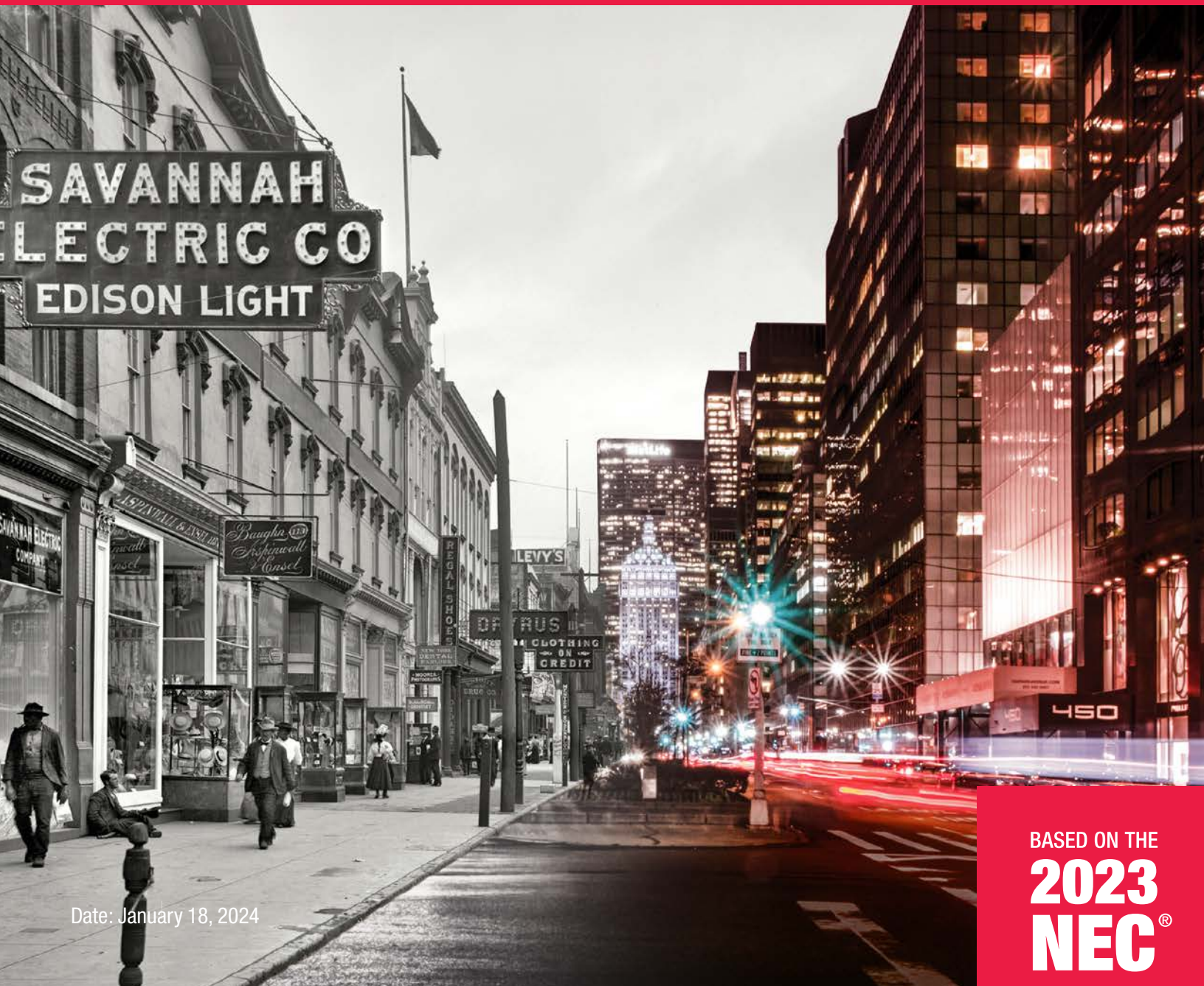
Mike Holt's Illustrated Guide to

TOP TEN CHANGES TO THE NATIONAL ELECTRICAL CODE®



Date: January 18, 2024

BASED ON THE
2023
NEC®

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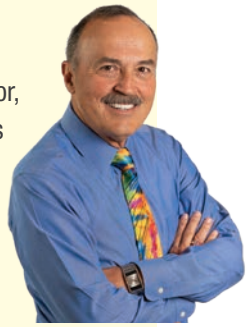
ABOUT THE AUTHOR



Mike Holt is an author, businessman, educator, speaker, publisher and *NEC®* expert. He has written hundreds of electrical training books and articles, founded three successful businesses, and has taught thousands of electrical *Code* seminars across the United States and internationally.

Mike's approach to electrical training is based on his own experience as an electrician, contractor, inspector and teacher. He's always felt a responsibility to his students and to the electrical industry to provide education beyond the scope of just passing an exam. This commitment, coupled with the lessons he learned at the University of Miami's MBA program, have helped him build one of the largest electrical training and publishing companies in the United States.

Mike's one-of-a-kind presentation style and his ability to simplify and clarify technical concepts explain his unique position as one of the premier educators and *Code* experts in the country. His passion for the electrical field drives his goal to increase electrical safety and improve lives.

Mike's commitment to pushing boundaries and setting high standards extends into his personal life. He's an eight-time Overall National Barefoot Waterski Champion with more than 20 gold medals, many national records, and he has competed in three World Barefoot Tournaments. In 2015, at the tender age of 64, he started a new adventure—competitive mountain bike racing. Every day he continues to find ways to motivate himself, both mentally and physically.

Mike and his wife, Linda, reside in New Mexico and Florida, and are the parents of seven children and six grandchildren. As his life has changed over the years, a few things have remained constant: his commitment to God, his love for his family, and doing what he can to change the lives of others through his products and seminars.

I dedicate this book to the
Lord Jesus Christ,
my mentor and teacher.
Proverbs 16:3

TABLE OF CONTENTS

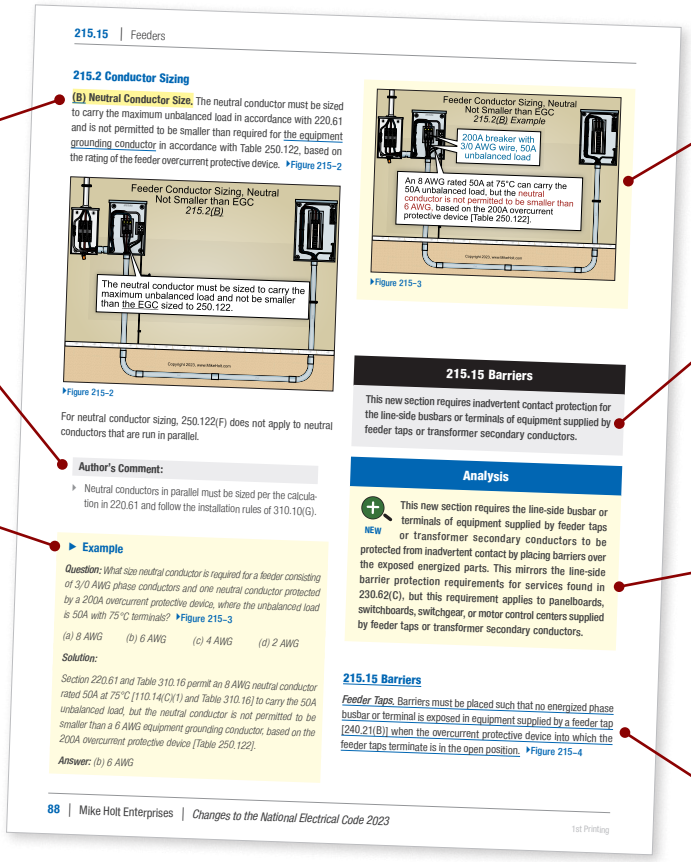
KEY FEATURES

Each first level subsection of each *Code* rule is highlighted in yellow to help you navigate through the text.

Author's Comments provide additional information to help you understand the context.

Examples and practical application questions and answers are contained in yellow boxes.

If you see an ellipsis (• • •) at the bottom right corner of a page or example box, it is continued on the following page.



Detailed full-color educational graphics illustrate the change in a real-world application.

A summary of the *NEC* change is indicated in a gray box immediately under a black bar with the *Code* rule title.

Analysis of the rule in the yellow box provides the explanation and context for the change.

Underlined text denotes changes to the *Code* for the 2023 *NEC*.

Code Change Icons

A *Code* Change icon signifies whether the rule is new, deleted, edited, reduced, clarified, expanded, reorganized, or moved.

Clarified—A change that clarifies the requirements of a rule that wasn't clear in the previous *Code* cycle.

Edited—An editorial revision that doesn't change the requirement; but it gives us the opportunity to review the rule.

Expanded—A change where a previous requirement(s) was expanded to cover additional applications.

New—A new requirement which could be an entirely new section, subsection, exception, table, and/or Informational Note.

Reduced—A change that's reduced the requirements from the previous edition of the *NEC*.

Relocated—This identifies a rule that was relocated from one section of the *Code* to another without a change in the requirement(s).

Reorganized—A change made to place the existing requirements in a more logical order or list.

ADDITIONAL PRODUCTS TO HELP YOU LEARN

Understanding the NEC Complete Video Library

Do you want a comprehensive understanding of the *Code*? Then you need Mike's best-selling Understanding the *NEC* Complete Video Library. This program has helped thousands of electricians learn the *Code* because of its easy-to-use format. Mike guides students through the most utilized rules and breaks them down in a complete and thorough way. The full-color instructional graphics in the textbooks help students visualize and understand the concepts being taught; the videos provide additional reinforcement with Mike and the panel discussing each article, its meaning and its application in the real world. When you need to know the *Code*, this program is the best tool you can use to start building your knowledge—there's no other product quite like it.

LIBRARY INCLUDES:

Understanding the *National Electrical Code*, Volume 1 Textbook

- *Understanding the National Electrical Code Volume 1 videos*

Understanding the *National Electrical Code*, Volume 2 Textbook

- *Understanding the National Electrical Code Volume 2 videos*

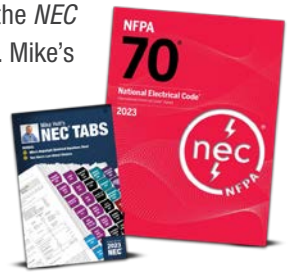
Understanding the *National Electrical Code* Workbook (Articles 90–480)

Bonding and Grounding Textbook

- *Bonding and Grounding videos*

Plus! Digital versions of the textbook and digitial answer keys

2023 *Code* Books and Tabs



The easiest way to use your copy of the *NEC* correctly is to tab it for quick reference. Mike's best-selling tabs make organizing your *Code* book easy. Please note that if you're using it for an exam, you'll need to confirm with your testing authority that a tabbed *Code* book is allowed into the exam room.

To order your *Code* book and tabs, visit MikeHolt.com/Code.

HOW TO USE THE *NATIONAL ELECTRICAL CODE*

The original *NEC* document was developed in 1897 as a result of the united efforts of various insurance, electrical, architectural, and other cooperative interests. The National Fire Protection Association (NFPA) has sponsored the *National Electrical Code* since 1911.

The purpose of the *Code* is the practical safeguarding of persons and property from hazards arising from the use of electricity. It isn't intended as a design specification or an instruction manual for untrained persons. It is, in fact, a standard that contains the minimum requirements for an electrical installation that's essentially free from hazard. Learning to understand and use the *Code* is critical to you working safely; whether you're training to become an electrician, or are already an electrician, electrical contractor, inspector, engineer, designer, or instructor.

The *NEC* was written for qualified persons; those who understand electrical terms, theory, safety procedures, and electrical trade practices. Learning to use the *Code* is a lengthy process and can be frustrating if you don't approach it the right way. First, you'll need to understand electrical theory and if you don't have theory as a background when you get into the *NEC*, you're going to struggle. Take one step back if necessary and learn electrical theory. You must also understand the concepts and terms in the *Code* and know grammar and punctuation in order to understand the complex structure of the rules and their intended purpose(s). The *NEC* is written in a formal outline which many of us haven't seen or used since high school or college so it's important for you to pay particular attention to this format. Our goal for the next few pages is to give you some guidelines and suggestions on using your *Code* book to help you understand that standard, and assist you in what you're trying to accomplish and, ultimately, your personal success as an electrical professional!

Language Considerations for the *NEC*

Terms and Concepts

The *NEC* contains many technical terms, and it's crucial for *Code* users to understand their meanings and applications. If you don't understand a term used in a rule, it will be impossible to properly apply the *NEC* requirement. Article 100 defines those that are used generally in two or more articles throughout the *Code*; for example, the term "Dwelling Unit" is found in many articles. If you don't know the *NEC* definition for a "dwelling unit" you can't properly identify its *Code* requirements. Another example worth mentioning is the term "Outlet." For many people it has always meant a receptacle—not so in the *NEC*!

Article 100 contains the definitions of terms used throughout the *Code*. Where a definition is unique to a specific article, the article number is indicated at the end of the definition in parenthesis (xxx). For example, the definition of "Pool" is specific to Article 680 and ends with (680) because it applies ONLY to that article. Definitions of standard terms, such as volt, voltage drop, ampere, impedance, and resistance are not contained in Article 100. If the *NEC* does not define a term, then a dictionary or building code acceptable to the authority having jurisdiction should be consulted.

