

# ARTICLE 110

## GENERAL REQUIREMENTS FOR ELECTRICAL INSTALLATIONS

### Introduction to Article 110—General Requirements for Electrical Installations

Article 110 sets the stage for how the rest of the *NEC* is implemented. It is critical for you to completely understand all aspects of this article since it is the basis for much of the *Code*. As you read and master Article 110, you are building your foundation for correctly applying the *NEC*. While the purpose of the *National Electrical Code* is to provide a safe installation, this article is perhaps focused a little more on providing an installation that is safe for the installer and maintenance electrician, so time spent here is a good investment.

#### 110.3 Use and Product Listing (Certification) of Equipment

A new list item (A)(8) was added to address cybersecurity for network-connected life safety equipment and QR codes. In addition, a few other improvements were made to 110.3(B).



##### EXPANDED

As technology progresses, so have the means to communicate information. Product manufacturers can now provide much better instructions for products using digital media and save a tree or two in the process. To reflect this shift in technology, a new Note allows the manufacturer's instructions to be printed material, a QR code, or a hyperlink on or provided with the product.

#### Analysis



##### NEW

A specific requirement was added by list item (A)(8) requiring network-connected life safety equipment be able to withstand unauthorized updates and malicious attacks while continuing to perform its intended safety function.



##### EXPANDED

The rule in 110.3(B) was expanded to include equipment that is not just listed, labeled, or both, but also identified for use in accordance with the manufacturer's instructions. Previously you only had to follow the instructions provided with listed and labeled products.

#### 110.3 Use and Product Listing (Certification) of Equipment

**(A) Guidelines for Approval.** The authority having jurisdiction must approve equipment. In doing so, consideration must be given to the following:

- (1) Suitability for installation and use in accordance with the *NEC*

**Note 1:** Equipment may be new, reconditioned, refurbished, or remanufactured.

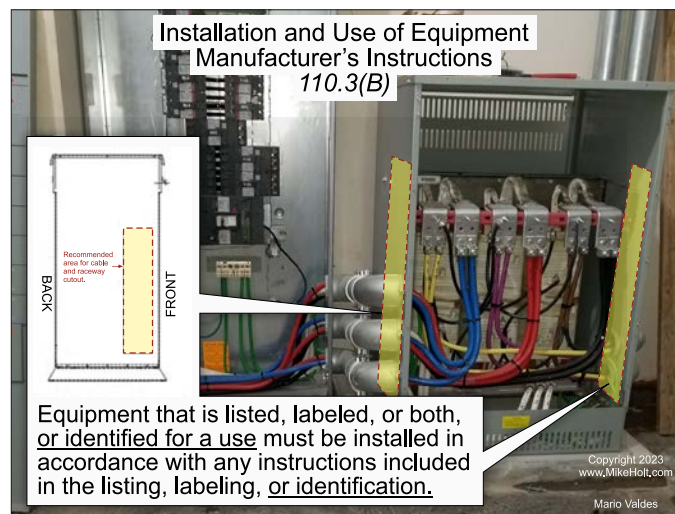
**Note 2:** Suitability of equipment use may be identified by a description marked on, or provided with, a product to identify the suitability of the product for a specific purpose, environment, or application. Special conditions of use or other limitations may be marked on the equipment, in the product instructions, or included in the appropriate listing and labeling information. Suitability of equipment may be evidenced by listing or labeling.

- (2) Mechanical strength and durability
- (3) Wire-bending and connection space
- (4) Electrical insulation
- (5) Heating effects under all conditions of use
- (6) Arcing effects
- (7) Classification by type, size, voltage, current capacity, and specific use
- (8) Cybersecurity for network-connected life safety equipment to address its ability to withstand unauthorized updates and malicious attacks while continuing to perform its intended life safety functionality.

**Note:** See the IEC 62443 series of standards for industrial automation and control systems, the UL 2900 series of standards for software cybersecurity for network connectible products, and UL 5500, *Standard for Remote Software Updates*, which are standards that provide frameworks to mitigate current and future security cybersecurity vulnerabilities and address software integrity in systems of electrical equipment.

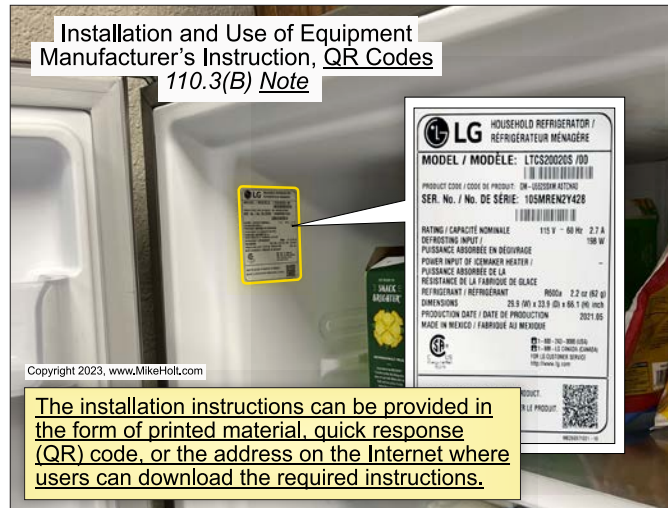
- (9) Other factors contributing to the practical safeguarding of persons using or in contact with the equipment

**(B) Installation and Use.** Equipment that is listed, labeled, or both, or identified for a use must be installed in accordance with any instructions included in the listing, labeling, or identification. ▶Figure 110-1



▶Figure 110-1

**Note:** The installation instructions can be provided in the form of printed material, quick response (QR) code, or the address on the Internet where users can download the required instructions. ▶Figure 110-2



▶Figure 110-2

#### Author's Comment:

- ▶ Many electricians simply throw away installation instructions, however that excuse is now becoming less valid since manufacturers are starting to use QR codes on electrical equipment, so the instructions are always readily available.

## 110.8 Wiring Methods

The words “or premises wiring system” were added to clarify that the covered wiring methods are not limited to installation on or in buildings.

### Analysis



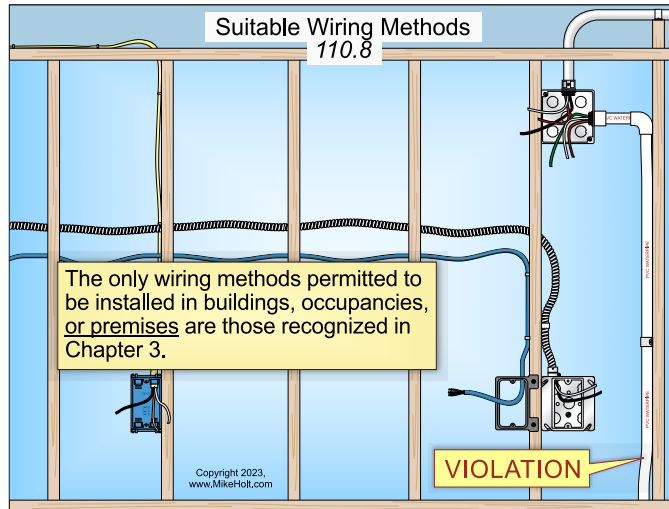
#### CLARIFIED

The *NEC* is a legal document and must identify exactly what is covered by a rule. In this case the language was revised so that a literal reading of the rule makes it clear that this one applies to wiring systems either in, on, or outside of a structure. The phrase “occupancy, or premises wiring system” was added to clarify that scope of the rule is not limited to installations on or in buildings.

### 110.8 Suitable Wiring Methods

The only wiring methods permitted to be installed in buildings, occupancies, or premises are those recognized by the *NEC* in Chapter 3.

►Figure 110-3



►Figure 110-3

### 110.12 Mechanical Execution of Work

The *Code* recognizes the importance of quality installations in this section. Some editorial changes were made to clarify how to recognize “quality.”

