size PV projects require plan review?

Residential

Commercial

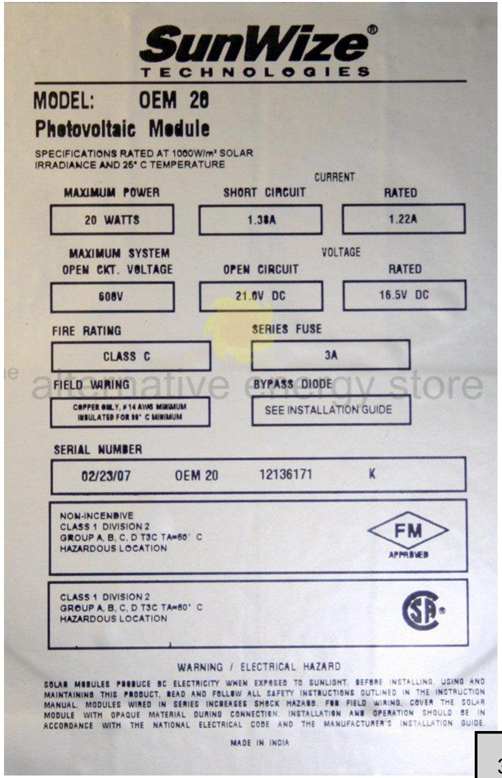
Large scale PV

PV Modules and Arrays

UL 1703 Standard for Flat-Plate Modules and Panels

- 110.3
- 690.4(B

Module Nameplate



Mechanical Attachment

- Modules attached to the listed mounting structure the manufacturer's instructions {(110.3 (B)}
- Roof penetrations secure and weather tight {110.12, 110.13}

UL 2703

Standard for Mounting Systems, Mounting Devices, Clamping and Retention devices and Ground Lugs for use with Flat-Plate Photovoltaic Modules

Racking

Racking

Module Nameplate Information

windynation

www.windynation.com

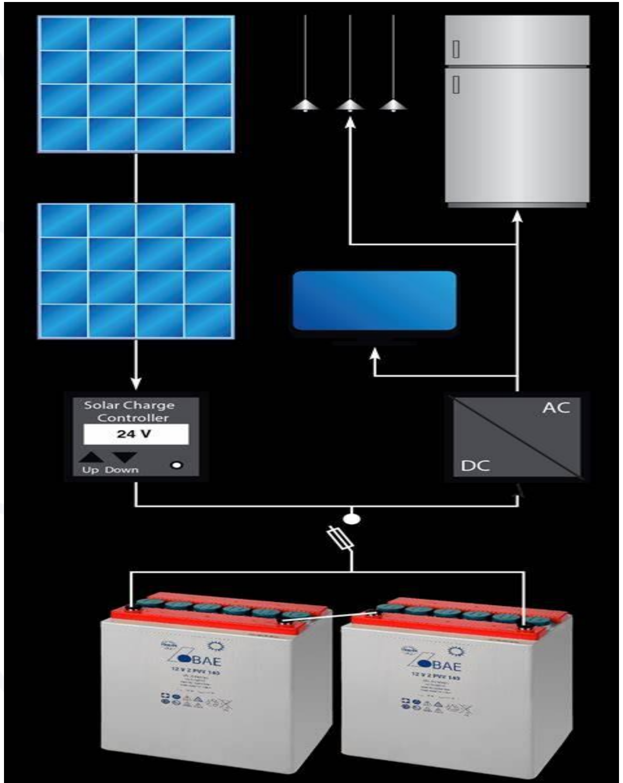
clean | power to the people

100W Polycrystalline Photovoltaic Solar Panel

Part #:	SOL-100P-01
Maximum Power (Pmax):	100 Watts
Open Circuit Voltage (Voc):	21.60 Volts
Short Circuit Current (Isc):	6.32 Amps
Max Power Voltage (Vpm):	17.40 Volts
Max Power Current (Imp):	5.75 Amps
Max System Voltage:	1000 VDC (600 VDC UL)
Dimensions:	40.0" x 26.4" x 1.2" [1015mm x 670mm x 30mm]
Weight:	18.7 lbs [8.5kg]
Max Series Fuse Rating:	8 Amps
Nom Operating Cell Temp:	48 C [+/-2]