Small Words, Grammar, and Punctuation

Technical words aren't the only ones that require close attention. Even simple words can make a big difference to the application of a rule. Is there a comma? Does it use "or," "and," "other than," "greater than," or "smaller than"? The word "or" can imply alternate choices for wiring methods. A word like "or" gives us choices while the word "and" can mean an additional requirement must be met.

An example of the important role small words play in the *NEC* is found in 110.26(C)(2), where it says equipment containing overcurrent, switching, "or" control devices that are 1,200A or more "and" over 6 ft wide require a means of egress at each end of the working space. In this section, the word "or" clarifies that equipment containing any of the three types of devices listed must follow this rule. The word "and" clarifies that 110.26(C)(2) only applies if the equipment is both 1,200A or more and over 6 ft wide.

Grammar and punctuation play an important role in establishing the meaning of a rule. The location of a comma can dramatically change the requirement of a rule such as in 250.28(A), where it says a main bonding jumper shall be a wire, bus, screw, or similar suitable conductor. If the comma between "bus" and "screw" was removed, only a "bus screw" could be used. That comma makes a big change in the requirements of the rule.

Slang Terms or Technical Jargon

Trade-related professionals in different areas of the country often use local "slang" terms that aren't shared by all. This can make it difficult to communicate if it isn't clear what the meaning of those slang terms are. Use the proper terms by finding out what their definitions and applications are before you use them. For example, the term "pigtail" is often used to describe the short piece of conductor used to connect a device to a splice, but a "pigtail" is also used for a rubberized light socket with pre-terminated conductors. Although the term is the same, the meaning is very different and could cause confusion. The words "splice" and "tap" are examples of terms often interchanged in the field but are two entirely different things! The uniformity and consistency of the terminology used in the *Code*, makes it so everyone says and means the same thing regardless of geographical location.

NEC Style and Layout

It's important to understand the structure and writing style of the *Code* if you want to use it effectively. The *National Electrical Code* is organized using twelve major components.

1. Table of Contents
2. Chapters—Chapters 1 through 9 (major categories)
3. Articles—Chapter subdivisions that cover specific subjects
4. Parts—Divisions used to organize article subject matter
5. Sections—Divisions used to further organize article subject matter
6. Tables and Figures—Represent the mandatory requirements of a rule
7. Exceptions—Alternatives to the main *Code* rule
8. Informational Notes—Explanatory material for a specific rule (not a requirement)
9. Tables—Applicable as referenced in the *NEC*
10. Annexes—Additional explanatory information such as tables and references (not a requirement)
11. Index
12. Changes to the *Code* from the previous edition

1. Table of Contents. The Table of Contents displays the layout of the chapters, articles, and parts as well as the page numbers. It's an excellent resource and should be referred to periodically to observe the interrelationship of the various *NEC* components. When attempting to locate the rules for a specific situation, knowledgeable *Code* users often go first to the Table of Contents to quickly find the specific *NEC* rule that applies.

2. Chapters. There are nine chapters, each of which is divided into articles. The articles fall into one of four groupings: General Requirements (Chapters 1 through 4), Specific Requirements (Chapters 5 through 7), Communications Systems (Chapter 8), and Tables (Chapter 9).

Chapter 1—General
Chapter 2—Wiring and Protection
Chapter 3—Wiring Methods and Materials
Chapter 4—Equipment for General Use
Chapter 5—Special Occupancies
Chapter 6—Special Equipment
Chapter 7—Special Conditions
Chapter 8—Communications Systems (Telephone, Data, Satellite, Cable TV, and Broadband)
Chapter 9—Tables–Conductor and Raceway Specifications

3. Articles. The *NEC* contains approximately 160 articles, each of which covers a specific subject. It begins with Article 90, the introduction to the *Code* which contains the purpose of the *NEC*, what is covered and isn't covered, along with how the *Code* is arranged. It also gives information on enforcement, how mandatory and permissive rules are written, and how explanatory material is included. Article 90 also includes information on formal interpretations, examination of equipment for safety, wiring planning, and information about formatting units of measurement. Here are some other examples of articles you'll find in the *NEC*:

Article 110—General Requirements for Electrical Installations
Article 250—Grounding and Bonding
Article 300—General Requirements for Wiring Methods and Materials
Article 430—Motors, Motor Circuits, and Motor Controllers
Article 500—Hazardous (Classified) Locations
Article 680—Swimming Pools, Fountains, and Similar Installations
Article 725—Class 2 and Class 3 Power-Limited Circuits
Article 800—General Requirements for Communications Systems

4. Parts. Larger articles are subdivided into parts. Because the parts of a *Code* article aren't included in the section numbers, we tend to forget to what "part" an *NEC* rule is relating. For example, Table 110.34(A) contains working space clearances for electrical equipment. If we aren't careful, we might think this table applies to all electrical installations, but Table 110.34(A) is in Part III, which only contains requirements for "Over 1,000 Volts, Nominal" installations. The rules for working clearances for electrical equipment for systems 1,000V, nominal, or less are contained in Table 110.26(A)(1), which is in Part II–1,000 Volts, Nominal, or Less.

5. Sections. Each *NEC* rule is called a "*Code* Section." A *Code* section may be broken down into subdivisions; first level subdivision will be in parentheses like (A), (B),..., the next will be second level subdivisions in parentheses like (1), (2),..., and third level subdivisions in lowercase letters such as (a), (b), and so on.

For example, the rule requiring all receptacles in a dwelling unit bathroom to be GFCI protected is contained in Section 210.8(A)(1) which is in Chapter 2, Article 210, Section 8, first level subdivision (A), and second level subdivision (1).

Note: According to the *NEC Style Manual*, first and second level subdivisions are required to have titles. A title for a third level subdivision is permitted but not required.

Many in the industry incorrectly use the term "Article" when referring to a *Code* section. For example, they say "Article 210.8," when they should say "Section 210.8." Section numbers in this textbook are shown without the word "Section," unless they're at the beginning of a sentence. For example, Section 210.8(A) is shown as simply 210.8(A).

6. Tables and Figures. Many *NEC* requirements are contained within tables, which are lists of *Code* rules placed in a systematic arrangement. The titles of the tables are extremely important; you must read them carefully in order to understand the contents, applications, and limitations of each one. Notes are often provided in or below a table; be sure to read them as well since they're also part of the requirement. For example, Note 1 for Table 300.5(A) explains how to measure the cover when burying cables and raceways and Note 5 explains what to do if solid rock is encountered.

7. Exceptions. Exceptions are *NEC* requirements or permissions that provide an alternative method to a specific rule. There are two types of exceptions–mandatory and permissive. When a rule has several exceptions, those exceptions with mandatory requirements are listed before the permissive exceptions.

Mandatory Exceptions. A mandatory exception uses the words "shall" or "shall not." The word "shall" in an exception means that if you're using the exception, you're required to do it in a specific way. The phrase "shall not" means it isn't permitted.

Permissive Exceptions. A permissive exception uses words such as "shall be permitted," which means it's acceptable (but not mandatory) to do it in this way.

8. Informational Notes. An Informational Note contains explanatory material intended to clarify a rule or give assistance, but it isn't a *Code* requirement.

9. Tables. Chapter 9 consists of tables applicable as referenced in the *NEC*. They're used to calculate raceway sizing, conductor fill, the radius of raceway bends, and conductor voltage drop.

10. Informative Annexes. Annexes aren't a part of the *Code* requirements and are included for informational purposes only.

- Annex A. Product Safety Standards
- Annex B. Application Information for Ampacity Calculation
- Annex C. Conduit, Tubing, and Cable Tray Fill Tables for Conductors and Fixture Wires of the Same Size
- Annex D. Examples
- Annex E. Types of Construction
- Annex F. Availability and Reliability for Critical Operations Power Systems (COPS), and Development and Implementation of Functional Performance Tests (FPTs) for Critical Operations Power Systems
- Annex G. Supervisory Control and Data Acquisition (SCADA)
- Annex H. Administration and Enforcement
- Annex I. Recommended Tightening Torque Tables from UL Standard 486A-486B
- Annex J. ADA Standards for Accessible Design
- Annex K. Use of Medical Electrical Equipment in Dwellings and Residential Board-and-Care Occupancies

11. Index. The Index at the back of the *NEC* is helpful in locating a specific rule using pertinent keywords to assist in your search.

12. Changes to the *Code*. Changes in the *NEC* are indicated as follows:

- Rules that were changed since the previous edition are identified by shading the revised text.
- New rules aren't shaded like a change, instead they have a shaded "N" in the margin to the left of the section number.
- Relocated rules are treated like new rules with a shaded "N" in the left margin by the section number.

- Deleted rules are indicated by a bullet symbol " • " located in the left margin where the rule was in the previous edition. Unlike older editions the bullet symbol is only used where one or more complete paragraphs have been deleted.
- A "Δ" represents partial text deletions and or figure/table revisions somewhere in the text. There's no specific indication of which word, group of words, or a sentence was deleted.

How to Locate a Specific Requirement

How to go about finding what you're looking for in the *Code* book depends, to some degree, on your experience with the *NEC*. Experts typically know the requirements so well that they just go to the correct rule. Very experienced people might only need the Table of Contents to locate the requirement for which they're looking. On the other hand, average users should use all the tools at their disposal, including the Table of Contents, the Index, and the search feature on electronic versions of the *Code* book.

Let's work through a simple example: What *NEC* rule specifies the maximum number of disconnects permitted for a service?

Using the Table of Contents. If you're an experienced *Code* user, you might use the Table of Contents. You'll know Article 230 applies to "Services," and because this article is so large, it's divided up into multiple parts (eight parts to be exact). With this knowledge, you can quickly go to the Table of Contents and see it lists the Service Equipment Disconnecting Means requirements in Part VI.

Author's Comment:

- The number "70" precedes all page numbers in this standard because the *NEC* is NFPA Standard Number 70.

Using the Index. If you use the Index (which lists subjects in alphabetical order) to look up the term "service disconnect," you'll see there's no listing. If you try "disconnecting means," then "services," you'll find that the Index indicates the rule is in Article 230, Part VI. Because the *NEC* doesn't give a page number in the Index, you'll need to use the Table of Contents to find it, or flip through the *Code* book to Article 230, then continue to flip through pages until you find Part VI.

Many people complain that the *NEC* only confuses them by taking them in circles. Once you gain experience in using the *Code* and deepen your understanding of words, terms, principles, and practices, you'll find it much easier to understand and use than you originally thought.

With enough exposure in the use of the *NEC*, you'll discover that some words and terms are often specific to certain articles. The word "solar" for example will immediately send experienced *Code* book users to Article 690—Solar Photovoltaic (PV) Systems. The word "marina" suggests what you seek might be in Article 555. There are times when a main article will send you to a specific requirement in another one in which compliance is required in which case it will say (for example), "in accordance with 230.xx." Don't think of these situations as a "circle," but rather a map directing you to exactly where you need to be.

Customizing Your *Code* Book

One way to increase your comfort level with your *Code* book is to customize it to meet your needs. You can do this by highlighting and underlining important *NEC* requirements. Preprinted adhesive tabs are also an excellent aid to quickly find important articles and sections that are regularly referenced. However, understand that if you're using your *Code* book to prepare to take an exam, some exam centers don't allow markings of any type. For more information about tabs for your *Code* book, visit MikeHolt.com/Tabs.

Highlighting. As you read through or find answers to your questions, be sure you highlight those requirements in the *NEC* that are the most important or relevant to you. Use one color, like yellow, for general interest and a different one for important requirements you want to find quickly. Be sure to highlight terms in the Index and the Table of Contents as you use them.

Underlining. Underline or circle key words and phrases in the *Code* with a red or blue pen (not a lead pencil) using a short ruler or other straightedge to keep lines straight and neat. This is a very handy way to make important requirements stand out. A short ruler or other straightedge also comes in handy for locating the correct information in a table.

Interpretations

Industry professionals often enjoy the challenge of discussing, and at times debating, the *Code* requirements. These types of discussions are important to the process of better understanding the *NEC* requirements and applications. However, if you decide you're going to participate in one of these discussions, don't spout out what you think without having the actual *Code* book in your hand. The professional way of discussing a requirement is by referring to a specific section rather than talking in vague generalities. This will help everyone involved clearly understand the point and become better educated. In fact, you may become so well educated about the *NEC* that you might even decide to participate in the change process and help to make it even better!

Become Involved in the *NEC* Process

The actual process of changing the *Code* takes about two years and involves hundreds of individuals trying to make the *NEC* as current and accurate as possible. As you advance in your studies and understanding of the *Code*, you might begin to find it very interesting, enjoy it more, and realize that you can also be a part of the process. Rather than sitting back and allowing others to take the lead, you can participate by making proposals and being a part of its development. For the 2023 cycle, there were over 4,000 Public Inputs and 1,956 Public Comments. This resulted in several new articles and a wide array of revised rules to keep the *NEC* up to date with new technologies and pave the way to a safer and more efficient electrical future.

Here's how the process works:

STEP 1—Public Input Stage

Public Input. The revision cycle begins with the acceptance of Public Input (PI) which is the public notice asking for anyone interested to submit input on an existing standard or a committee-approved new draft standard. Following the closing date, the committee conducts a First Draft Meeting to respond to all Public Inputs.

First Draft Meeting. At the First Draft (FD) Meeting, the Technical Committee considers and provides a response to all Public Input. The Technical Committee may use the input to develop First Revisions to the standard. The First Draft documents consist of the initial meeting consensus of the committee by simple majority. However, the final position of the Technical Committee must be established by a ballot which follows.

Committee Ballot on First Draft. The First Draft developed at the First Draft Meeting is balloted. In order to appear in the First Draft, a revision must be approved by at least two-thirds of the Technical Committee.