#### Analysis



#### CLARIFIED

The subjective term “neat” was replaced with a less subjective term “professional,” and “workmanlike” was replaced with “skillful” to better communicate what this rule is about. While the changes in these terms may not provide more enforceability than those used previously, the attention to this section reminds us how important it is to be a professional.

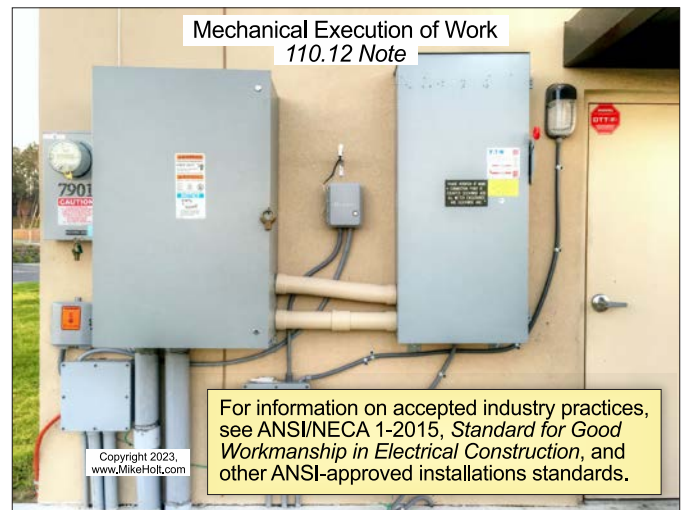
### 110.12 Mechanical Execution of Work

Electrical equipment must be installed in a professional and skillful manner. ►Figure 110-4



►Figure 110-4

**Note:** For information on accepted industry practices, see ANSI/NECA 1, *Standard for Good Workmanship in Electrical Construction*, and other ANSI-approved installation standards. ►Figure 110-5



►Figure 110-5

#### Author's Comment:

- This rule is perhaps one of the most subjective of the entire *Code* and its application is still ultimately a judgment call made by the authority having jurisdiction

## 110.16 Arc-Flash Hazard Warning

The title and rule of 110.16(B) were updated to expand the arc-flash marking requirements from only service equipment to include feeder-supplied equipment. Furthermore, the ampacity threshold requirement was changed from 1200A to 1000A.

### Analysis



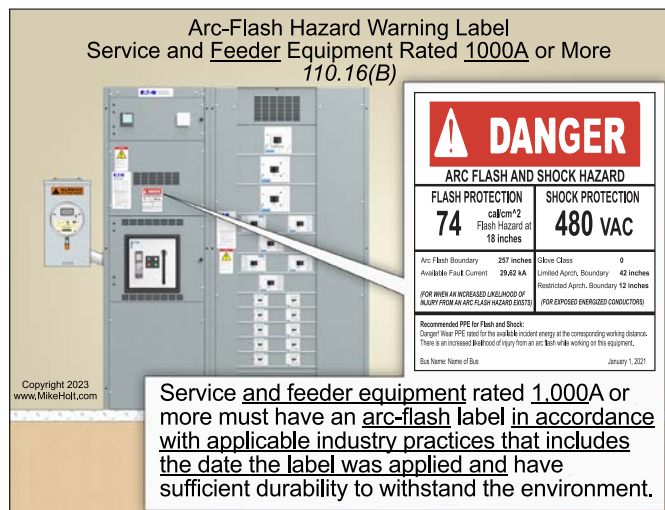
#### EXPANDED

As awareness has increased as to the dangers of injury or death from arc-flash and arc-blast events, the industry has identified the need to expand this rule. Arc-flash label requirements in this rule previously applied to service equipment rated 1200A or larger. In this *Code* cycle, the requirements were expanded to include both feeders and service equipment with a rating of 1000A or more. Other changes in this section removed some of the specific marking requirements for the labels instead requiring them to include the date the label was applied and be created in accordance with acceptable industry practices (NFPA 70E, *Standard for Electrical Safety in the Workplace*) as indicated in Note 2.

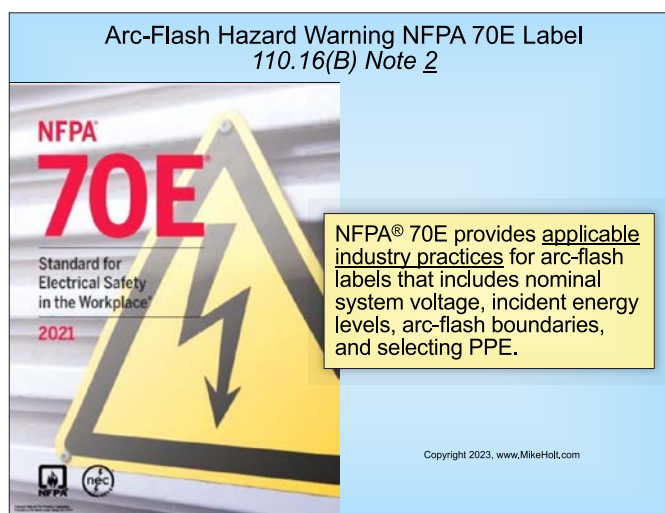
## 110.16 Arc-Flash Hazard Warning, Other Than Dwelling Units

**(B) Service and Feeder Equipment.** In other than dwelling units, service and feeder equipment rated 1000A or more must have an arc-flash label in accordance with applicable industry practices that includes the date the label was applied and have sufficient durability to withstand the environment. ▶Figure 110-6

**Note 2:** NFPA 70E, *Standard for Electrical Safety in the Workplace* provides applicable industry practices for developing arc-flash labels that include nominal system voltage, incident energy levels, arc-flash boundaries, and selecting personal protective equipment. ▶Figure 110-7



▶Figure 110-6



▶Figure 110-7

### Author's Comment:

- ▶ The information required by 110.16(B) is necessary to determine the incident energy and arc-flash boundary distance by using of an app or computer software to ensure the label complies with NFPA 70E, *Standard for Electrical Safety in the Workplace* to increase safety during future work on service and feeder equipment.



## 110.17 Servicing and Maintenance of Equipment

A new section was added to address the servicing and maintenance of equipment

### Analysis



NEW

This new rule was added to clarify the differences between servicing and maintenance of equipment, and reconditioning equipment. However, it has requirements as to who and how servicing and maintenance can be performed.

### 110.17 Servicing and Maintenance of Equipment

Equipment servicing and maintenance is required to be performed by a qualified person trained in servicing and maintenance of equipment and comply with the following: ▶Figure 110-8



▶Figure 110-8

**(1) Standards.** Servicing and maintenance must be performed in accordance with the equipment manufacturer's instructions, applicable industry standards, or as approved by the authority having jurisdiction.

**(2) Replacement Parts.** Servicing and maintenance replacement parts must:

- a. Be provided by the original equipment manufacturer
- b. Be designed by an engineer experienced in the design of replacement parts for the type of equipment being serviced or maintained
- c. Be approved by the authority having jurisdiction

**Note 2:** See NFPA 70B, *Recommended Practice for Electrical Equipment Maintenance*, for information related to preventive maintenance for electrical equipment.

## 110.20 Reconditioned Equipment

This new section identifies the general requirements for reconditioned equipment.

### Analysis



NEW

As more equipment ages out and becomes harder to replace, it has become increasingly popular to recondition equipment to prolong the service life of an existing installation. This new section and its three subdivisions tell us what equipment can be reconditioned and what reconditioning includes. Subdivisions (A) and (B) cover listed and unlisted equipment, while subdivision (C) provides a method for the AHJ to approve reconditioned equipment.

### 110.20 Reconditioned Equipment

Equipment that is restored to operating condition must be reconditioned with identified replacement parts, verified under applicable standards, which are either provided by the original equipment manufacturer or that are designed by an engineer experienced in the design of replacement parts for the type of equipment being reconditioned.