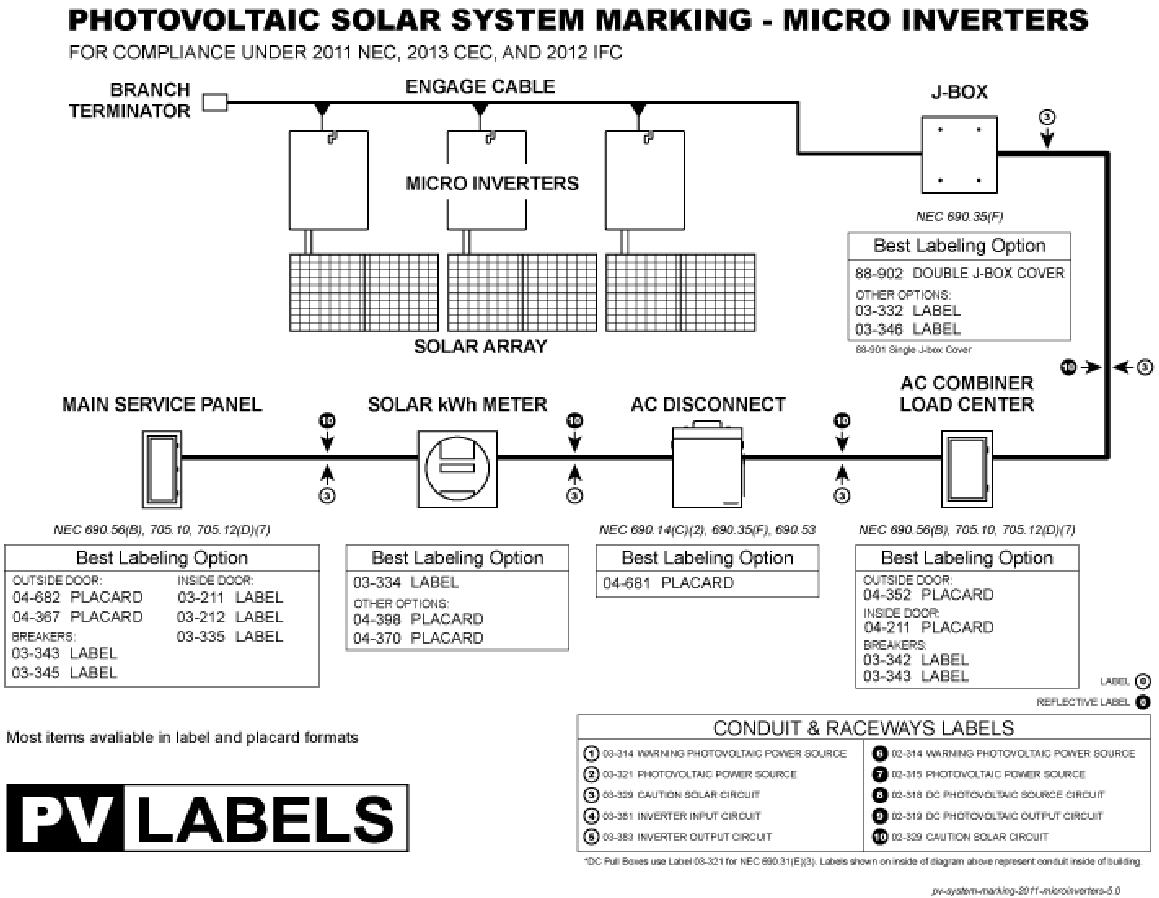
C US UL-1703 CE VDE RoHS

Off Grid Solar Components

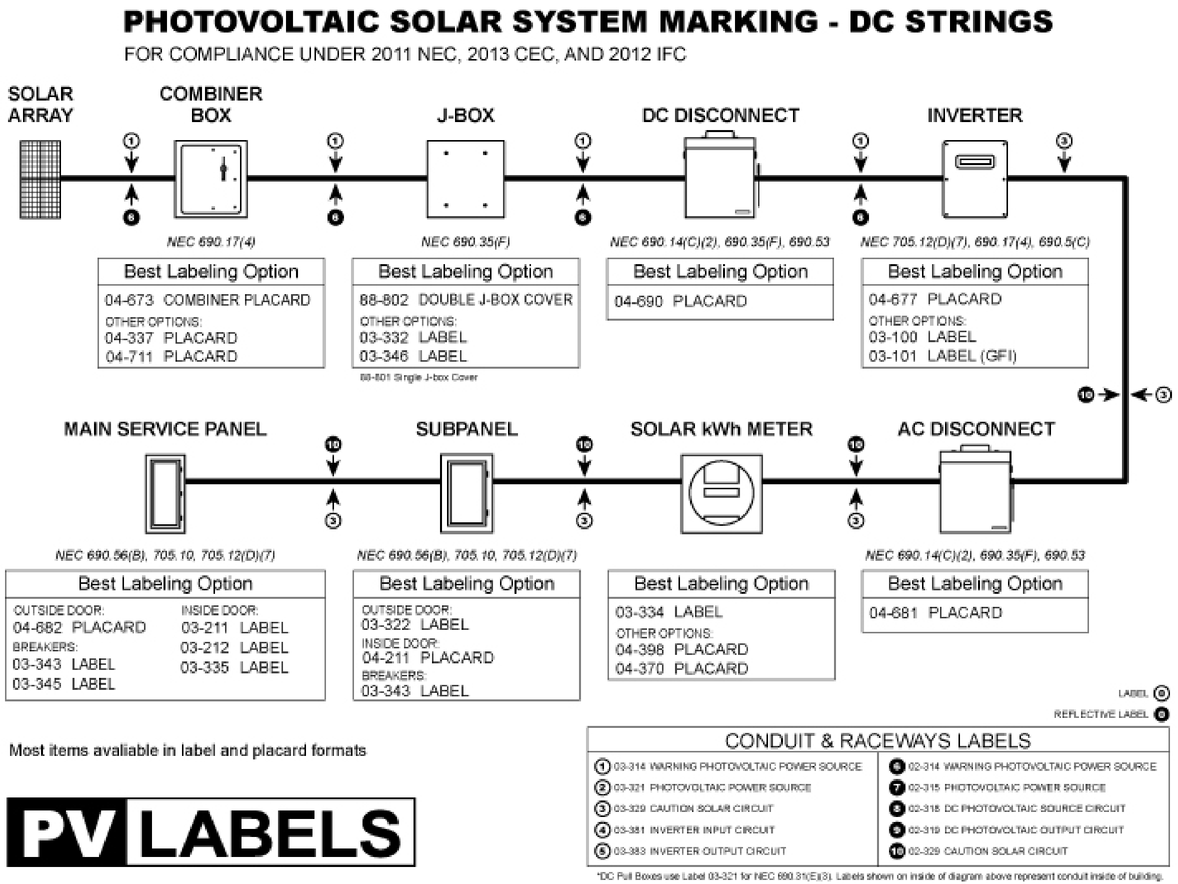