First Draft Report Posted. First revisions which pass ballot are ultimately compiled and published as the First Draft Report on the document's NFPA web page. This report serves as documentation for the Input Stage and is published for review and comment. The public may review the First Draft Report to determine whether to submit Public Comments on the First Draft.

STEP 2—Public Comment Stage

Public Comment. Once the First Draft Report becomes available, there's a Public Comment period during which anyone can submit a Public Comment on the First Draft. After the Public Comment closing date, the Technical Committee conducts/holds their Second Draft Meeting.

Second Draft Meeting. After the Public Comment closing date, if Public Comments are received or the committee has additional proposed revisions, a Second Draft Meeting is held. At the Second Draft Meeting, the Technical Committee reviews the First Draft and may make additional revisions to the draft Standard. All Public Comments are considered, and the Technical Committee provides an action and response to each Public Comment. These actions result in the Second Draft.

Committee Ballot on Second Draft. The Second Revisions developed at the Second Draft Meeting are balloted. To appear in the Second Draft, a revision must be approved by at least two-thirds of the Technical Committee.

Second Draft Report Posted. Second Revisions which pass ballot are ultimately compiled and published as the Second Draft Report on the document's NFPA website. This report serves as documentation of the Comment Stage and is published for public review.

Once published, the public can review the Second Draft Report to decide whether to submit a Notice of Intent to Make a Motion (NITMAM) for further consideration.

STEP 3—NFPA Technical Meeting (Tech Session)

Following completion of the Public Input and Public Comment stages, there's further opportunity for debate and discussion of issues through the NFPA Technical Meeting that takes place at the NFPA Conference & Expo®. These motions are attempts to change the resulting final Standard from the committee's recommendations published as the Second Draft.

STEP 4—Council Appeals and Issuance of Standard

Issuance of Standards. When the Standards Council convenes to issue an NFPA standard, it also hears any related appeals. Appeals are an important part of assuring that all NFPA rules have been followed and that due process and fairness have continued throughout the standards development process. The Standards Council considers appeals based on the written record and by conducting live hearings during which all interested parties can participate. Appeals are decided on the entire record of the process, as well as all submissions and statements presented.

After deciding all appeals related to a standard, the Standards Council, if appropriate, proceeds to issue the Standard as an official NFPA Standard. The decision of the Standards Council is final subject only to limited review by the NFPA Board of Directors. The new NFPA standard becomes effective twenty days following the Standards Council's action of issuance.

Temporary Interim Amendment—(TIA)

Sometimes, a change to the *NEC* is of an emergency nature. Perhaps an editing mistake was made that can affect an electrical installation to the extent it may create a hazard. Maybe an occurrence in the field created a condition that needs to be addressed immediately and can't wait for the normal *Code* cycle and next edition of the standard. When these circumstances warrant it, a TIA or "Temporary Interim Amendment" can be submitted for consideration.

The NFPA defines a TIA as, "tentative because it has not been processed through the entire standards-making procedures. It is interim because it is effective only between editions of the standard. A TIA automatically becomes a Public Input of the proponent for the next edition of the standard; as such, it then is subject to all of the procedures of the standards-making process."

Author's Comment:

- Proposals, comments, and TIAs can be submitted for consideration online at the NFPA website, www.nfpa.org. From the homepage, look for "Codes & Standards," then find "Standards Development," and click on "How the Process Works." If you'd like to see something changed in the *Code*, you're encouraged to participate in the process.

GLOBAL CHANGES IN THE 2023 *NATIONAL ELECTRICAL CODE*

Introduction to Global Changes in the 2023 *National Electrical Code*

Global Changes

The 2023 *NEC* cycle was very active with 4,006 Public Inputs, 1,805 First Revisions, 1,956 Public Comments, 900 Second Revisions, 164 Correlating Revisions, and 55 Certified Amending Motions. This resulted in several new articles and a wide array of new and revised rules. In addition to all this activity, it was a busy year for the correlating committee who eliminated "subjective terms," and tasked the Code-Making Panels with reorganizing many of the rules that were long paragraphs into list formats. Long terms were replaced with acronyms where possible. Redundant language was removed, and definitions were consolidated with nearly all being relocated to Article 100. Many of these changes were made to bring the existing *NEC* text in line with the *NEC* Style Manual requirements.

New Medium Voltage Articles

Several new articles were created to address the growing number of medium voltage installations that are being installed under the purview of the *NEC*. Some proposed medium voltage articles were also rejected. This will be worked out in the second revision of the *Code*.

The medium voltage articles that are in the 2023 *NEC* are:

- Article 235. Branch Circuits, Feeders, and Services Over 1000V ac, 1500V dc, Nominal.
- Article 245. Overcurrent Protection for Systems Rated Over 1000V ac, 1500V dc.
- Article 305. General Requirements for Wiring Methods and Materials for Systems Rated Over 1000V ac, 1500V dc, Nominal. This article replaces Article 399 because Article 305 is a more logical location for the information.
- Article 315. Medium Voltage Conductors, Cable, Cable Joints, and Cable Terminations. This article replaces Article 311 in a more logical location for the information.
- Article 495. Equipment Over 1000V ac, 1500V dc, Nominal. This article replaces Article 490 in the 2020 *NEC*.

Other New Articles Found in the 2023 *NEC*

- **Article 369. Insulated Bus Pipe (IBP)/Tubular Covered Conductors (TCC) Systems.** A cylindrical solid or hollow conductor with a solid insulation system, having conductive grading layers and a grounding layer embedded in the insulation, and provided with an overall covering of insulating or metallic material.

• • •

- **Article 371. Flexible Bus Systems.** This is an engineered product like cable bus systems but is instead using thin pieces of copper bus covered with insulation. It is installed in a support system much like cable tray but is specifically designed for the flexible bus.
- **Article 722. Cables for Power-Limited Circuits, Fault-Managed Power Circuits, and Optical Fiber.** This new article creates a common set of cabling rules for Articles 725, 760, and 770 to avoid repeating many of the common general requirements in each of those articles.
- **Article 724. Class 1 Power-Limited Circuits and Class 1 Power-Limited Remote-Control and Signaling Circuits.** A new article was created for Class 1 power-limited circuits to separate them from Class 2 and Class 3 power-limited circuits. This revision adds clarity and better usability to the *Code*. Historically, Class 1 circuits were either nonpower-limited or power limited. But now Chapter 7 only addresses Class 1 power-limited circuits with a power limitation of 30V and 1000 VA. Nonpower-limited remote control and signaling circuits will be covered by the first four chapters of the *NEC.*
- **Article 726. Class 4 Fault-Managed Power Systems.** This article covers a new class of power systems that provide excellent protection for people by limiting exposure times (short pulses or fast shut-off times) and eliminating repetitive impulses. In addition to increased personnel safety, they utilize sophisticated monitoring and control systems providing better equipment monitoring and protection rather than a traditional OCPD.

ARTICLE
210
BRANCH CIRCUITS

Introduction to Article 210—Branch Circuits

This article contains branch-circuit requirements such as those for conductor sizing and identification, GFCI, AFCI and overcurrent protection, and receptacle and lighting outlet requirements. It consists of three parts:

- Part I. General Provisions
- Part II. Branch-Circuit Ratings
- Part III. Required Outlets

210.8 Ground-Fault Circuit-Interrupter Protection for Personnel

For over 30 years GFCI requirements have been added to the *NEC*, and this *Code* cycle continues that trend. The term "listed Class A GFCI" replaced "ground-fault circuit-interrupter" throughout the rule. It is now clear that the path of measurement for a power-supply cord is related to the receptacle and not the appliance from which it came. An interesting Exception was added for exhaust fans, nondwelling GFCI requirements have taken over in food service areas, and protection is required for all outlets in garages, accessory buildings, boathouses, and aquariums. These rules now basically say that where there is water you need a GFCI!

Analysis

CLARIFIED

The term "ground-fault circuit-interrupter" throughout this section was changed to "listed Class A GFCI" because acronyms are now permitted to be used in the *NEC*. The addition of "Class A" to GFCI clarifies that the device must trip at the nominal 5 mA (± 1 mA) required for the protection of personnel. In addition, the words "of an appliance" were removed from the charging text clarifying that the measurement applies to all power-supply cords plugged into a receptacle—not just appliance cords. Furthermore, the phrase "shortest path without passing through a window" was removed to alleviate confusion resulting from a cord passing through an interior opening similar to a window.

EXPANDED

The specific mention in 210.8(A) and (B) of the list items included in those first level subdivisions was replaced with a general reference to the "following locations."

EXPANDED

List item (A)6 was expanded to address GFCI protection for any cord-and-plug-connected appliance in kitchens by deleting the reference to the receptacles serving the countertop.

NEW

A new list item (A)7 requires areas with sinks and permanent provisions for food preparation, beverage preparation, or cooking to have GFCI-protected receptacles. The remaining list items became 8 through 12.

RELOCATED The Exceptions that previously followed the list items in 210.8(A) were relocated to follow the last list item and clarifications were made as to when the Exception(s) applies, but there were no technical changes.

NEW A new Exception No. 4 to 210.8(A) was added to say that the internal receptacle in a bathroom exhaust fan does not require GFCI protection, unless required by the installation or listing instructions. This receptacle is not accessible and not used as a convenience receptacle, so this rule makes sense.

EXPANDED In 210.8(B), the word "kitchens" was added as list item (2) and removed from list item (3) clarifying that all areas with permanent provisions for food serving, beverage service, or cooking must be protected.

List item (4) was added to include buffet areas and beverage serving areas in the GFCI requirements. This is kind of an open-ended rule using the term "area" instead of a specific distance, as is used in list item (7), and may cause some problems with enforcement. Only time will tell.

List item (7) expands the requirement in other than dwellings to protect electric appliances and not just receptacles located within 6 ft of a sink. This lets us know that the rule is about the hazard from both the appliance and its supplying receptacle.

A new rule in (13) requires GFCI protection for receptacles within 6 ft of the top inside edge or conductive support framing of aquariums, bait wells, and similar aquatic vessels.

RELOCATED All the Exceptions that previously followed the list items in 210.8(B) were relocated to follow the last list item, and clarifications were made as to when the Exception(s) applies, but there were no technical changes.

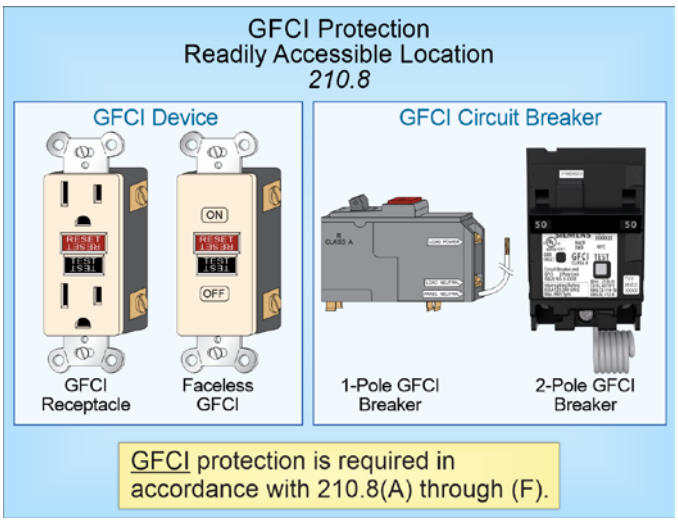
EXPANDED Changes in 210.8(D) now require GFCI protection to be provided for the branch circuit or the outlet supplying listed appliances rated 150V to ground and 60A or less. This rule previously referenced others to determine if protection was required—now you can just read the list here.

Five more appliances have been added in addition to the seven that were in the Article 422 appliances requiring GFCI protection and inserted here in (D) They include electric ranges, wall-mounted ovens, counter-mounted cooking units, clothes dryers, and microwave ovens. This expansion of the GFCI requirements applies to both cord-and-plug-connected and hardwired equipment.

EXPANDED The rule in 210.8(F) for outdoor outlets was new last cycle and caused a big problem with air-conditioning units in areas outside of dwelling units. This battle continued during the 2023 revision and four new items were added to the list. Dwelling unit receptacles rated 50A or less in garages, accessory buildings, outdoors, and in boathouses already had GFCI protection requirements, but this change requires the outlet to be protected and GFCI protection must be added for unprotected existing equipment that is replaced.