**(A) Equipment Required to Be Listed.** Equipment that is reconditioned and required by this *Code* to be listed must be listed or field labeled as reconditioned using available instructions from the original equipment manufacturer.

**(B) Equipment Not Required to Be Listed.** Equipment that is reconditioned and not required by this *Code* to be listed must comply with one of the following:

- (1) Be listed or field labeled as reconditioned
- (2) Have the reconditioning performed in accordance with the original equipment manufacturer instructions

**(C) Approved Equipment.** If the options specified in 110.20(A) or (B) are not available, the authority having jurisdiction can approve reconditioned equipment, and the reconditioner must provide the authority having jurisdiction with documentation of the changes to the product.

## 110.22 Identification of Disconnecting Means

Additional language was added to clarify the identification of the disconnect supply source.

### Analysis



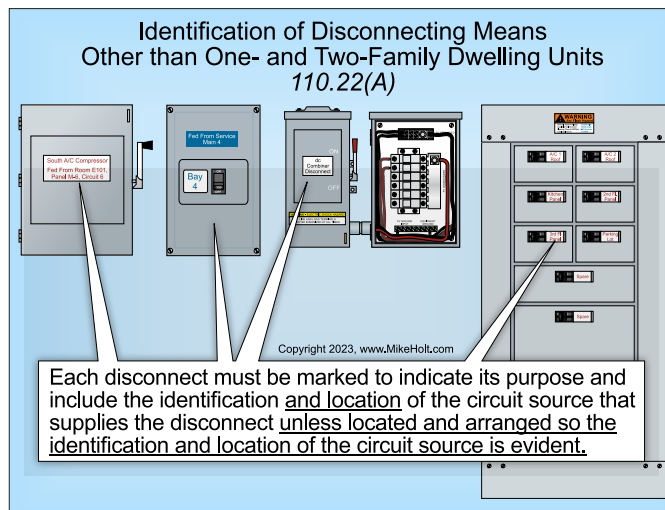
#### CLARIFIED

This change makes it clear that where the purpose of the disconnect and the location of the circuit source for the disconnect is not evident, identification of the purpose and the supply circuit location must be provided at the disconnect. This clarifies that where the disconnect is a circuit breaker installed in a panelboard, one need not identify the source of the supply to the disconnect as it would be evident.

## 110.22 Identification of Disconnecting Means

**(A) General.** Each disconnect must be legibly marked to indicate its purpose unless located and arranged so the purpose is evident.

In other than one- or two-family dwelling units, the disconnect marking must include the identification and location of the circuit source that supplies the disconnect unless located and arranged so the identification and location of the circuit source is evident. The marking must be of sufficient durability to withstand the environment involved. ▶Figure 110-9



▶Figure 110-9

#### Author's Comment:

- ▶ See 408.4 for additional requirements for identification markings on circuit directories for switchboards and panelboards.

## 110.26 Spaces About Electrical Equipment

Several requirements for equipment doors that open into the path of egress were relocated within this section and now apply to all electrical installations—not just large equipment. Standing areas of working space are now required to be relatively flat. In addition, “service equipment” now requires dedicated equipment space.

### Analysis



#### RELOCATED

A requirement from 110.26(C)(2) in 2020 was relocated to the parent text. It prohibits open doors from impeding the entry or egress path. The relocation makes it apply to all electrical installations—not just large equipment. This rule now specifies that when open equipment doors result in an egress path that is less than 24 in. wide or 6 ft 6 in. high, the opening must be increased to prevent the equipment doors from impeding the egress path.

**RELOCATED**

The requirement from 110.26(C)(2) that open equipment doors not impede access to and egress from the working space was relocated to 110.26(A)(4). Revisions clarify that the space in front of equipment must be unobstructed by fixed cabinets, walls, or partitions. A weight-bearing ceiling structural member is permitted if it does not result in a side reach of more than 6 in. to access the equipment.

**NEW**

New 110.26(A)(6) requires the standing surface of the work area required by (A)(1), (A)(2), and (A)(3) to be level and as flat as practical for the entire required depth and width of the working surface. This addresses the required working space or attic installations where there are no floorboards to establish a surface for the electrical equipment.

**CLARIFIED**

Revisions in 110.26(C)(2)(2) clarify that large equipment includes multiple individual service disconnects where the combined width of the multiple disconnects exceeds 6 ft. It also changed the reference from 230.71 to the more specific reference of 230.71(B).

**EXPANDED**

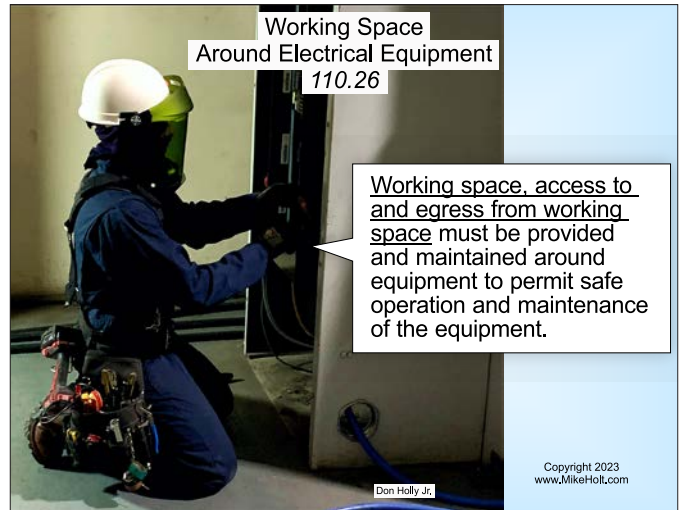
Changes to 110.26(C)(3) require egress doors to open at least 90 degrees in the direction of egress to provide a safe and effective egress path. A door that does not open at least 90 degrees could impede a safe exit in case of an emergency.

**EXPANDED**

Revisions to 110.26(E) add “service equipment” to the list of equipment that requires dedicated equipment space. The intent is to provide dedicated space for a required emergency disconnect [230.85] which was not covered in previous requirements and needs to remain accessible in case of an emergency.

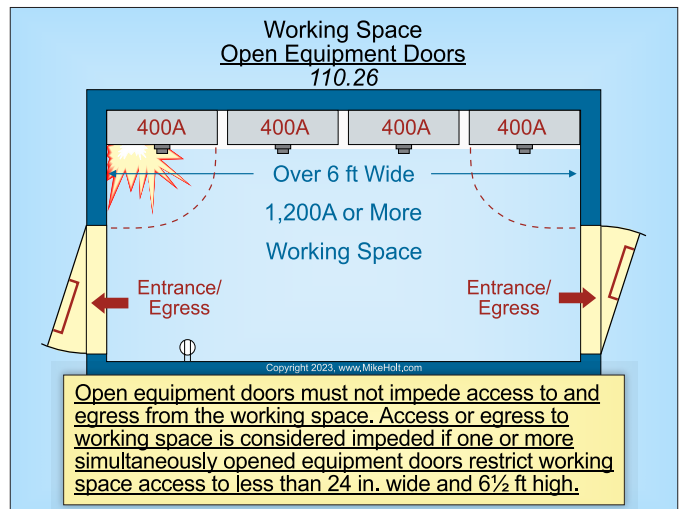
## 110.26 Spaces Around Electrical Equipment

Working space, access to and egress from working space must be provided and maintained around equipment to permit safe operation and maintenance of equipment. ▶Figure 110-10



▶Figure 110-10

Open equipment doors must not impede access to and egress from the working space. Access or egress to working space is considered impeded if one or more simultaneously opened equipment doors restrict working space access to less than 24 in. wide and 6½ ft high. ▶Figure 110-11