Example of an off-grid solar photovoltaic system

PV Labeling Micro-inverters



PV Labeling Micro-inverters



Solar PV Priorities

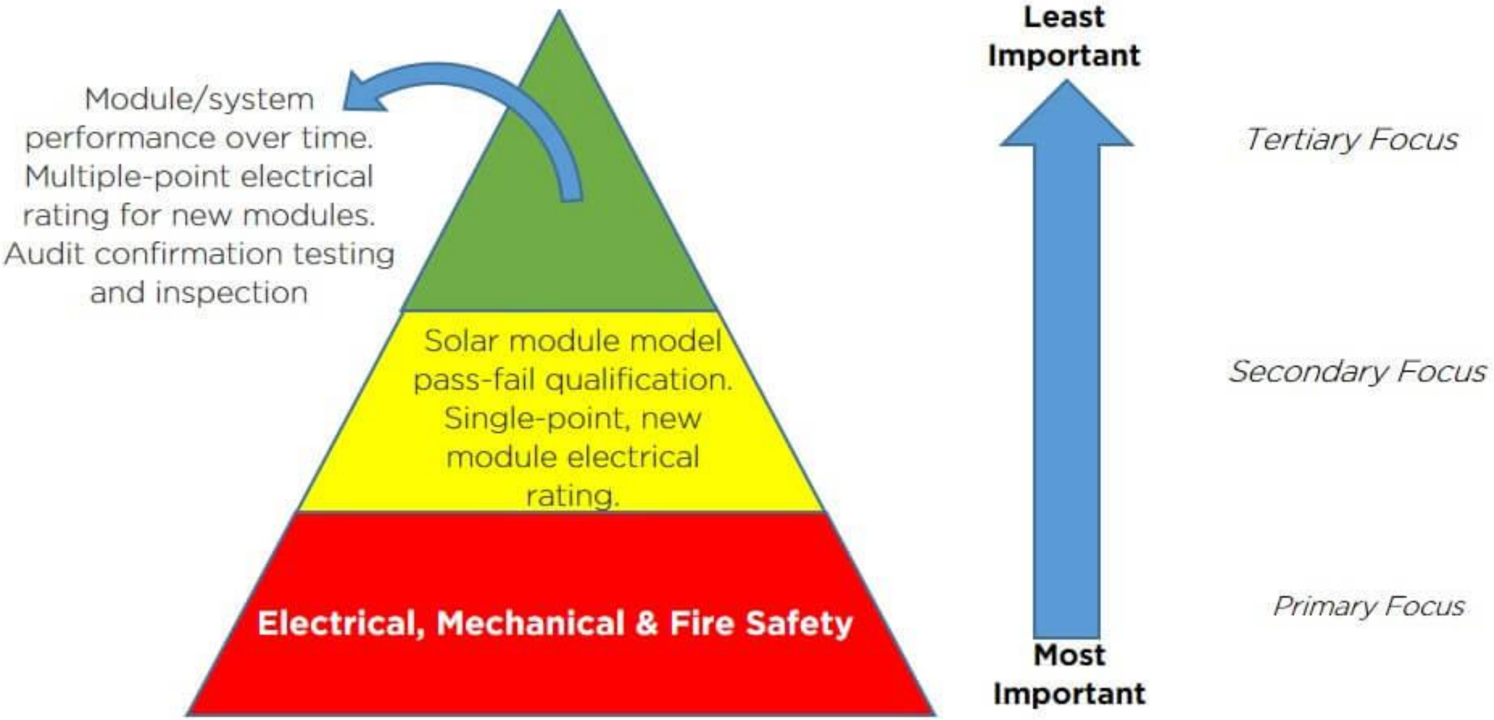
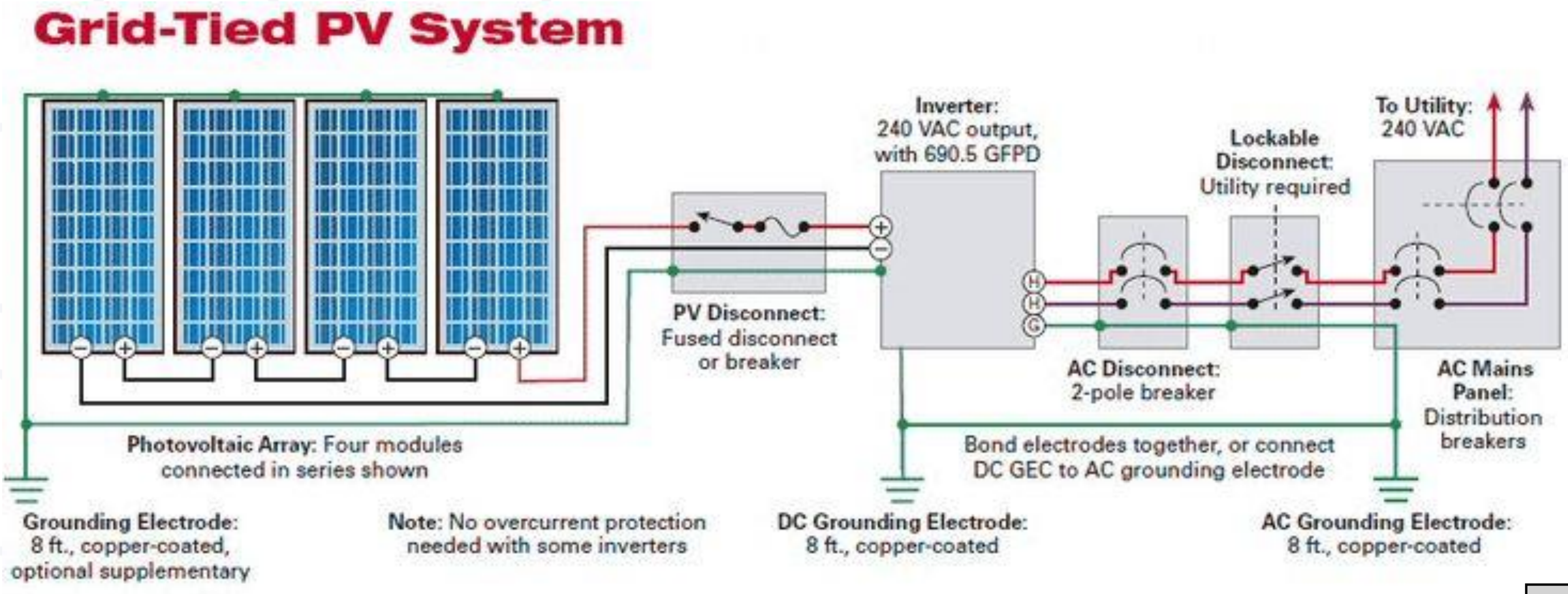
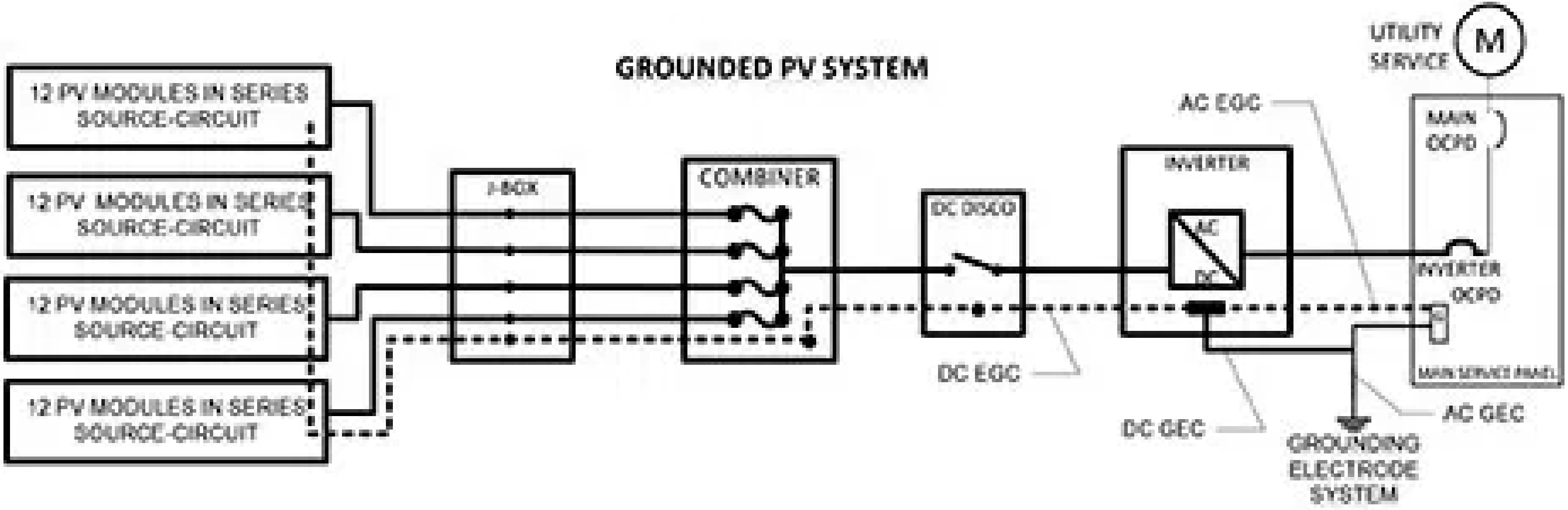