210.8 GFCI Protection

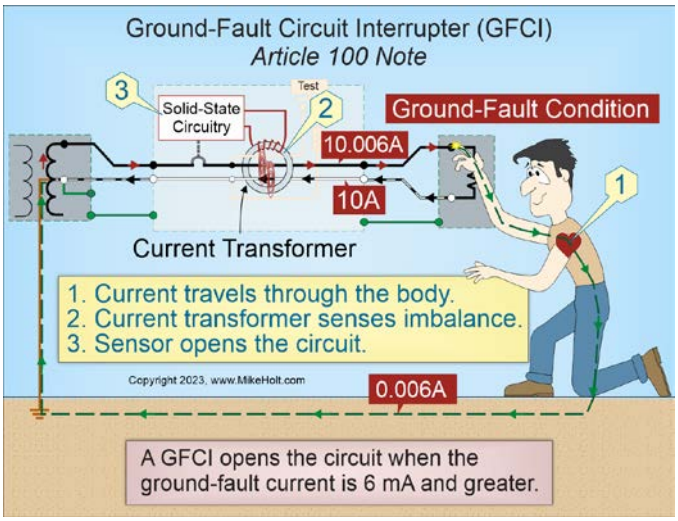
A listed ground-fault circuit interrupter (GFCI) must provide protection as required in 210.8(A) through (F). The GFCI protective device must be in a readily accessible location. ▸Figure 210–10



▸Figure 210–10

Author's Comment:

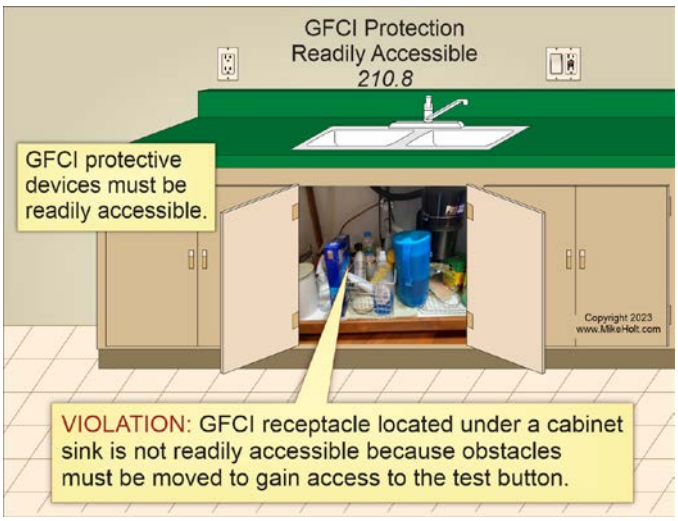
- According to Article 100, a "Ground-Fault Circuit Interrupter" (GFCI) is a device intended to protect people by opening a circuit when a current imbalance is 6 mA or higher and does not open when the current to ground is less than 4 mA. ▸Figure 210–11



▸Figure 210–11

- The GFCI protection required by 210.8(A) and (B) can be provided using either a breaker with GFCI protection or a receptacle with GFCI protection. However, the use of a GFCI receptacle is somewhat limited by the requirement that the GFCI must be readily accessible.
- According to Article 100, "Readily Accessible" means capable of being reached quickly without having to climb over or remove obstacles, or resort to the use of portable ladders. ▸Figure 210–12

For the application of 210.8(A)(8), 210.8(A)(10), 210.8(B)(7), 210.8(B)(13), and 210.8(B)(15), the distance (from the sink or bathtub/shower) is measured as the shortest path the power-supply cord connected to the receptacle will follow without piercing a floor, wall, ceiling, or fixed barrier. ▸Figure 210–13

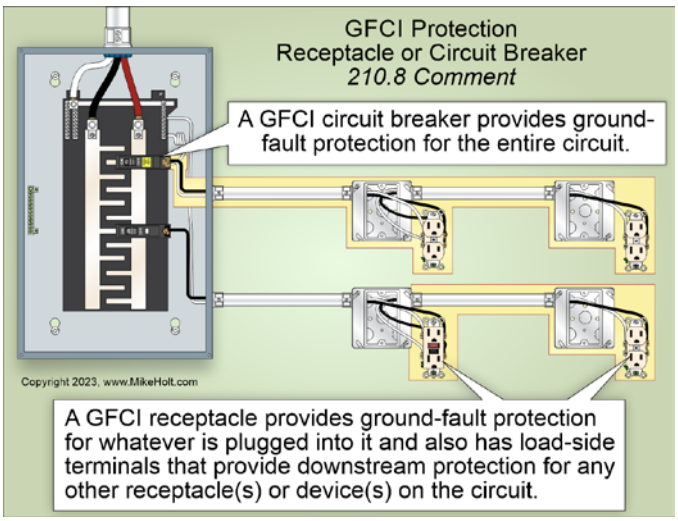


▸Figure 210–12

▸Figure 210–13

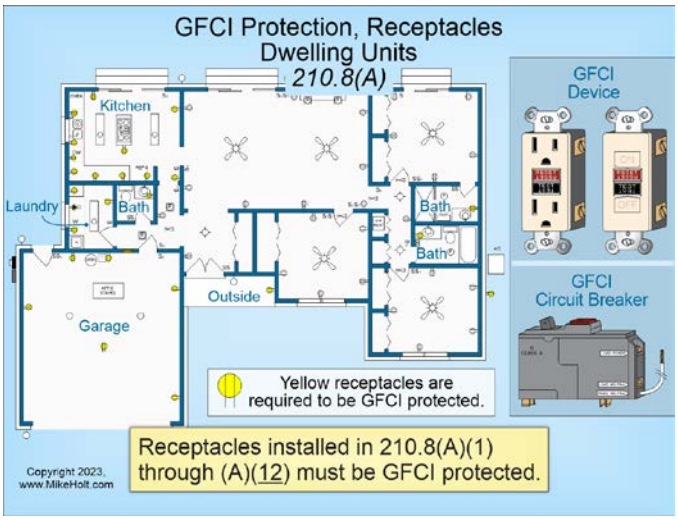
Author's Comment:

- The reference to windows and doors was removed to ensure receptacles within the measured distance as required in 210.8, even if passing through a window or door, are afforded GFCI protection.
- The GFCI circuit breaker provides ground-fault protection starting at the breaker, so the entire circuit has ground-fault protection. A GFCI receptacle provides ground-fault protection for whatever is plugged into it and also has load-side terminals that provide downstream protection for any other receptacle(s) or device(s) on the circuit. ▸Figure 210–14



▸Figure 210–14

(A) Dwelling Units. Receptacles installed in the following dwelling unit locations must be GFCI protected. ▸Figure 210–15

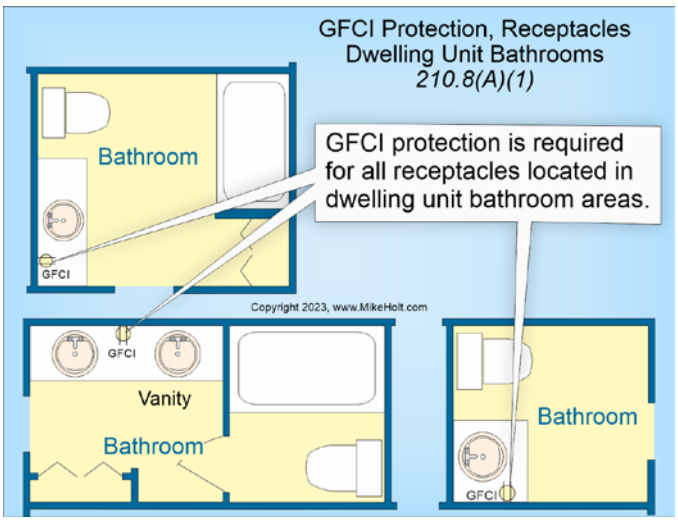


▸Figure 210–15

(1) Bathrooms. GFCI protection is required for receptacles in dwelling unit bathroom areas. ▸Figure 210–16

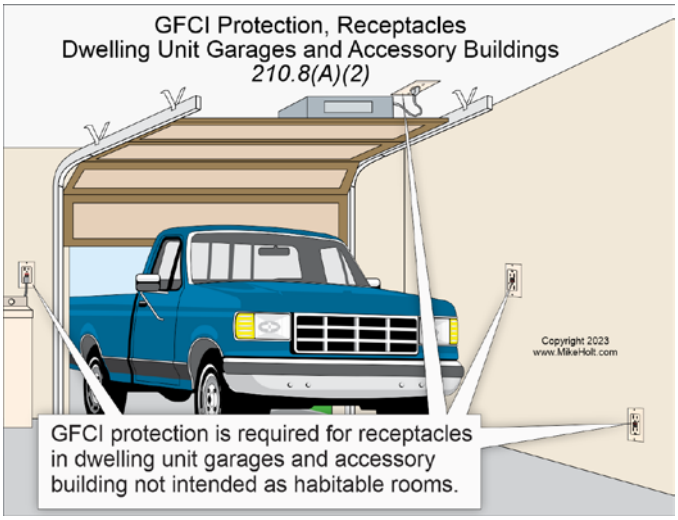
Author's Comment:

- According to Article 100, a "Bathroom Area" is an area that includes a sink (basin) and one or more of the following: a toilet, urinal, tub, shower, bidet, or similar plumbing fixture.



▸Figure 210–16

(2) Garages and Accessory Buildings. GFCI protection is required for receptacles in dwelling unit garages and dwelling unit accessory buildings not intended as habitable rooms and limited to storage areas, work areas, and areas of similar use. ▸Figure 210–17



▸Figure 210–17

(3) Outdoors. GFCI protection is required for receptacles located outdoors of a dwelling unit. ▸Figure 210–18

Figure 210–18

(4) Crawl Spaces. GFCI protection is required for receptacles in dwelling unit crawl spaces at or below grade. Figure 210–19

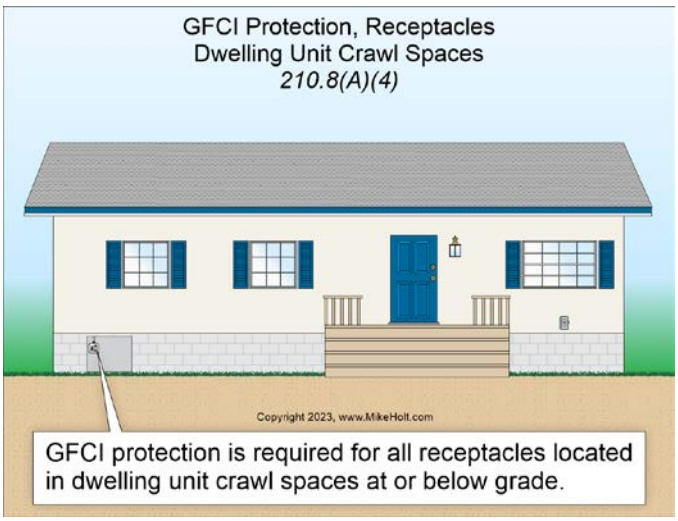


Figure 210–19

(5) Basements. GFCI protection is required for receptacles in dwelling unit basements. Figure 210–20

(6) Kitchens. GFCI protection is required for receptacles in dwelling unit kitchens. Figure 210–21

Author's Comment:

- Traditionally this requirement only applied to kitchen countertop receptacles, now any cord-and-plug-connected appliance in the kitchen such as the range receptacle, refrigerator receptacle, disposal receptacle, and microwave receptacles will require GFCI protection.

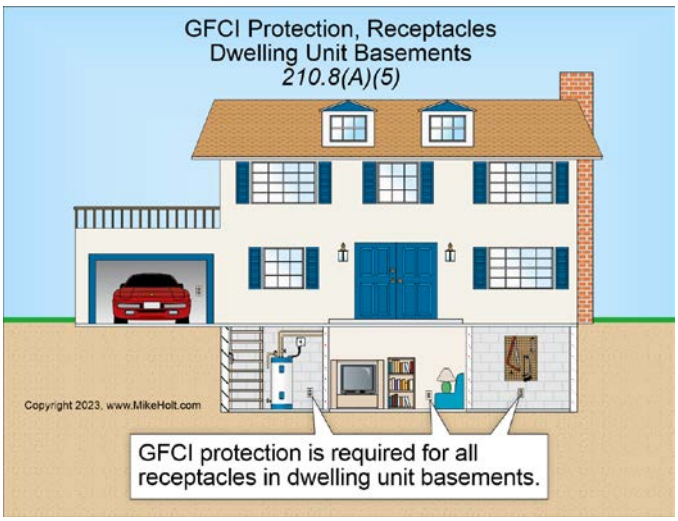


Figure 210–20

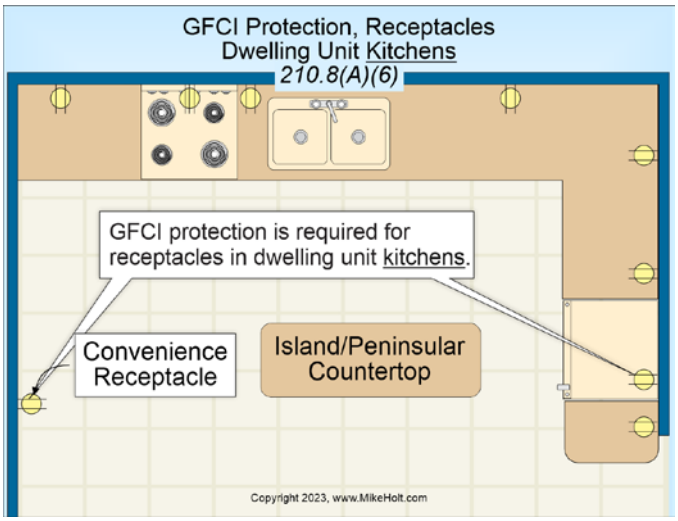


Figure 210–21

(7) Food Preparation Areas. GFCI protection is required for receptacles in areas with sinks with permanent provisions for food preparation, beverage preparation, or cooking.

(8) Sinks. GFCI protection is required for receptacles within 6 ft of the top inside edge of the bowl of a dwelling unit sink.

(9) Boathouses. GFCI protection is required for receptacles in a boathouse for a dwelling unit. Figure 210–22

Figure 210–22

Author's Comment:

- The *Code* does not require a receptacle to be installed in a boathouse, but if any are then they must be GFCI protected.