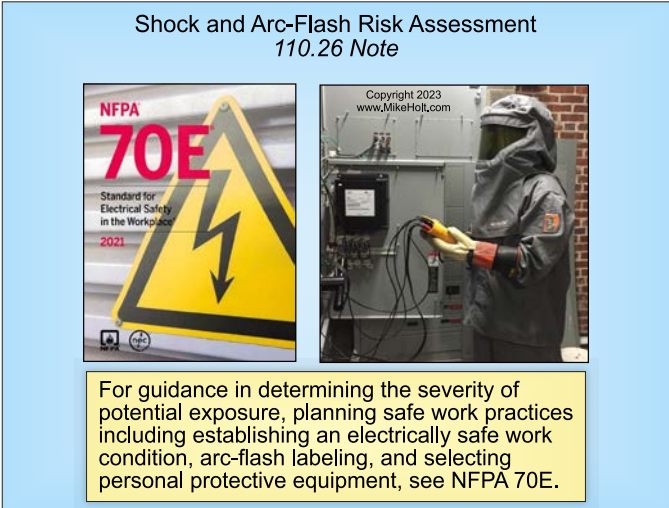
▶Figure 110-11

**(A) Working Space.** Equipment that may need examination, adjustment, servicing, or maintenance while energized must have working space provided in accordance with 110.26(A)(1), (2), (3), and (4).

### Author's Comment:

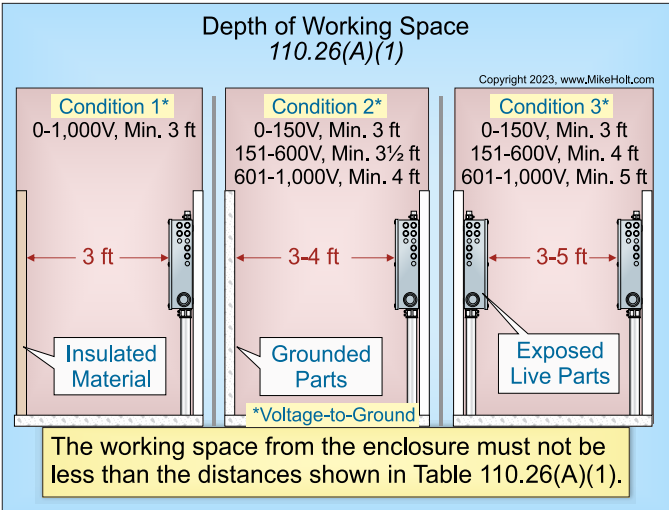
- ▶ The phrase “while energized” is the root of many debates. As always, check with the authority having jurisdiction to see what equipment he or she believes needs a clear working space.

**Note:** For guidance in determining the severity of potential exposure, planning safe work practices including establishing an electrically safe work condition, arc-flash labeling, and selecting personal protective equipment, see NFPA 70E, *Standard for Electrical Safety in the Workplace*. ▶Figure 110-12



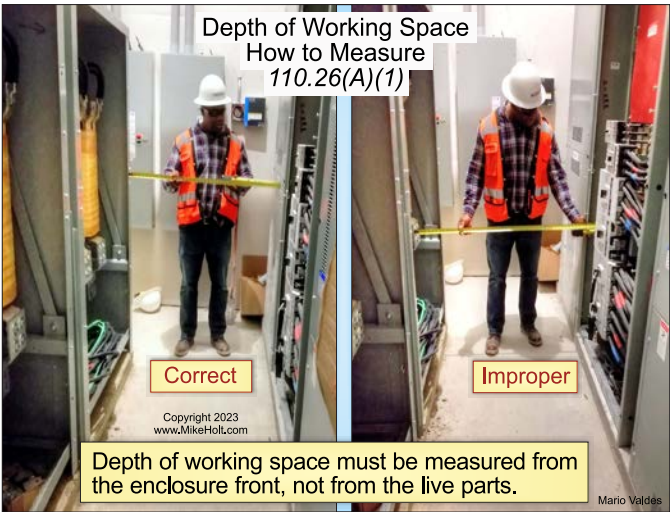
▶Figure 110-12

**(1) Depth of Working Space.** The depth of working space, which is measured from the enclosure front, cannot be less than the distances contained in Table 110.26(A)(1), which are dependent on voltage-to-ground and three different conditions. ▶Figure 110-13



▶Figure 110-13

Depth of working space must be measured from the enclosure front, not the live parts. ▶Figure 110-14



▶Figure 110-14

| Table 110.26(A)(1) Working Space |             |             |             |
|----------------------------------|-------------|-------------|-------------|
| Voltage-to-Ground                | Condition 1 | Condition 2 | Condition 3 |
| 0–150V                           | 3 ft        | 3 ft        | 3 ft        |
| 151–600V                         | 3 ft        | 3½ft        | 4 ft        |
| 601–1000V                        | 3 ft        | 4 ft        | 5 ft        |

▶Figure 110-15, ▶Figure 110-16, and ▶Figure 110-17

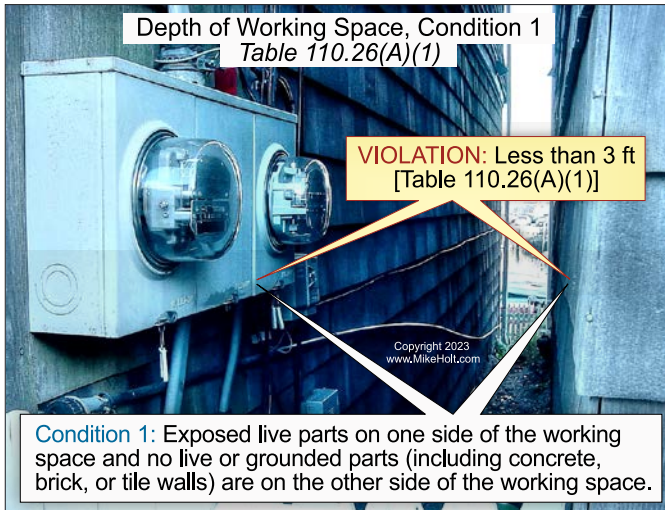
**Table Note:**

*Condition 1:* Exposed live parts on one side of the working space and no live or grounded parts (including concrete, brick, or tile walls) on the other side of the working space.

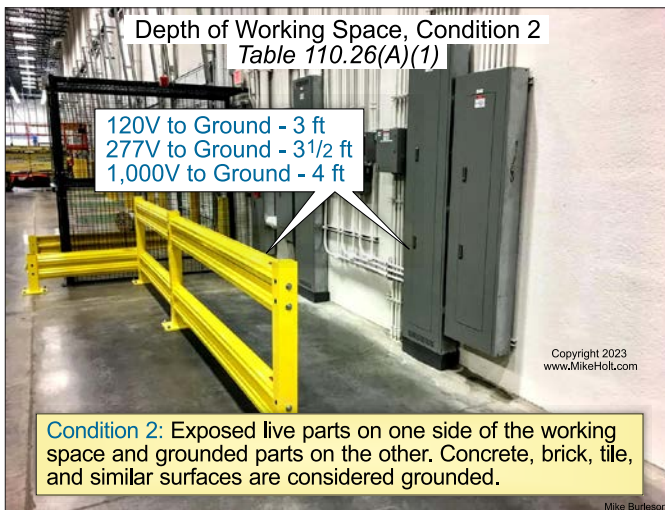
*Condition 2:* Exposed live parts on one side of the working space and grounded parts on the other. Concrete, brick, tile, and similar surfaces are considered grounded.

*Condition 3:* Exposed live parts on both sides of the working space.