Figure 1. Hierarchy of Solar PV Priorities

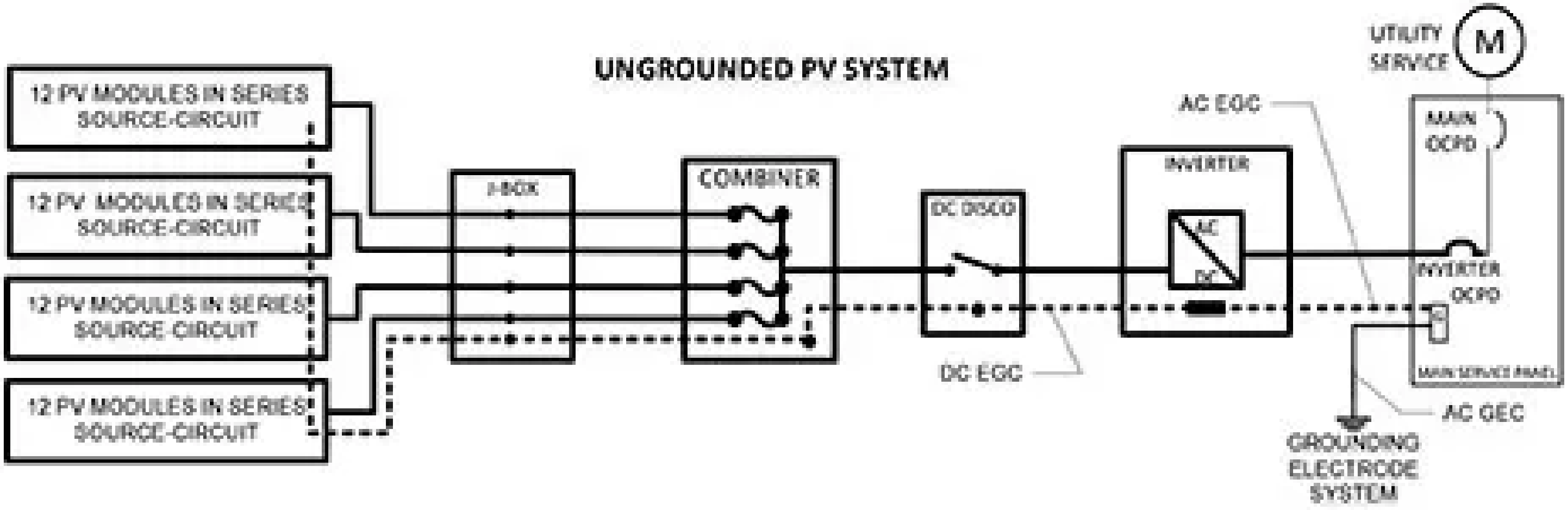
Layout of Grid Tie PV System



Grounded PV System



Ungrounded PV System



Grounding

Each module grounded using supplied hardware, the grounding point identified on the module and the manufacturer's instructions.

Bolting the module to a grounded structure usually will not meet the NEC requirements in 110.3(B) and may not comply with the installation instructions for grounding the PV module.

Array PV mounting racks are usually not identified as equipment grounding conductors unless listed to UL 2703

Grounding

690.43

Module instruction manual must specifically show or indicate grounding and mounting methods.

690.45

Properly sized equipment grounding conductors (EGC) routed with the circuit conductors

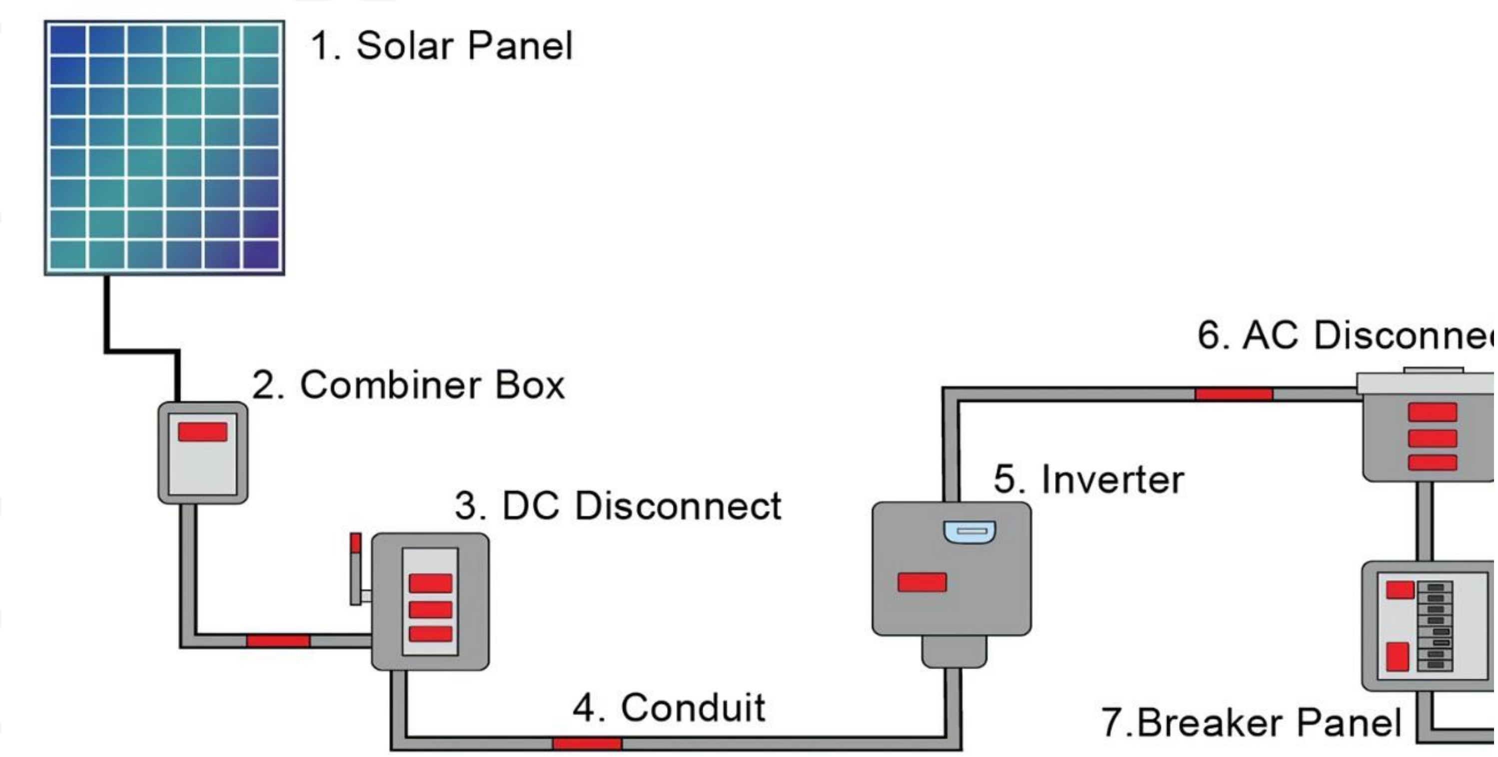
Listed PV grounding clamps

Means of grounding terminations

Grounding Terminations

http://www.solarabcs.org/about/publications/reports/systemgrounding/pdfs/SystemGrounding_studyreport.pdf