(10) Bathtubs or Shower Stalls. GFCI protection is required for receptacles within 6 ft of the outside edge of a bathtub or shower stall not installed within a bathroom as defined in Article 100. Figure 210–23

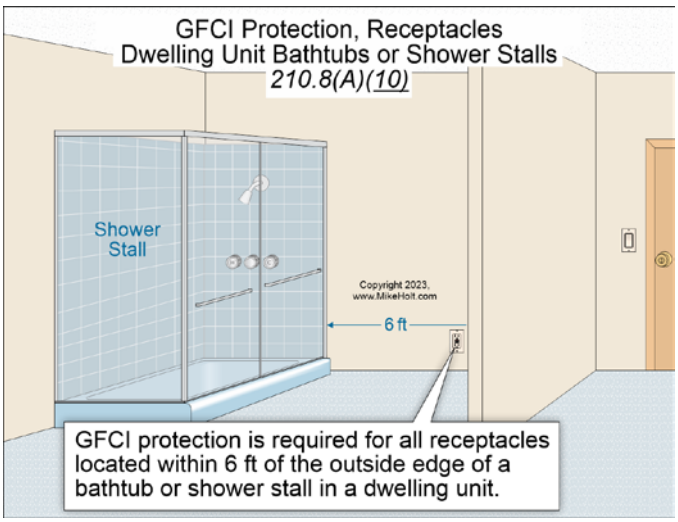


Figure 210–23

(11) Laundry Areas. GFCI protection is required for receptacles installed in the laundry area of a dwelling unit. Figure 210–24

(12) Damp and Wet Locations Indoors. GFCI protection is required for receptacles installed in indoor damp and wet locations.

Figure 210–24

Ex 1: GFCI protection is not required for a receptacle dedicated to fixed electric snow-melting equipment if the receptacle is not readily accessible and ground-fault protection of equipment (GFPE) is provided as required by 426.28 and 427.22. Figure 210–25

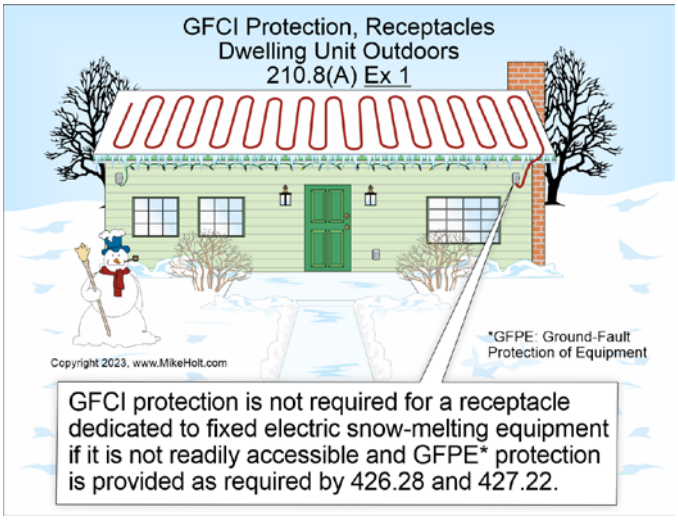


Figure 210–25

Ex 2: A receptacle supplying only a permanently installed premises security system is permitted to omit ground-fault circuit-interrupter protection.

Ex 4: GFCI protection is not required for receptacles in dwelling unit bathroom exhaust fans, unless specified by the fan instructions. Figure 210–26

Figure 210–26

Figure 210–27

Author's Comment:

- The receptacle for exhaust fans is internal to the exhaust fan and is not accessible as a convenience cord-and-plug receptacle, therefore GFCI protection is not required.
- In accordance with the UL GPWX guide information, exhaust fans installed in the area directly above the footprint of the bathtub or shower must be GFCI protected.

(B) Other Than Dwellings. GFCI protection is required for 125V through 250V receptacles supplied by single-phase branch circuits 50A or less, and receptacles supplied by three-phase branch circuits 100A or less installed in the following locations:

(1) Bathrooms. GFCI protection is required for receptacles in bathroom areas. Figure 210–27

Author's Comment:

- According to Article 100, a "Bathroom Area" is one that includes a sink (basin) and one or more of the following: a toilet, urinal, tub, shower, bidet, or similar plumbing fixture.

(2) Kitchens. GFCI protection is required for 125V through 250V receptacles in kitchens. Figure 210–28

(3) Food Preparation Areas. GFCI protection is required for 125V through 250V receptacles in areas with sinks with permanent provisions for food preparation, beverage preparation, or cooking.

(4) Buffet Serving Areas. GFCI protection is required for 125V through 250V receptacles in buffet serving areas with permanent provisions for food serving, beverage serving, or cooking.

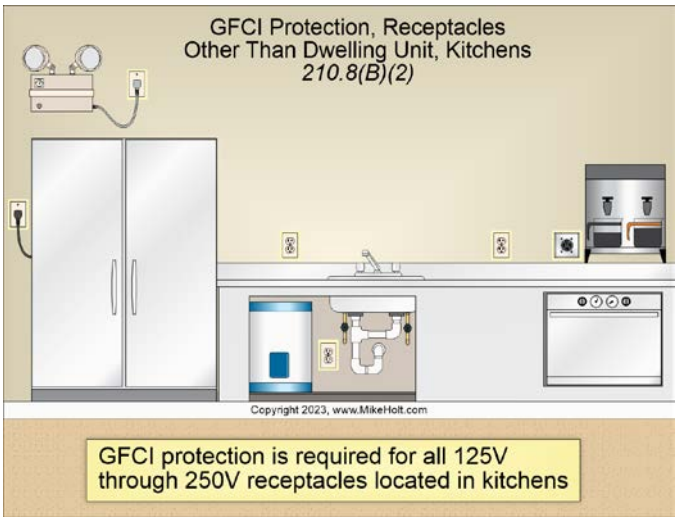


Figure 210–28

Author's Comment:

- This requires GFCI protection for receptacles in the break area of a commercial occupancy.

(5) Rooftops. GFCI protection is required for 125V through 250V receptacles on rooftops. Figure 210–29

(6) Outdoors. GFCI protection is required for 125V through 250V receptacles outdoors. Figure 210–30

(7) Sinks. GFCI protection is required for 125V through 250V receptacles and receptacles used for cord-and-plug-connected appliances located within 6 ft from the top inside edge of the bowl of a sink. Figure 210–31

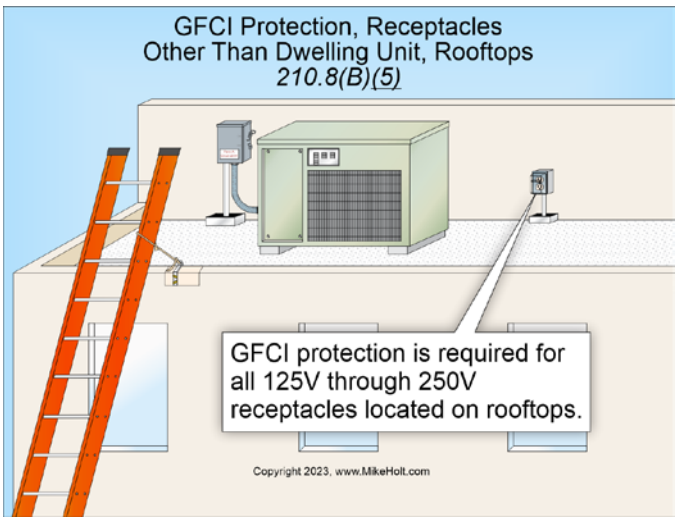


Figure 210–29

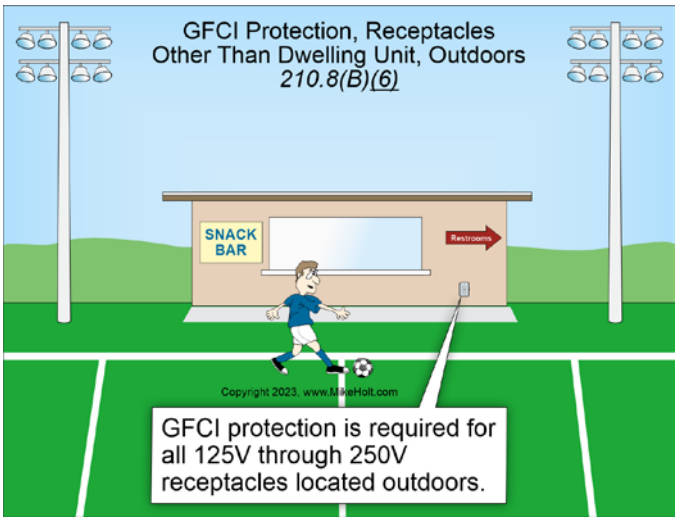


Figure 210–30

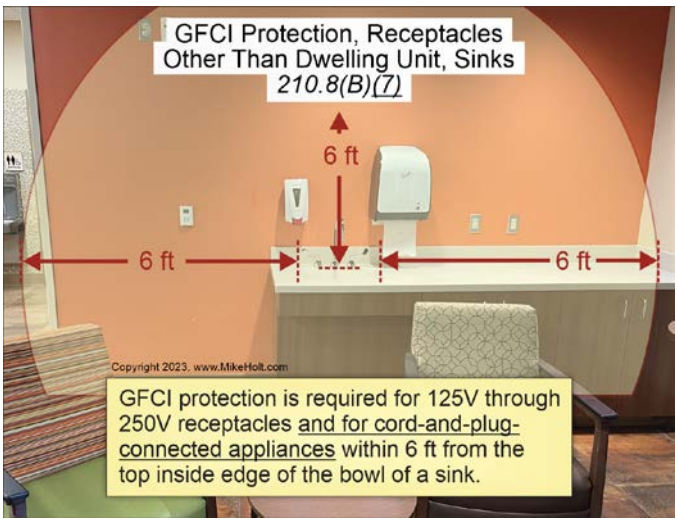


Figure 210–31

(8) Indoor Damp or Wet Locations. GFCI protection is required for 125V through 250V receptacles in indoor damp or wet locations.

(9) Locker Rooms. GFCI protection is required for 125V through 250V receptacles in locker rooms with showering facilities. Figure 210–32

Figure 210–32

(10) Garages and Similar Areas. GFCI protection is required for 125V through 250V receptacles in garages, accessory buildings, service bays, and similar areas. Figure 210–33

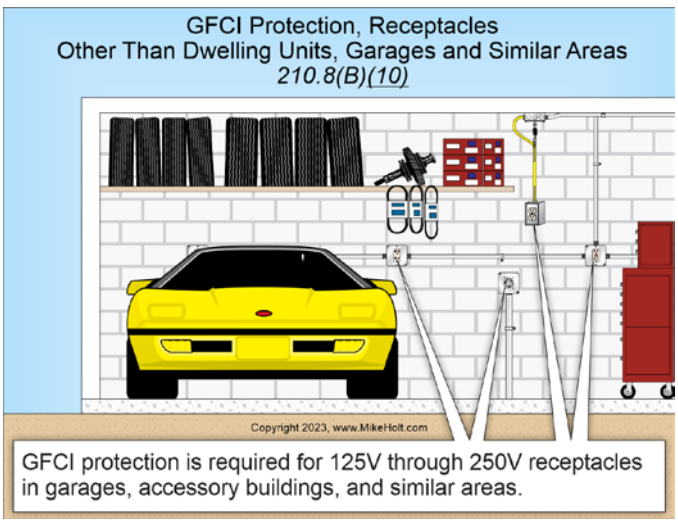


Figure 210–33

Author's Comment:

- According to Article 100, a "Garage" is a building or portion of a building in which one or more self-propelled vehicles can be kept for use, sale, storage, rental, repair, exhibition, or demonstration.

(11) Crawl Spaces. GFCI protection is required for 125V through 250V receptacles in crawl spaces at or below grade level.

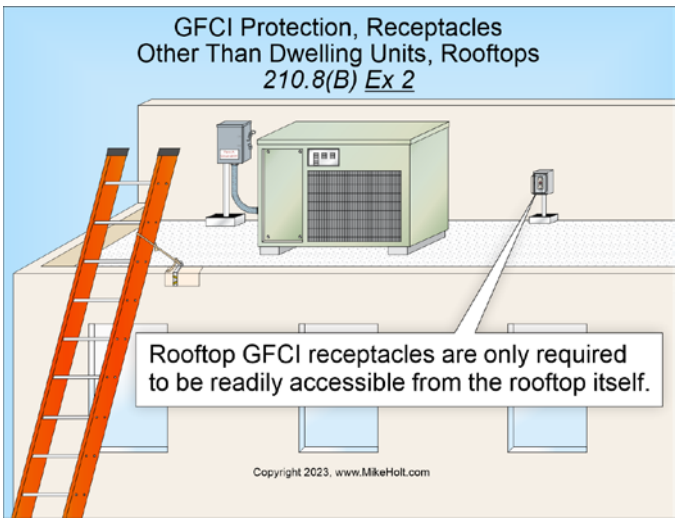
(12) Unfinished Areas of Basements. GFCI protection is required for 125V through 250V receptacles in the unfinished areas of basements.

(13) Aquatic Tanks or Bowls. GFCI protection is required for 125V through 250V receptacles within 6 ft from the top inside edge or rim from the conductive support framing of the vessel or container for aquariums, bait wells, and similar open aquatic vessels or containers, such as tanks or bowls.

(14) Laundry Areas. GFCI protection is required for 125V through 250V receptacles in laundry areas.

(15) Bathtubs and Shower Stalls. GFCI protection is required for 125V through 250V receptacles installed within 6 ft of the outside edge of a bathtub or shower stall not installed in a bathroom as defined in Article 100.