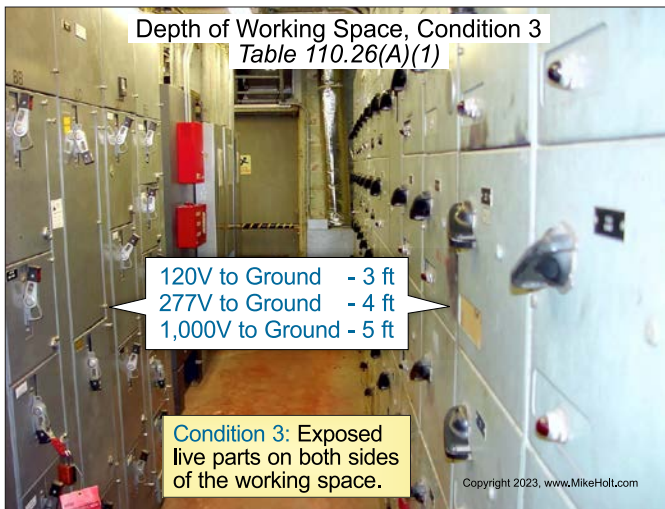




►Figure 110-15



►Figure 110-16



►Figure 110-17

**(a) Rear and Sides of Dead-Front Equipment.** Working space is not required at the back or sides of equipment where all connections and all renewable, adjustable, or serviceable parts are accessible from the front. ►Figure 110-18



►Figure 110-18

#### Author's Comment:

- Sections of equipment that require rear or side access to make field connections must be marked by the manufacturer on the front of the equipment. See 408.18(C).

**(c) Existing Buildings.** If electrical equipment is being replaced, Condition 2 working space is permitted between dead-front switchboards, switchgear, panelboards, or motor control centers located across the aisle from each other where conditions of maintenance and supervision ensure that written procedures have been adopted to prohibit equipment on both sides of the aisle from being open at the same time, and only authorized, qualified persons will service the installation.

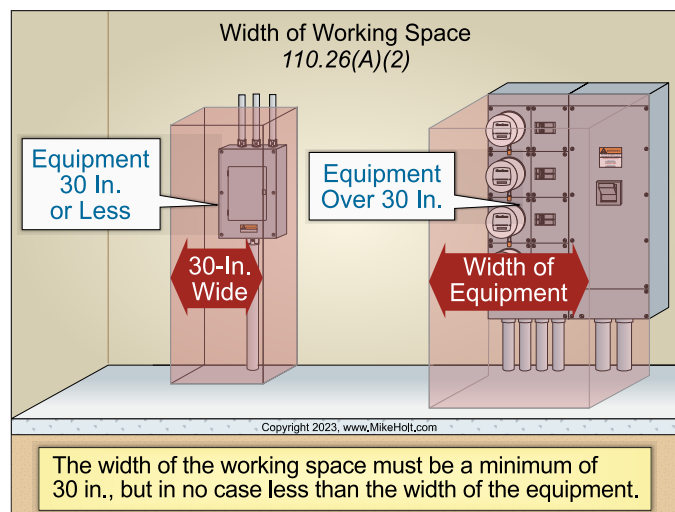
**(2) Width of Working Space.** The width of the working space must be a minimum of 30 in., but in no case less than the width of the equipment.

►Figure 110-19

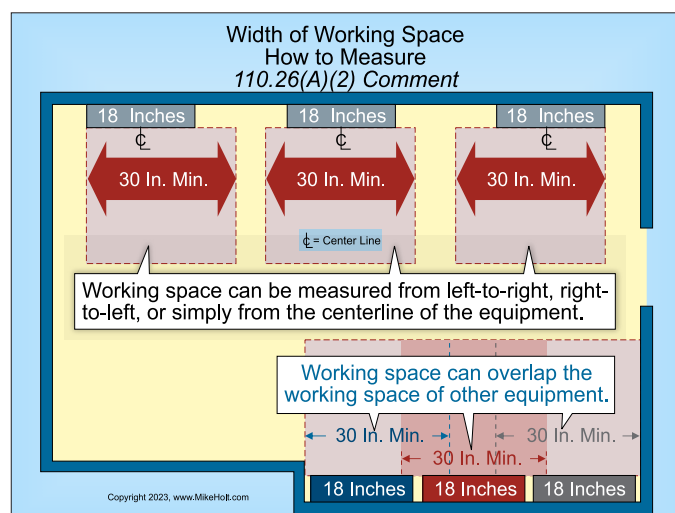
#### Author's Comment:

- The width of the working space can be measured from left-to-right, from right-to-left, or simply centered on the equipment and can overlap the working space for other electrical equipment.

►Figure 110-20 and ►Figure 110-21



►Figure 110-19

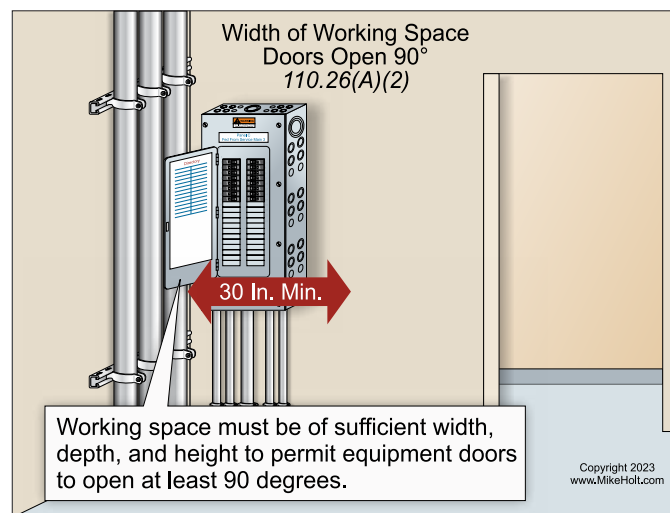


►Figure 110-20



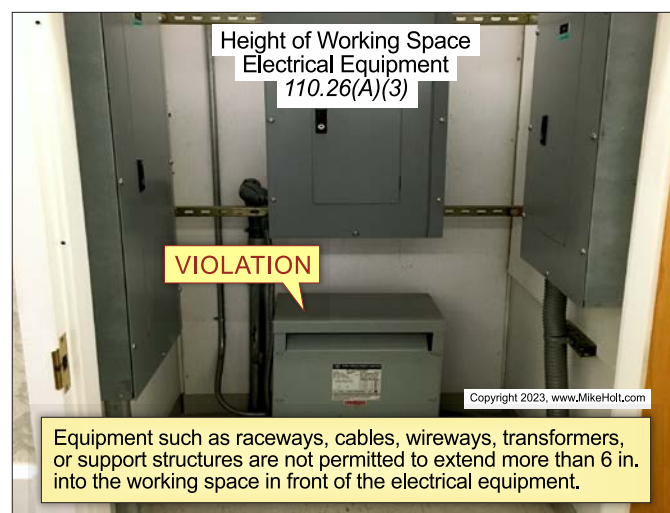
►Figure 110-21

The working space must be of sufficient width, depth, and height to permit equipment doors to open at least 90 degrees. ►Figure 110-22



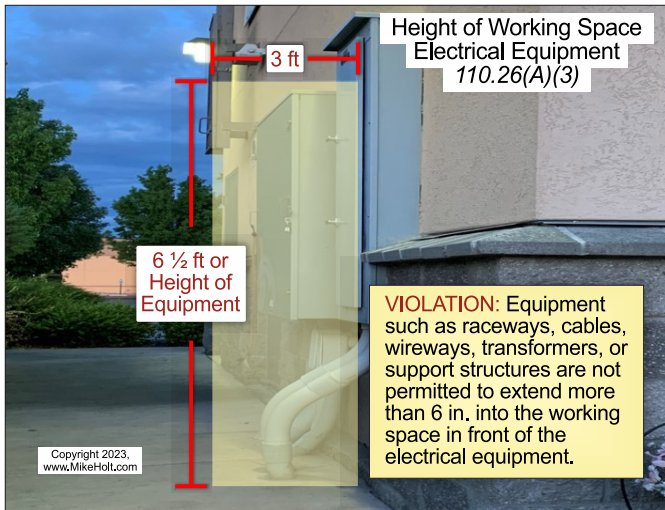
►Figure 110-22

**(3) Height of Working Space.** The height of the working space must be clear and extend from the grade, floor, or platform to a height of 6½ ft or the height of the equipment, whichever is greater. ►Figure 110-23 and ►Figure 110-24