PV System Components



Conductors

Standard for Photovoltaic Wire

UL 4703

Conductors


UL 4703
PV WIRE
Photovoltaic
MADE IN U. S. A.
UNLIMITED SOLAR


E339768 (UL) PV Wire 10AWG 90°C Dry

Conductors

Listed Conductors UL 4703

Conductor Type-

If exposed USE-2 or PV wire for grounded PV arrays

All PV modules will use PV wire

> ***2017 NEC allows USE-2 or PV wire for both grounded and ungrounded systems***

Conductor Insulation

Conductor insulation rated at 90 degrees C (UL 1703) to allow for operations 70 degrees C near modules and in conduit or cables exposed to sunlight {Table 310.15 (B) (3) (c)}

Temperature corrected ampacity calculations based on 125% of short circuit current (Isc) or the 156% Isc without conditions of use.

Use the worst case

Conductor Temperature Correction

Suggest temperature derating factors of 65 degrees C for conductors behind modules in installations where the backs of the modules receive cooling air (4 " or more from the roof)

Suggest temperature derating factors of 75 degrees C for conductors behind modules in installations where no cooling air can get to the backs of the modules

Ambient temperatures near and at the array location of more than

40 degrees C may require different derating factors

Overcurrent Protection

Overcurrent devices in the DC circuit listed for DC operation?

If device is not marked for “DC” verify listing with the manufacturer

Auto, Marine and Telecom devices are not acceptable

In PV circuits OCPD must be listed as a PV device {690.9 (B)}

Rated at 156% (1.25 x 1.25) short circuit current from modules?

{UL 1703, 690,8 and module instructions}

Overcurrent devices listed for PV applications are required

{690.9(B)}

Overcurrent Protection

- **Each module or series string of modules have an overcurrent devices protecting the module(s)?**
- **Frequently installers ignore this requirement marked on the back of the modules**
- ***Listed combiner boxes meeting this requirement are available. One or two strings of modules do not generally require overcurrent devices, however three strings or more in parallel will usually require an overcurrent device. The module maximum series fuse must be at least 1.56 Isc. {690.9(A)}***

Overcurrent Protection

- Only one conductor of and ungrounded PV source or PV output circuit is permitted to have and Overcurrent Protective Device (OCPD).
- If used other OCPD’s in the dc circuit must be in the same polarity
- Located in a position in the circuit to protect the module conductors from back-fed currents from parallel module circuits or from the charge controller or battery? {609.9(A)}

Overcurrent Protection

- Is the smallest conductor used to wire modules protected? Sources of overcurrent are parallel connected modules, batteries and ac back feed through inverters. {690.9(A)}

- Are User accessible fuses in “touch safe” holders or fuses capable of being changes without touching live contacts? Disconnect form all sources of voltage in dc combiners at the inverter? {690.16}

Electrical Connections

UL 6703 Standard for the use in Photovoltaic Systems

Electrical Connections

- **Pressure terminals tightened to the recommended torque specifications? {110.3(B), 110.14}**
- **Crimp-on terminals listed and installed with the listed crimping tools by the same manufacturer? {110.3 (B)}**
- **Twist on wire connectors listed for the environment (dry, damp, wet or direct burial) and installed per manufacturer's instructions?**

Electrical Connections

- Pressure lugs or other terminals listed for the environment? (inside, outside, wet or direct burial)
- Power distribution blocks (PDB) listed and not just a recognized ?
- Terminals containing more than one conductor listed for multiple conductors?
- Connectors or terminals using flexible fine stranded conductors listed for use with such conductors? {690.321(H), 690.74 (A), 110.14}
- Locking connectors (tool required) on readily accessible {V conductors operating at over 30 volts? {690.33 (C)}

Charge Controllers

- Charge controllers listed to UL 1741? {690.4(B)}
- Exposed energized terminals not readily accessible?
- Does the diversion controller have an independent back-up control method {706.23 (B) (1)}

Disconnects

- **Rapid shutdown system installed? {690.12}**
- **Applied to inverter inputs, module outputs, batteries and combiner outputs.**
- ***Listed equipment is available and the UL Standards addressing the requirements are published.***
- **Rapid Shutdown operation verified?**
- **Disconnects listed for dc operation in DC circuits?**
- **PV disconnect readily accessible and located at the first point of penetration of the PV conductors? (Location not specified)**

Disconnects

- **PV conductors outside of the structure until reaching the first readily accessible disconnect unless in a metallic raceway?**
  {690.13(A) & 690.31 (F)}
- ***Metallic raceway now required all of the way to the inverter dc input***
- **Disconnects for all current carrying conductors for the PV system?**
  {690.13}
- **PV system disconnect must disconnect all circuit conductors even on solidly grounded systems. However solidly grounded conductors should not be opened.**