Ex 2: Rooftop GFCI receptacles are only required to be readily accessible from the rooftop itself. ▸Figure 210–34



▸Figure 210–34

(C) Crawl Space Lighting Outlets. GFCI protection is required for 120V lighting outlets in crawl spaces.

Author's Comment:

- A lighting outlet is not required for a dwelling unit crawl space unless the space is used for storage or has equipment requiring servicing [210.70(C)].

(D) Specific Appliance. GFCI protection is required for the outlet supplying the following appliances rated 150V or less to ground, 60A or less, single- or three-phase:

(1) Automotive vacuum machines

(2) Drinking water coolers and bottle fill stations

(3) High-pressure spray washing machines

(4) Tire inflation machines

(5) Vending machines

(6) Sump pumps

(7) Dishwashers

(8) Electric ranges

(9) Wall-mounted electric ovens

(10) Counter-mounted electric cooking units

(11) Clothes dryers

(12) Microwave ovens

Author's Comment:

- The appliances in list items 210.8(D)(8) through (12) are commonly installed as hardwired outlets and the GFCI protection requirements of 210.8(A) and (B) only apply to receptacles. The shock hazards exist whether appliances are hardwired, or cord-and-plug-connected and therefore GFCI protection must be provided for the appliance branch circuit or outlet.

(E) Equipment Requiring Servicing.

Air-Conditioning Equipment. GFCI protection is required for air-conditioning equipment 125V, 15A or 20A service receptacle outlets installed within 25 ft of the equipment as specified in 210.63(A). ▸Figure 210–35

Indoor Service Equipment. GFCI protection must be provided for indoor service equipment 125V, 15A or 20A service receptacle outlets as required by 210.63(B)(1). ▸Figure 210–36

Indoor Switchboards, Switchgear, Panelboards, and Motor Control Centers. GFCI protection must be provided for 125V, 15A or 20A service receptacles as required by 210.63(B)(2) for indoor switchboards, switchgear, panelboards, and motor control centers.

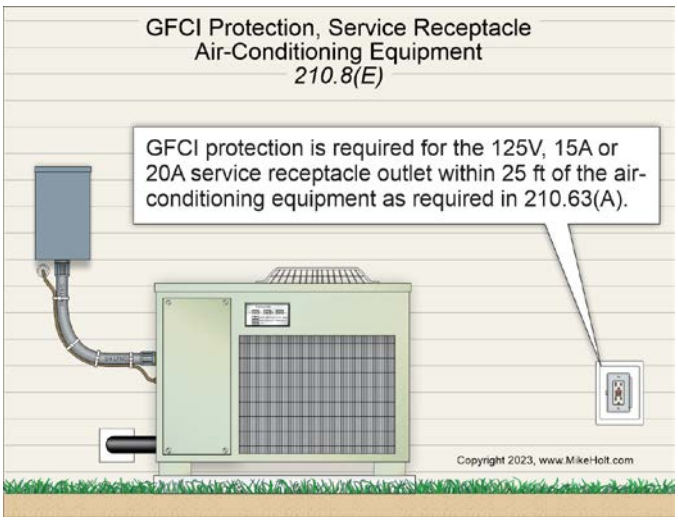


Figure 210–35

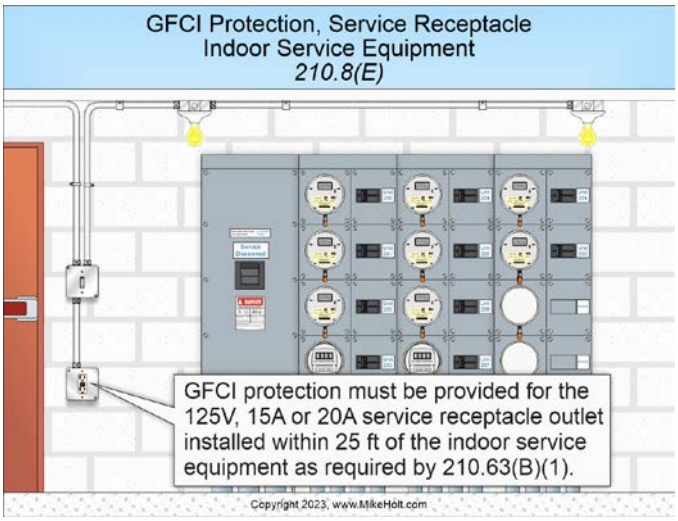


Figure 210–36

(F) Outdoor Dwelling Unit Outlets. GFCI protection is required for all outlets rated 50A or less located outside the following dwelling spaces: Figure 210–37

(1) Garages

(2) Accessory Buildings

(3) Boathouses

Author's Comment:

- According to Article 100, an "Outlet" is a point on the wiring system at which current is taken to supply utilization equipment.

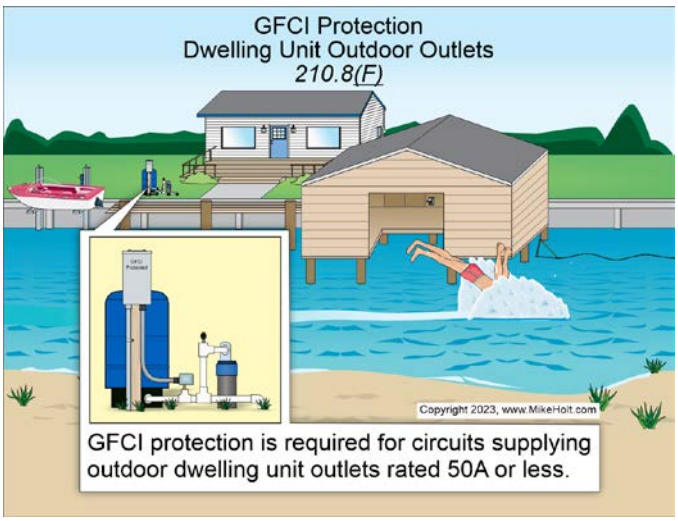


Figure 210–37

If equipment connected to any of the above outlets is replaced, the circuit to the outlet must be GFCI protected.

Ex 2: GFCI protection is not required for listed HVAC equipment, such as motor compressors or heat pumps. Figure 210–38

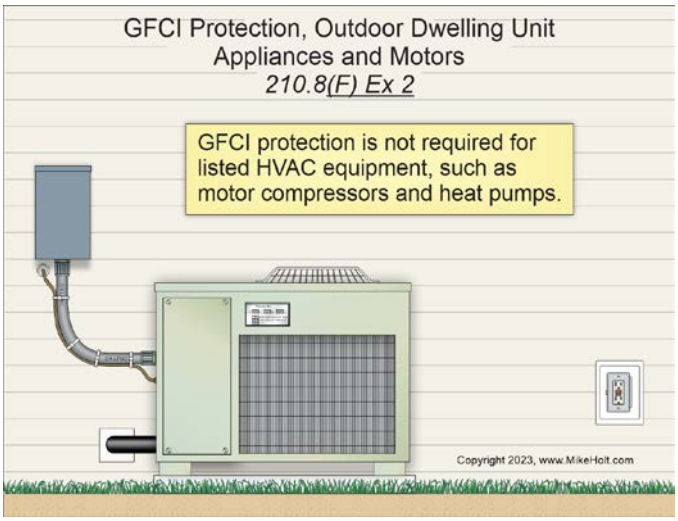


Figure 210–38

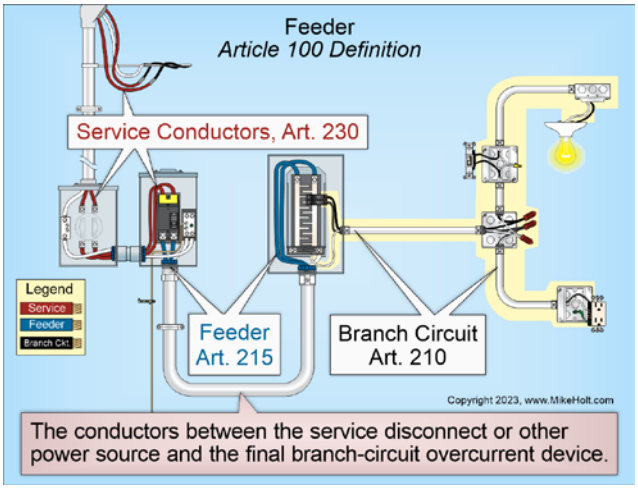
ARTICLE 215 FEEDERS

Introduction to Article 215—Feeders

Article 215 covers the rules for the installation, protection, and ampacity of feeders. It is important to understand the distinct differences between these circuits to correctly apply the *Code* requirements.

Feeders are the conductors between the service disconnect, the separately derived system, or other supply source, and the final branch-circuit overcurrent protective device. Conductors past the final overcurrent protective device protecting the circuit and the outlet are branch-circuit conductors and fall within the scope of Article 210 [Article 100 Definitions]. ▸Figure 215–1

It is easy to be confused between feeder, branch-circuit, and service conductors so it is important to evaluate each installation carefully using the Article 100 definitions to be sure the correct *NEC* rules are followed.



▸Figure 215–1

215.18 Surge Protection

New rules were added to require surge protection for distribution equipment that supplies feeders.

Analysis

NEW

Surge protection is now required to be installed for new or replaced distribution equipment where a feeder supplies dwelling units, dormitory units, guest rooms and suites of hotels or motels, and patient sleeping areas of nursing homes and limited care facilities. Surge protection is already required for dwelling unit services to protect appliances and safety devices such as AFCIs, GFCIs, and smoke alarms. This new requirement adds protection for equipment located at an extended distance from the service. If you struggle with this requirement, read up on how surge protection works, and you will understand the need for this change.

215.18 Surge Protection

(A) Surge-Protective Device (SPD). Where a feeder supplies any of the following occupancies, a surge-protective device must be provided:

(1) Dwelling units ▸Figure 215–6 and ▸Figure 215–7

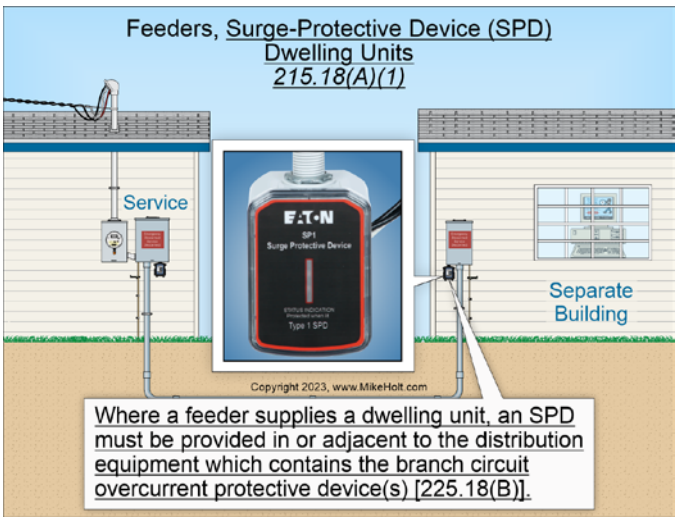


Figure 215–6

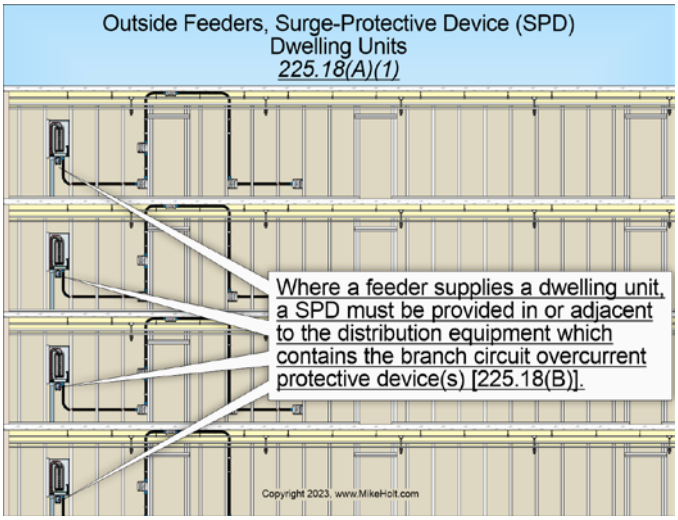


Figure 215–7

(2) Dormitory units

(3) Guest rooms and guest suites of hotels and motels

(4) Areas of nursing homes and limited care facilities used exclusively as patient sleeping rooms

(B) Location. The SPD must be installed in or adjacent to distribution equipment which contains the branch-circuit overcurrent protective device(s).

Note: Surge protection is most effective when closest to the branch circuit. Surges can be generated from multiple sources including, but not limited to, lightning, the electric utility, or utilization equipment.

(C) Type. The SPD must be either Type 1 or Type 2.

(D) Replacement. Where the distribution equipment supplied by the feeder is replaced, all the requirements of this section apply.

(E) Ratings. SPDs must have a nominal discharge current rating (In) of not less than 10 kA.

ARTICLE
220

BRANCH-CIRCUIT, FEEDER, AND SERVICE LOAD CALCULATIONS

Introduction to Article 220—Branch-Circuit, Feeder, and Service Load Calculations

This article focuses on the requirements for calculating demand loads (including demand factors) to size branch circuits [210.19(A)], feeders [215.2(A)(1)], and service conductors [230.42(A)].

Part I describes the layout of Article 220 and provides a table showing where other types of load calculations can be found in the *NEC*. Part II provides requirements for branch-circuit calculations and for specific types of branch circuits. Part III covers the requirements for feeder and service calculations using what is commonly called the "Standard Method of Calculation." Part IV provides optional calculations that can be used in place of the standard calculations [Parts II and III]. "Farm Load Calculations" are discussed in Part V of this article.