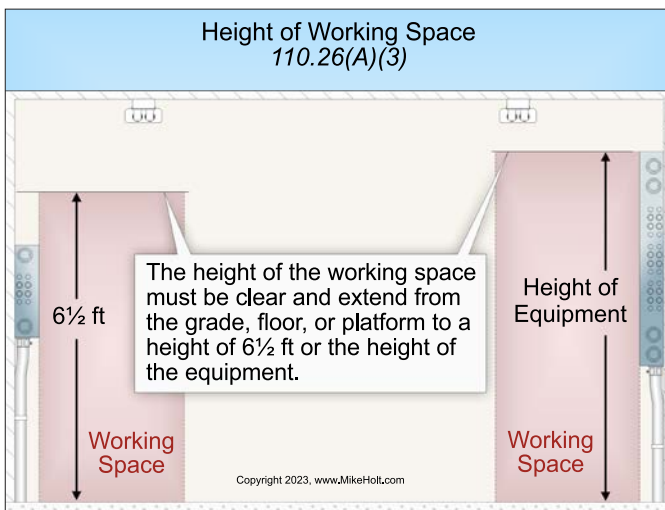
►Figure 110-23





►Figure 110-24

Other equipment such as raceways, cables, wireways, transformers, or support structures (such as concrete pads) are not permitted to extend more than 6 in. into the working space in front of the electrical equipment. ►Figure 110-25, ►Figure 110-26, and ►Figure 110-27

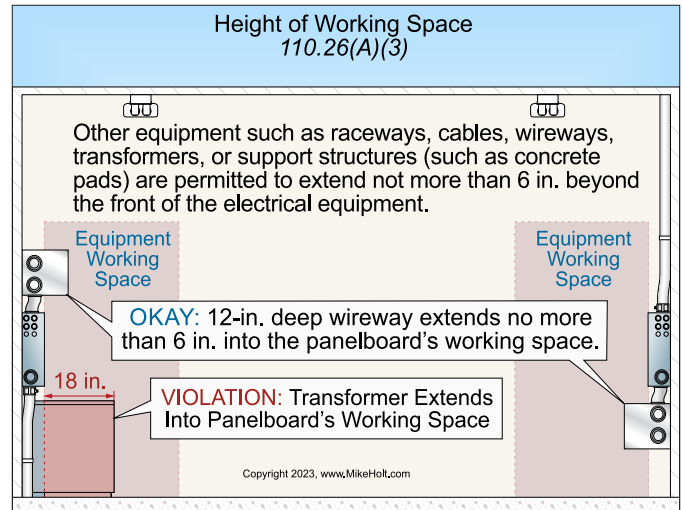


►Figure 110-25

*Ex 2: The minimum height of working space does not apply to a service disconnect or panelboards rated 200A or less located in an existing dwelling unit.*

*Ex 3: Meters are permitted to be installed in the required working space.*

**(4) Limited Access.** Where equipment is likely to require examination, adjustment, servicing, or maintenance while energized is located above a suspended ceiling or crawl space, all the following conditions apply:



►Figure 110-26



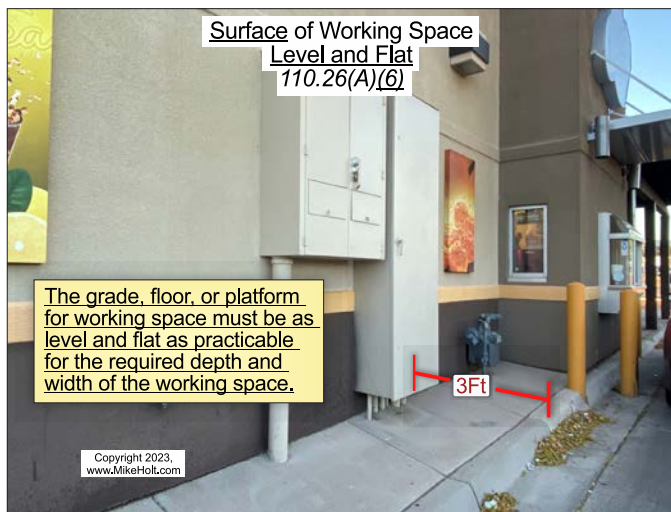
►Figure 110-27

- (1) Equipment installed above a suspended ceiling must have an access opening not smaller than 22 in. × 22 in., and equipment installed in a crawl space must have an accessible opening not smaller than 22 in. × 30 in.
- (2) The width of the working space must be a minimum of 30 in., but in no case less than the width of the equipment.
- (3) The working space must permit equipment doors to open 90°.
- (4) The working space in front of equipment must comply with the depth requirements of Table 110.26(A)(1) and be unobstructed to the floor by fixed cabinets, walls, or partitions. Horizontal ceiling structural members are permitted in this space provided the location of weight-bearing structural members does not result in a side reach of more than 6 in. to work within the enclosure.

**(6) Grade, Floor, or Working Platform.** The grade, floor, or platform for working space must be as level and flat as practical for the required depth and width of the working space. ▶Figure 110-28 and ▶Figure 110-29



▶Figure 110-28



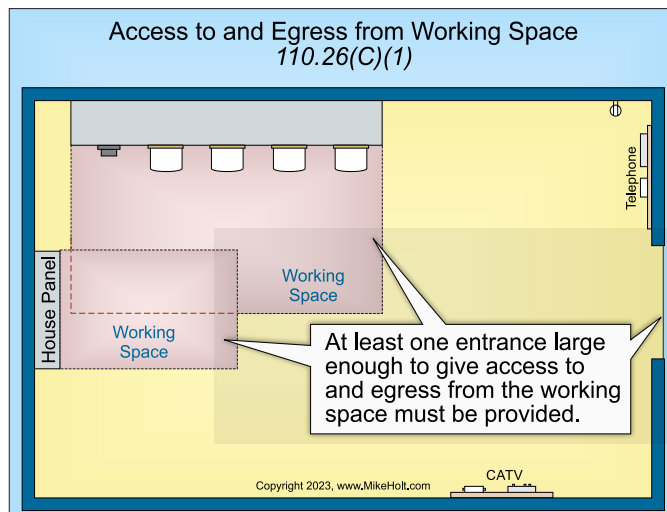
▶Figure 110-29

### (C) Entrance to and Egress from Working Space.

**(1) Minimum Required.** At least one entrance large enough to give access to and egress from the working space must be provided. ▶Figure 110-30

#### Author's Comment:

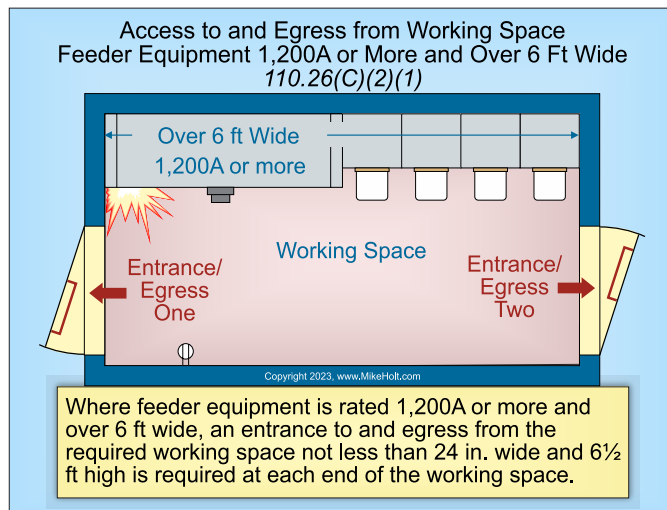
- ▶ Check to see what the authority having jurisdiction considers "large enough." Building codes contain minimum dimensions for doors and openings for personnel travel.