Disconnects

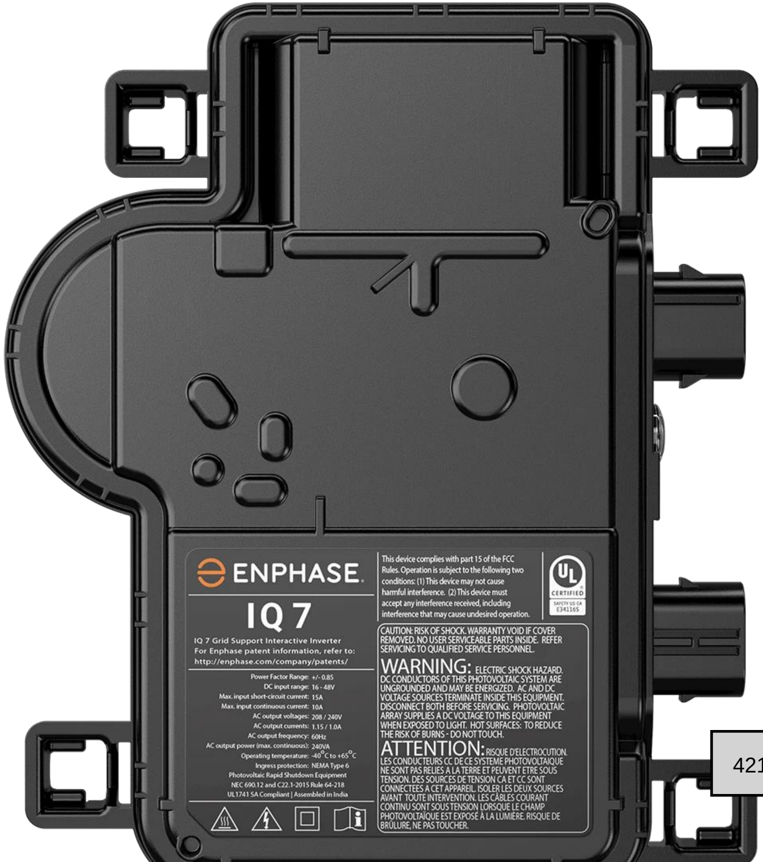
- Disconnects for equipment? {690.15 & 690.17}
- Equipment isolation disconnects may disconnect only the ungrounded conductor
- DC combiner has output circuit disconnect/isolator internal or within 10 ft? {690.15(A)}

Disconnects

- Grounded conductors are NOT fused or switched except PV system disconnect?
- Listed PV Power centers are available for 12, 24 and 48-volt systems. They contain charge controllers, disconnects and overcurrent protection for the entire dc system with the possible exception of the source circuit and module protective devices

Inverters

Micro-Inverters



Inverters

- Stand Alone systems
- Inverters listed to UL 1741 {110.3(B) 690.4 (B)}
- DC input current from the battery calculated for conductor and fuse requirements? Input current equals rated ac output in watts divided by the lowest battery voltage divided by the inverter efficiency at that power level {690.8 706.20}
- Cables to batteries sized at 125% of the inverter input current? {609/8(a) 706.20}

Inverters

- Overcurrent/Disconnects mounted near batteries and external to PV load centers if conductors are longer than 4-5 feet to batteries or inverter.
- High interrupt listed DC-rated fuses or circuit breakers used in battery circuits? Ampere Interrupt Rating at least 20,000 amps {706.21 110.9 110.10}
- No multi-wire branch circuits where 120-volt inverters are connected to 120/240 volt load centers. {710.15}

Batteries

- NO separate battery cells are listed
- AC battery systems are generally self-contained and will be listed as an assembly
- Building wire type cabling used?
- Must be a Chapter 3 type conductor. No welding cable , DLO, appliance wire (AWM) or automotive battery cables. Do NOT meet NEC. Listed flexible RHW and THW cables available. Flexible cable 2/0 and larger for battery cell connections {690.74 400.8}. Fine stranded (Class K) cables require special listed terminations {110.14 690.74}

Batteries

- Access limited? {706.30}
- Installed in well ventilated areas? {706.10 (A)}
- Have the conductor routing requirements in 706. 20 and 706.32 been met?
- Cables to inverters, dc load centers and/or charge controllers in conduit?
- Conduit enters the battery enclosure below the terminals of the flooded batteries? {300.4} There are a few listed battery boxes. Lockable heavy-duty plastic polyethylene toolboxes are usually acceptable

Utility Interactive Inverter Systems

UL 1741

- Standard for Inverters, Converters, Controllers and Interconnection System Equipment for use with Distributed Energy Resources
- Identified for use in interactive photovoltaic power system {690.4(B) 705.4}
- Back-up charge controllers to regulate the batteries in the systems with multi-mode inverters when the grid fails. {706.23(B)}
- Connected to dedicated branch circuits with back-fed overcurrent protection?{705.12(B)} or connected as a supply side connection with overcurrent protection within 10 feet? {705.12(A) 705.31}

Utility Interactive Inverter Systems

- Listed dc and ac disconnects and overcurrent protection?{690.15 690.17}
- All requirements of 705.12 (A) or 705.12(B) met?
- Square wave or modified sine wave inverters may be listed to UL 1741 but are not compatible with many power tools battery chargers, smoke alarms and other listed electronic devices and should NOT be used. The manufacturer's instructions will usually have a warning statement {110.3(B)}

Grounding

- **Only one bonding conductor (ground only on solidly grounded PV systems) for DC circuits on grounded PV arrays and one bonding conductor for ac circuits (neutral to ground) for ac system grounding**
- ***Utility interactive inverters will generally provide the "Functional ground" for the system. Instructions for "functional ground will be in the inverter instruction manual***
- **System inverter grounding meets requirements of 690.47?**
- **EGC properly sized? {690.43 690.45 690.46}**

Grounding

- Disconnects and overcurrent in both ungrounded conductors in each circuit on 12-volt, ungrounded systems or on ungrounded systems of any voltage {690.9 690.13 690.15 690.31}
- Functionally grounded PV systems will not have any DC PV source or output conductors with white insulation
- Bonding-grounding fittings or bushings used with metal conduits when dc system voltage is more than 250 volts DC? {250.97}
- Grounding-bushings used where grounding electrode conductors are in metallic raceways or enclosures?