In some cases, the *Code* provides an optional method [Part IV] for feeder and service calculations in addition to the standard method [Part III], however they do not yield identical results. In fact, the optional method of calculation will often result in a smaller feeder or service. The neutral conductor must be calculated using the standard method [220.61]. As you work through Article 220, be sure to study the illustrations to help you fully understand this article's requirements. Also, be sure to review the examples in Annex D of the *NEC* to gain more practice with these calculations. The *Code* recognizes that not all demand for power will occur at the same time and it is because of this load diversity that certain demand factors are able to be applied.

220.70 Energy Management Systems (EMSs)

A new section was added for energy management systems that can control the maximum load of a service.

Analysis

NEW

Technology has become a big part of our electrical systems. This new section allows an energy management system to limit the maximum current used by the electrical system. I am sure there will be growing pains with this rule, but this is a major step forward in integrating technology with power systems on a large scale.

220.70 Energy Management Systems

If an energy management system is used to limit the current to a feeder or service in accordance with 750.30(C)(1)(2), the maximum ampere setpoint of the energy management system can be used in load calculations. The setpoint value of the energy management system is considered a continuous load.

ARTICLE
225
OUTSIDE BRANCH CIRCUITS AND FEEDERS

Introduction to Article 225—Outside Branch Circuits and Feeders

This article covers the installation requirements for equipment, including overhead and underground branch-circuit and feeder conductors outdoors on or between buildings, poles, and other structures on the premises. Conductors installed outdoors can serve many purposes such as area lighting, power for outdoor equipment, or for providing power to separate buildings or structures. It is important to remember that the power supply for buildings is not always a service conductor but may be feeder or branch-circuit conductors originating in another building. Never just assume that the conductors supplying power to a building are service conductors until you have identified where the service point is [Article 100] and have reviewed the Article 100 definitions for feeders, branch circuits, and service conductors. If you have correctly determined the conductors are service conductors, then use Article 230.

Part II of this article limits the number of feeders plus branch circuits to a building and provides rules regarding their disconnects. These requirements include the disconnect rating, construction characteristics, labeling, where to locate the disconnect, and the grouping of multiple disconnects.

225.41 Emergency Disconnects

This new section requires outside emergency disconnects for feeders supplied to one- and two-family dwelling units, and mirrors the requirements in 230.85 for service-supplied dwelling units.

Analysis

NEW

This new section requires outside emergency disconnects for feeders supplied to one- and two-family dwelling units. This mirrors the requirements in 230.85 for service-supplied dwelling units so first responders are always able to shut off the power on the exterior of a dwelling regardless of how it is supplied.

Section 225.41(B) requires the identification of the location of other isolation disconnects for other power sources where those disconnects are not located adjacent to the emergency disconnect.

225.41 Emergency (Shutoff) Disconnects

For one- and two-family dwelling units, an emergency disconnect must be installed for first responders and others.

(A) General.

(1) Location. The emergency disconnect must be installed in a readily accessible outdoor location on or within sight of the dwelling unit. ▸Figure 225–3

(2) Rating. The emergency disconnect must have a short-circuit current rating equal to or greater than the available fault current.

(3) Grouping. If more than one emergency disconnect is provided, they must be grouped.

(B) Identification of Other Disconnects. Where disconnects for other energy source systems are not adjacent to the emergency disconnect, a plaque or directory identifying the location of other energy source disconnects must be adjacent to the emergency disconnect.

Note: See 445.18, 480.7, 705.20, and 706.15 for examples of other energy source system isolation means.

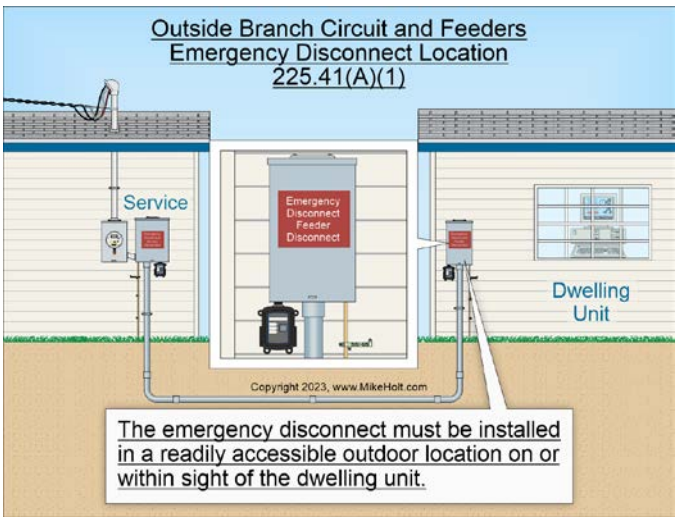


Figure 225–3

(C) Marking. The emergency disconnect must be marked "EMERGENCY DISCONNECT."

Markings must be permanently affixed and be sufficiently durable to withstand the environment involved in accordance with 110.21(B) and comply with following:

(1) The emergency disconnect marking or label must be on the outside front of the disconnect with a red background and white text.

(2) The letters must be at least ½ in. high.

ARTICLE
300

GENERAL REQUIREMENTS FOR WIRING METHODS AND MATERIALS

Introduction to Article 300—General Requirements for Wiring Methods and Materials

Article 300 contains the general requirements for all wiring methods included in the *NEC*. However, it does not apply to twisted-pair cable and coaxial cable (which are covered in Chapters 7 and 8), unless Article 300 is specifically referenced.

This article is primarily concerned with how to install, route, splice, protect, and secure cables, conductors, and raceways. How well you understand and apply the requirements of Article 300 will usually be evident in the finished work. Many of its requirements will affect the appearance, longevity, and even the safety of the installation. Installing conductors takes critical thinking, for example installing the phase conductors in one raceway and the neutral conductors in another raceway will cause inductive heating effects. Pay close attention to the building construction to be aware of what to do when cables are installed through framing members or penetrate fire walls. After studying and learning the rules in this article, you will immediately realize that the burial depth requirements of 300.5 were possibly overlooked or ignored.

A good understanding of this article will start you on the path to correctly and safely installing the wiring methods included in Chapter 3. Be sure to carefully consider the accompanying illustrations and refer to the definitions in Article 100 as needed.

300.14 Length of Free Conductors at Outlets, Junctions, and Switch Points

New language clarifies that the required 6 in. of free conductor can be spliced!

Analysis

CLARIFIED

This has been a point of contention for a long time, and now we have an answer—you can use spliced conductors to meet the requirement for 6 in. of free conductor in this rule. In the past, some AHJs read this rule to mean that conductors needed to be replaced if they were damaged or too short. Now it is clear that you can just splice them.

300.14 Conductor Length at Boxes

At least 6 in. of spliced or unspliced conductor, measured from the point in the box where the conductors enter the enclosure, must be provided for conductor splices or terminations. ▸Figure 300–22

Boxes with openings less than 8 in. at any dimension must have at least 6 in. of conductor, measured from the point where the conductors enter the box, and at least 3 in. of conductor outside the box. ▸Figure 300–23

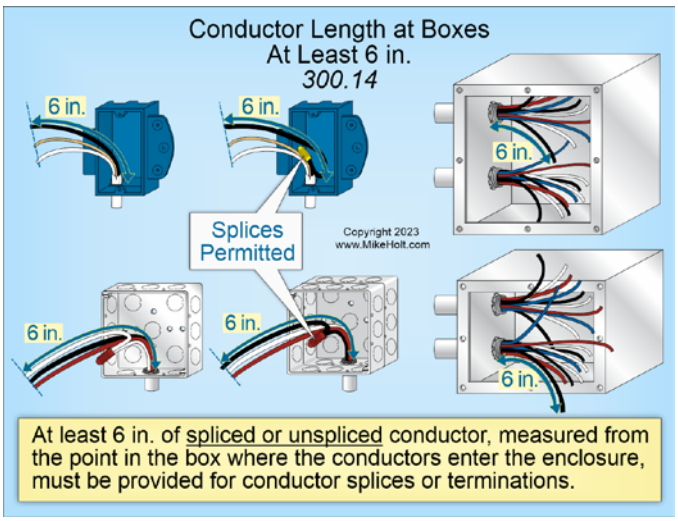


Figure 300–22

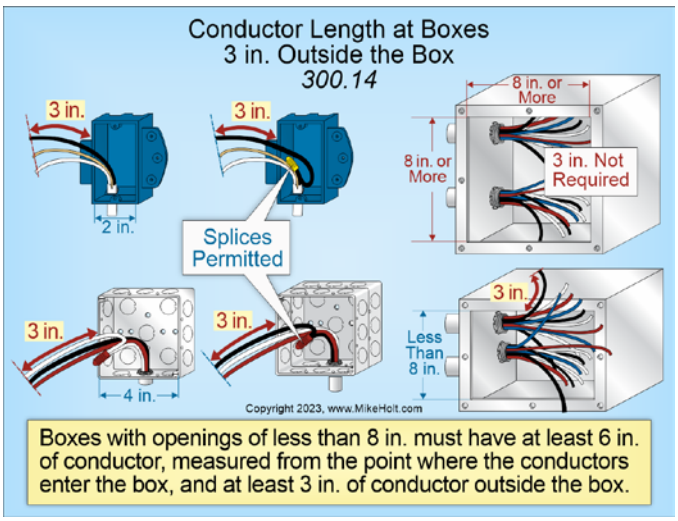


Figure 300–23

ARTICLE
358

ELECTRICAL METALLIC TUBING (EMT)

Introduction to Article 358—Electrical Metallic Tubing (EMT)

Electrical metallic tubing (EMT) is perhaps the most used raceway in commercial and industrial installations. It is a lightweight raceway that is relatively easy to bend, cut, and ream. Because EMT is not threaded, all connectors and couplings are of the threadless type (either set screw or compression) and provide for quick, easy, and inexpensive installations as compared to other metallic raceway systems—all of which make it very popular.

358.10 Uses Permitted

Two permitted uses for EMT were added.

Analysis

NEW

Two permitted uses for EMT were added in list item (1) and list item (4).

List item (1) was expanded to permit the use of EMT for direct burial applications when used with fittings listed and identified for direct burial.

New item (4) permits EMT to be used for manufactured wiring systems as permitted in 604.100(A)(2). That is going to be a real time saver for floor level connections!

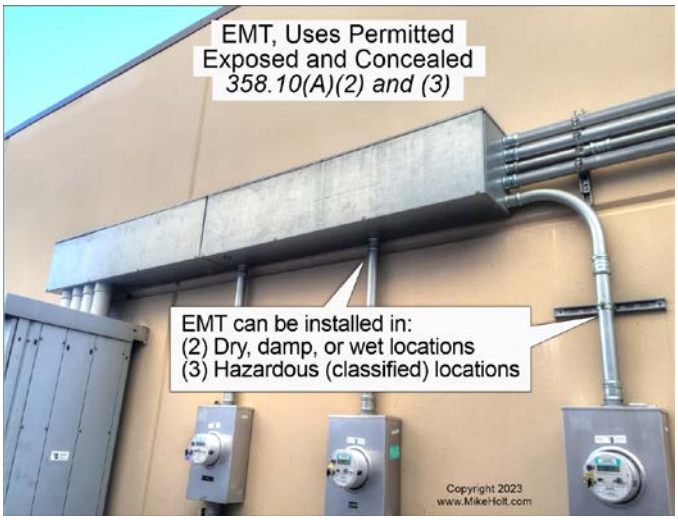
358.10 Uses Permitted

(A) Exposed and Concealed. EMT is permitted to be used exposed and concealed for the following applications: ▸Figure 358–2

(1) In concrete and in direct contact with the earth with fittings identified for direct burial. ▸Figure 358–3

(2) In dry, damp, or wet locations.

(3) In any hazardous (classified) location as permitted by other articles in this *Code*.



▸Figure 358–2

(B) Corrosive Environments.

(1) Galvanized Steel. Galvanized and stainless steel EMT, elbows, and fittings can be installed in concrete, in direct contact with the earth, or in areas subject to severe corrosive influences if protected by corrosion protection and approved as suitable for the condition.

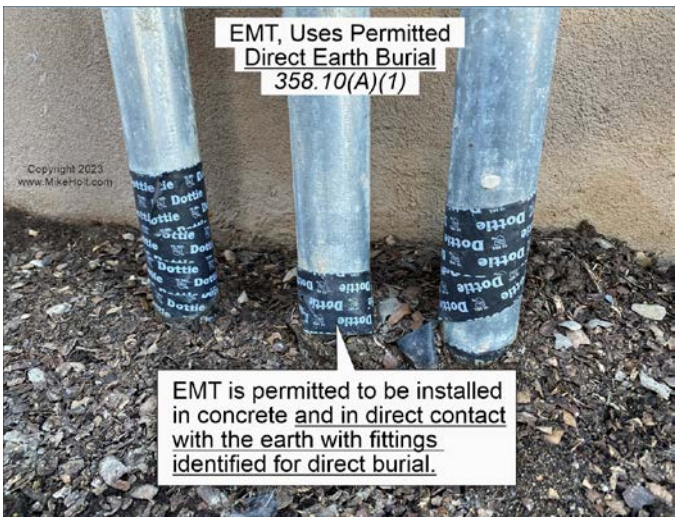


Figure 358–3

Author's Comment:

- According to UL "FJMX" Guide, supplementary corrosion protection is required when EMT and associated fittings are buried. In addition, supplementary corrosion protection is required at the point where EMT transitions from concrete encasement to the soil.