▶Figure 110-30

**(2) Large Equipment.** For large equipment containing overcurrent, switching, or control devices, an entrance to and egress from the required working space not less than 24 in. wide and 6½ ft high is required at each end of the working space. This requirement applies for either of the following conditions:

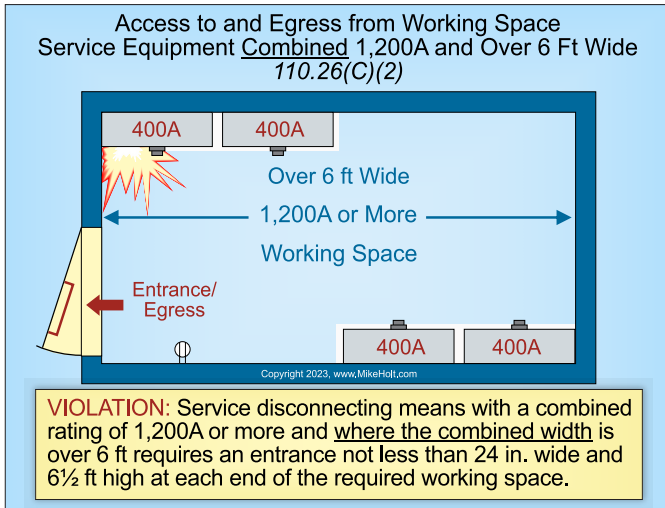
- (1) Where feeder equipment is rated 1200A or more and over 6 ft wide. ▶Figure 110-31



▶Figure 110-31

- (2) Where the service disconnect installed in accordance with 230.71(B) has a combined rating of 1200A or more and where the combined width is over 6 ft. ▶Figure 110-32

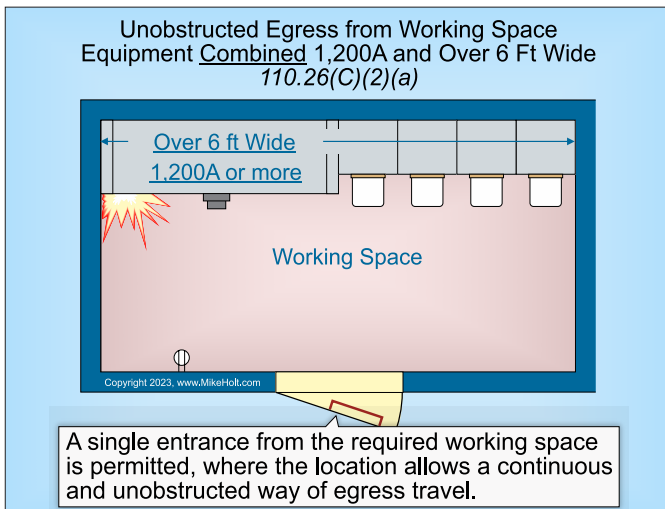




►Figure 110-32

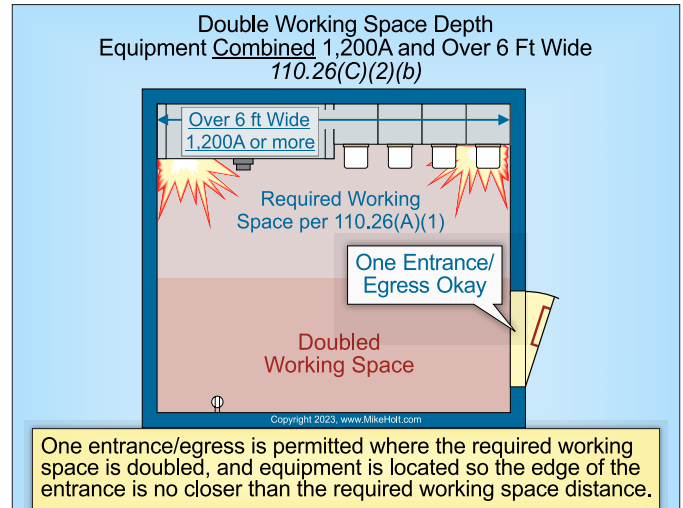
A single entrance for access to and egress from the required working space is permitted where either of the following conditions are met:

**(a) Unobstructed Egress.** Where the location permits a continuous and unobstructed way of egress travel. ►Figure 110-33



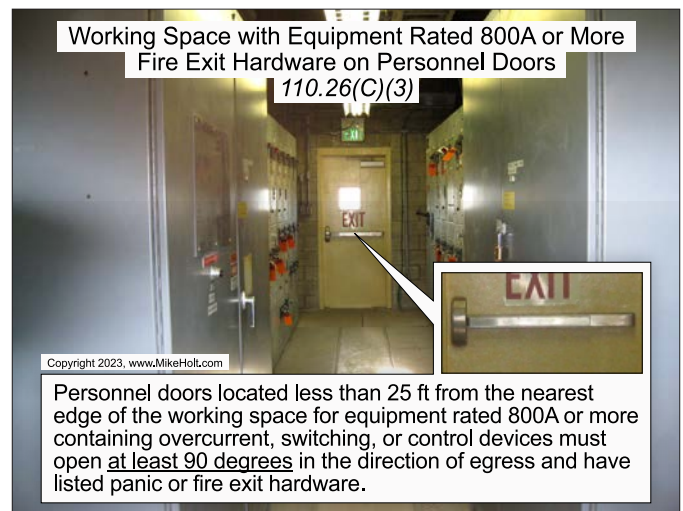
►Figure 110-33

**(b) Double Working Space.** Where the required working space depth is doubled, and the equipment is located so the edge of the entrance is no closer than the required working space distance required by 110.26(A)(1). ►Figure 110-34



►Figure 110-34

**(3) Fire Exit Hardware on Personnel Doors.** Where equipment rated 800A or more contains overcurrent, switching, or control devices is installed and there is a personnel door(s) intended for entrance to and egress from the working space less than 25 ft from the nearest edge of the working space, the door(s) are required to open at least 90 degrees in the direction of egress and be equipped with listed panic or listed fire exit hardware. ►Figure 110-35



►Figure 110-35

#### Author's Comment:

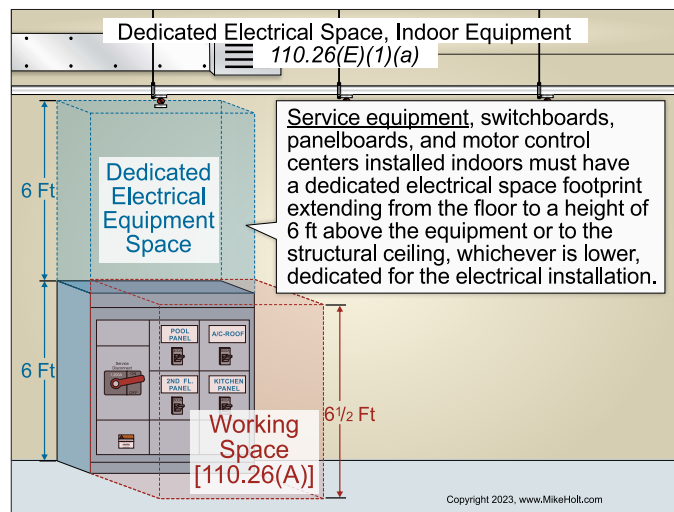
- History has shown that electricians who suffer burns on their hands in electrical arc flash or arc blast events often cannot open doors equipped with knobs that must be turned or doors that must be pulled open.