Conductors

- Standard building wire cables and wiring methods are used? {300.1 (A)}
- Wet rated conductors used in conduits in exposed locations?
- Conductor insulations other than black will NOT be durable in outdoor UV-rich environments
- DC color codes; are they correct?
- Same as AC color codes for grounded and grounding {200.6 (A)}
- Ungrounded PV array conductors on ungrounded PV arrays will NOT be white in color. White only used in solidly grounded PV systems {690.41}

Markings

- All field-applied markings; are they correct?

  {690.13 690.31(B) 690.51 690.53 690.54 690.55 705.10 705.12}

- Meet color and letter size requirements? {690.56}

DC PV Arc Fault

- Photovoltaic (PV) DC Arc-Fault Circuit Protection UL 1699 B
- Usually installed in the inverter or on larger systems in the array field. May be multiple devices {690.11}

PV Rapid Shutdown

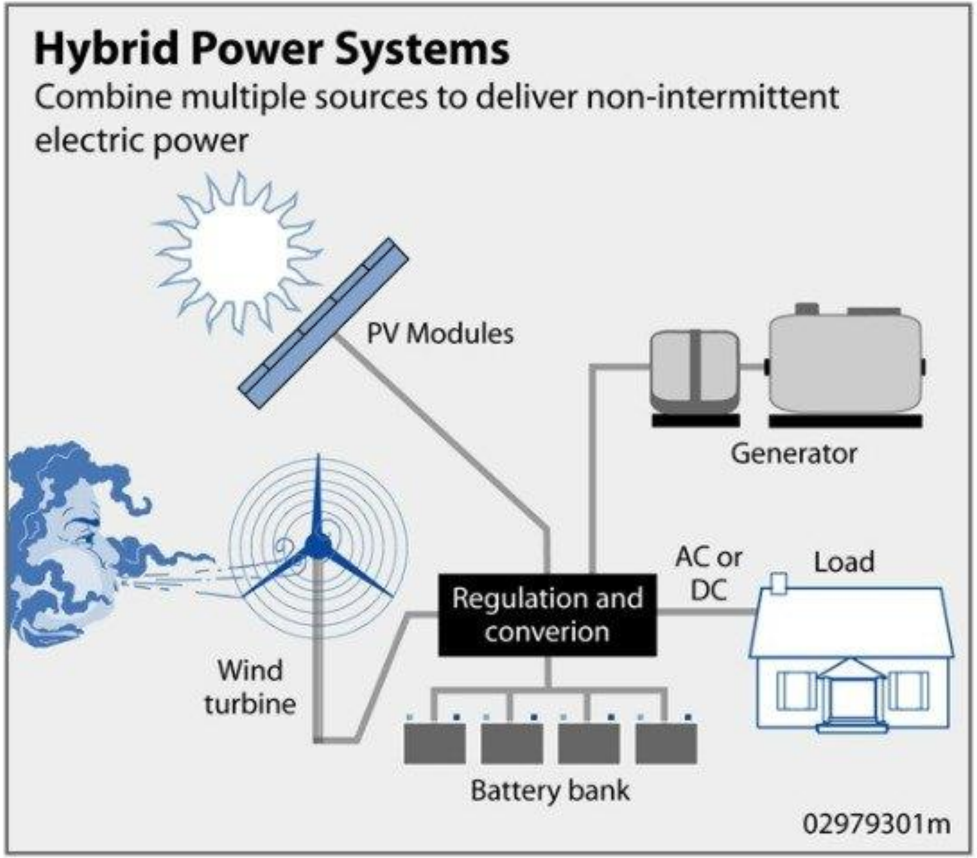
Installed per NEC 690.12 and local requirements?

Operational?

Article 691

- Large Scale Photovoltaic (PV) Electric Power Production Facility
- 5 Mega-watts and Larger
- Independent Power Producer

NEC Article 705



Combiner box

Combiner Boxes

Standards

- Rack Mounting products to UL 2703
- Modular Framing Systems to ICC AC 428
- Solar Trackers to UL 3703
- Junction Boxes to UL 3730
- Wiring Harnesses to UL Subject 9703
- Connectors to UL 6703

Standards

- Power Ratings to IEC 61853-1
- Inverters to IEC 62109-2
- UL1741 (Inverters, Combiner boxes, DC Optimizers, Charge Controllers)
- IEEE 1547.1 (Grid Interaction Equipment)
- UL4703 (PV Wire)
- UL/ULC ORD C1703 (PV Modules)
- IEC61730 (PV Modules Safety Requirements)
- IEC61215 (Performance Requirements for PV Modules)

Photovoltaic Power Systems

For Inspectors, Plan Reviewers 7 Professionals

Third Edition

John Wyles

International Association of Electrical Inspectors

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Thank you for attending

Questions?

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