(D) Wet Locations. Support fittings such as screws, straps, and so on, installed in a wet location must be made of corrosion-resistant material.

Note: See 300.6 for protection against corrosion.

Author's Comment:

- If installed in wet locations, fittings for EMT must be listed for use in wet locations and prevent moisture or water from entering or accumulating within the enclosure in accordance with 314.15 [358.42].

ARTICLE
406

RECEPTACLES, ATTACHMENT PLUGS, AND FLANGED INLETS

Introduction to Article 406—Receptacles, Attachment Plugs, and Flanged Inlets

This article covers the rating, type, and installation of receptacles, attachment plugs, and flanged inlets. There are many types of receptacles such as self-grounding, isolated ground, tamper resistant, weather resistant, GFCIs and AFCIs, energy controlled, work surface and countertop assemblies, USBs, surge protectors, and so on. Examine the rules carefully and remember an outlet is not a receptacle.

406.12 Tamper-Resistant Receptacles

These rules were expanded once again to include additional required locations.

Analysis

EXPANDED

Tamper-resistant receptacles have been protecting curious minds for years now. This *Code* cycle, additional locations that require protection were added to the list.

CLARIFIED

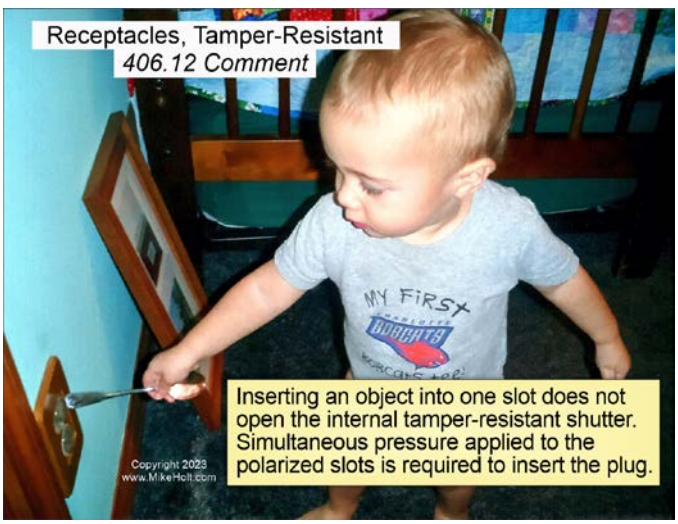
Exception No. 3 was clarified to say that a single receptacle for a single appliance, or a duplex receptacle for two appliances, not readily accessible and located within the space designated for the appliance(s) are exempt from this rule.

406.12 Tamper-Resistant Receptacles

Nonlocking-type 15A and 20A receptacles in the following areas must be tamper resistant "TR":

Author's Comment:

- Inserting an object into one slot of a tamper-resistant receptacle does not open the internal shutter mechanism. Simultaneous pressure applied to the polarized slots is required to insert the plug. ▸Figure 406–22



▸Figure 406–22

(1) In dwelling units, boathouses, mobile homes, and manufactured homes, including their attached and detached garages and accessory buildings, and common areas of multifamily dwellings. ▸Figure 406–23

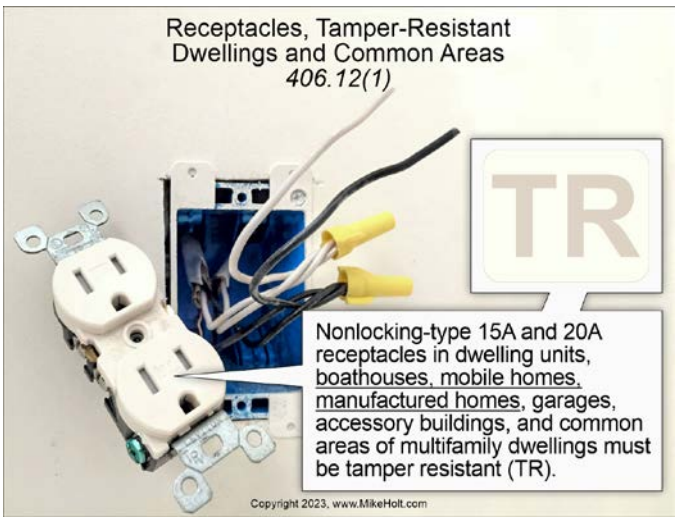


Figure 406–23

(2) In hotel and motel guest rooms and guest suites, and their common areas.

(3) In childcare facilities.

Author's Comment:

- A childcare facility is a building or portions of a building used for educational, supervision, or personal care services for five or more children seven years in age or less [Article 100].

(4) In preschools and education facilities.

Author's Comment:

- This applies to all educational facilities including high schools, colleges, vocational schools, universities, and so forth.

(5) Within clinics, medical and dental offices, outpatient facilities, and the following spaces:

a. Business offices accessible to the general public

b. Lobbies and waiting spaces

c. Spaces of nursing homes and limited care facilities used exclusively as patient sleeping rooms

(6) Places of awaiting transportation, gymnasiums, skating rinks, fitness centers, and auditoriums.

(7) Dormitory units.

(8) Residential care/assisted living facilities, social and substance abuse rehabilitation facilities, and group homes.

(9) Foster care facilities, nursing homes, and psychiatric hospitals.

(10) Areas and common areas of agricultural buildings accessible to the general public.

Note 3: Areas of agricultural buildings frequently converted to hospitality areas include petting zoos, stables, and buildings used for recreation or educational purposes.

Ex to (1) through (10): Receptacles in the following locations are not required to be tamper resistant:

(1) Receptacles more than 5½ ft above the floor. Figure 406–24

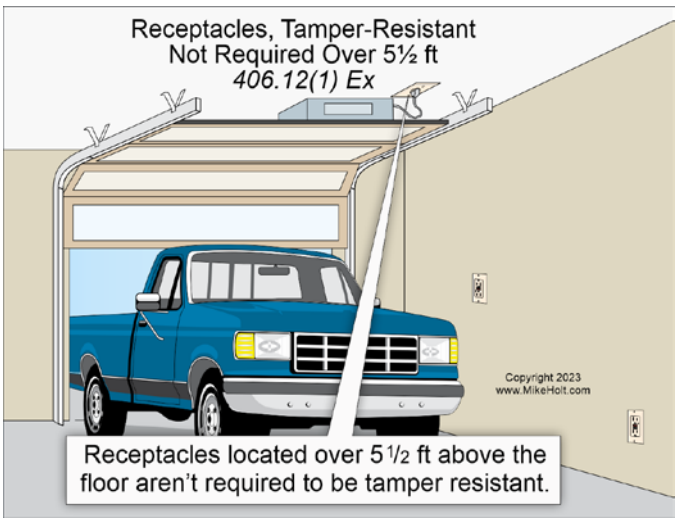


Figure 406–24

(2) Receptacles that are part of a luminaire or appliance.

(3) A receptacle within dedicated space for an appliance that in normal use is not easily moved.

(4) Nongrounding receptacles installed as permitted in 406.4(D)(2)(a).

ARTICLE
450

TRANSFORMERS AND TRANSFORMER VAULTS (INCLUDING SECONDARY TIES)

Introduction to Article 450—Transformers and Transformer Vaults (Including Secondary Ties)

This article covers transformers supplying power and lighting loads. For the purposes of Article 450 only, a transformer is an individual power transformer, single- or poly-phase, identified by a single nameplate—unless otherwise indicated.

A major concern with transformers is preventing overheating. The *Code* does not completely address this issue. Article 90 explains that the *NEC* is not a design manual, and it assumes that anyone using the *Code* has a certain level of expertise. Proper transformer selection is an important part of preventing them from overheating. The *NEC* assumes you have already selected a transformer suitable for the load characteristics. For the *Code* to tell you how to do that would push it into the realm of a design manual. Article 450 then takes you to the next logical step—providing overcurrent protection and the proper connections. But this article does not stop there because 450.9 provides ventilation requirements, and 450.13 contains accessibility requirements.

Part I contains the general requirements such as guarding, marking, and accessibility, Part II contains those for different types of transformers, and Part III covers transformer vaults.

450.10 Grounding and Bonding

The word "Bonding" was added to the title of the section as the rule address both grounding and bonding.

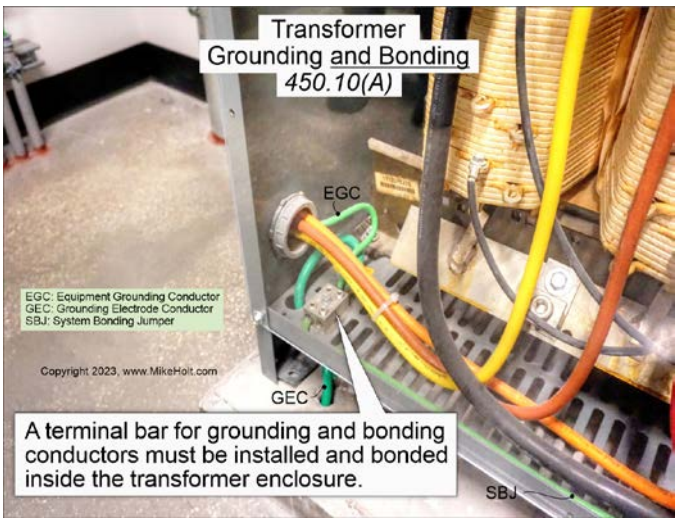
Analysis

EDITED

The *NEC* Style Manual requires the title of a section reflect the section's content, so the word "Bonding" was added to the title.

450.10 Grounding and Bonding

(A) Dry-Type Transformer Enclosures. A terminal bar for equipment grounding conductors, system bonding jumpers, supply-side bonding jumpers, and grounding electrode conductors must be installed and bonded inside the transformer enclosure. ▸Figure 450–2



▸Figure 450–2

The terminal bar must be bonded to the transformer enclosure in accordance with 250.12 and not installed on or over any vented portions.

ARTICLE
555

MARINAS, BOATYARDS, FLOATING BUILDINGS, AND COMMERCIAL AND NONCOMMERCIAL DOCKING FACILITIES

Introduction to Article 555—Marinas, Boatyards, Floating Buildings, and Commercial and Noncommercial Docking Facilities

Water levels are not constant. Ocean tides rise and fall, while lakes and rivers vary in depth in response to rain. To provide power to a marina or docking facility, you must allow for these variations in water level between the point of use and the electric power source. Article 555 addresses this issue.

This article begins with the concept of the electrical datum plane. You might think of it as the border of a "demilitarized zone" for electrical equipment. Or you can think of it as a line that marks the beginning of a "no man's land" where you simply do not place electrical equipment. Once you determine where this plane is, do not place transformers, connections, or receptacles below that line.

Because of recent electric shock drowning (ESD) incidents, installations supplying shore power in marinas and boatyards have increased electrical safety with the use of ground-fault protection (GFPE), leakage devices, and warning signs to raise awareness of possible hazardous voltage and currents present in the water of marinas and docking facilities.

555.38 Luminaires

A new subdivision addresses the requirements for luminaire installations and retrofits.

Analysis

NEW

A new rule (A) requires luminaires and retrofit kits installed in marinas to be listed and identified for the use in their intended environment and installed to prevent damage from watercraft or entanglement with sea life.

NEW

Subdivision (B) requires luminaires that are installed below the highest tide level, and likely to be periodically submersed, to be identified as submersible, operate below the low-voltage contact limit, and be supplied by a transformer or power supply in accordance with 680.23(A)(2).

555.38 Luminaires

(A) General. All luminaires and retrofit kits must be listed and identified for use in their intended environment. Luminaires and their supply connections must be secured to structural elements of the marina to limit damage from watercraft and prevent entanglement of, and interaction with, sea life.

(B) Underwater Luminaires. Luminaires installed below the highest high tide level or electrical datum plane and likely to be periodically submersed must be limited to the following:

(1) Identified as submersible

(2) Operate below the low-voltage contact limit as defined in Article 100

(3) Supplied by an isolating transformer or power supply in accordance with 680.23(A)(2)

ARTICLE
630
ELECTRIC WELDERS

Introduction to Article 630—Electric Welders

Electric welding equipment does its job either by creating an electric arc between two surfaces or by heating a rod that melts from overcurrent. Either way results in a hefty momentary current draw. Welding machines come in many shapes and sizes. On the smaller end of the scale are portable welding units used for manual welding, such as in a fabrication shop. At the larger end are robotic welding machines the size of a house used for making everything from automobile bodies to refrigerator panels. All of these must comply with Article 630.

The primary concern of this article is adequately sizing the conductors and circuit protection to handle this type of load. Fortunately for the design engineer and the field electrician, Article 630 requires certain information to be provided on the nameplate of the equipment. This article explains how to use that information to properly size conductors and circuit protection.

630.8 Ground-Fault Circuit-interrupter Protection for Personnel

GFCI protection makes yet another appearance in the workplace and is now required for receptacles used for hand tools and portable lighting.

Analysis

NEW

This is a new section that requires all 125V, single-phase, 15A and 20A receptacles for hand tools or portable lighting equipment in areas where welders are operated to be GFCI protected. This rule does not require GFCI protection for the receptacle that supplies the welder, however requirements in 210.8 may.

630.8 Receptacle, GFCI Protection

GFCI protection is required for all 15A and 20A, 125V receptacles used for electrical hand tools or portable lighting equipment installed in work areas where welders are operated. ▸Figure 630–1

▸Figure 630–1

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