- ▶ Since this requirement is in the *NEC*, electrical contractors are responsible for ensuring fire exit hardware is installed where required. Some are surprised at being held liable for nonelectrical responsibilities, but this rule is designed to save the lives of electricians. For this and other reasons, many construction professionals routinely hold “pre-construction” or “pre-con” meetings to review potential opportunities for miscommunication—before the work begins.

**(E) Dedicated Electrical Equipment Space.** Service equipment, switchboards, panelboards, and motor control centers must have dedicated electrical equipment space and be protected from damage that could result from condensation, leaks, breaks in the foreign systems, and vehicular traffic as follows:

**(1) Indoors.** Service equipment, switchboards, panelboards, and motor control centers installed indoors must comply with the following:

**(a) Equipment Space.** The footprint space of the dedicated electrical space extending from the floor to a height of 6 ft above the equipment or to the structural ceiling, whichever is lower, must be dedicated for the electrical equipment. ▶Figure 110-36

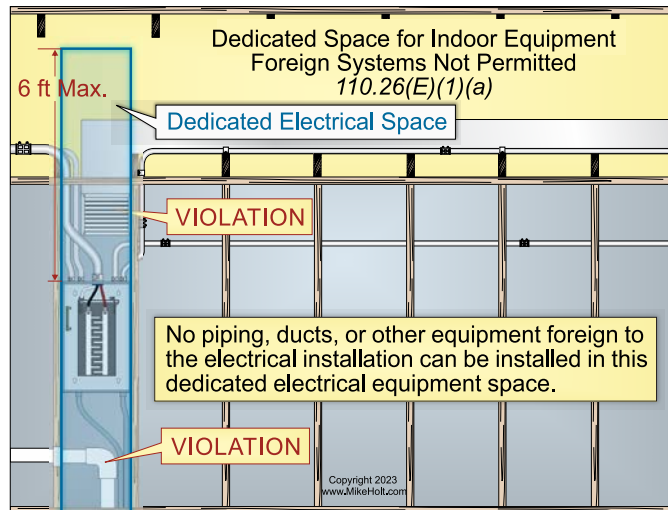


▶Figure 110-36

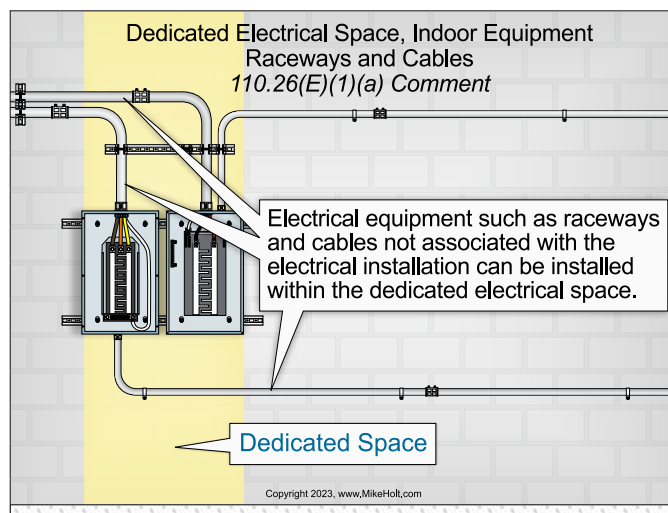
No piping, ducts, or other equipment foreign to the electrical system can be installed in this dedicated electrical equipment space. ▶Figure 110-37

#### Author's Comment:

- ▶ Electrical equipment such as raceways and cables not associated with the electrical equipment can be installed within the dedicated electrical space. ▶Figure 110-38



▶Figure 110-37



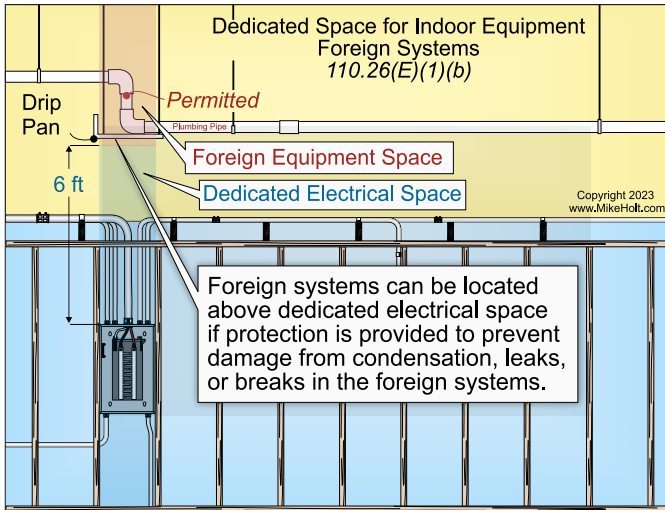
▶Figure 110-38

*Ex: Suspended ceilings with removable panels can be within the dedicated space [6 ft zone].*

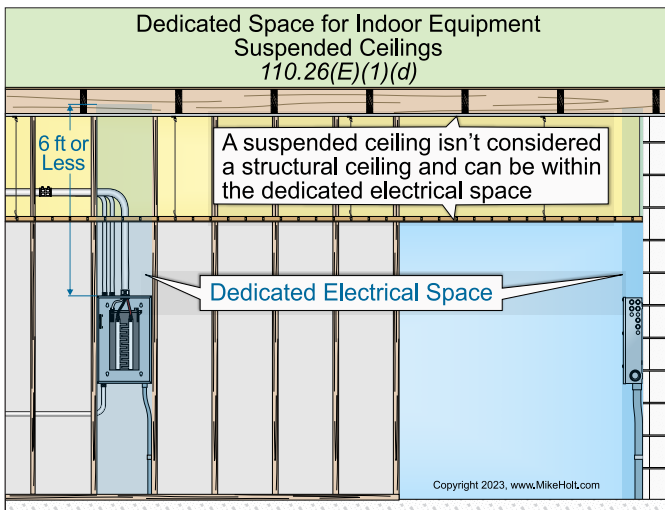
**(b) Foreign Systems.** Foreign systems can be located above the dedicated space if protection is installed to prevent damage to the electrical equipment from condensation, leaks, or breaks in the foreign systems. Such protection can be as simple as a drip-pan. ▶Figure 110-39

**(c) Sprinkler Protection.** Sprinkler protection piping is not permitted in the dedicated space, but the *NEC* does not prohibit sprinklers from spraying water on electrical equipment.

**(d) Suspended Ceilings.** A dropped, suspended, or similar ceiling is not considered a structural ceiling. ▶Figure 110-40



►Figure 110-39



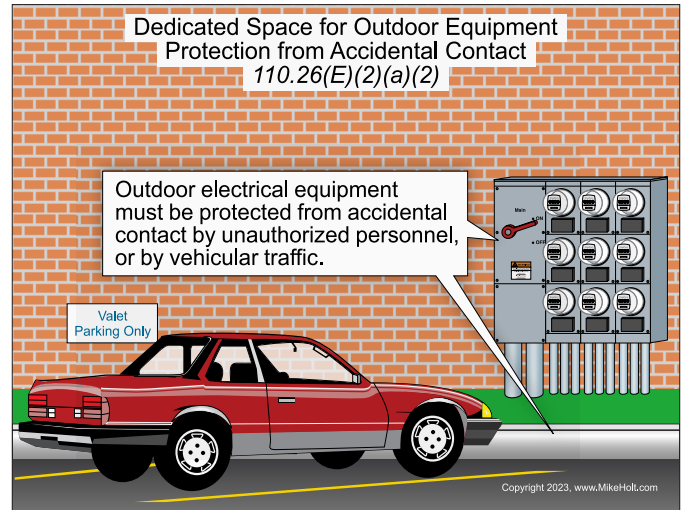
►Figure 110-40

**(2) Outdoor.** Outdoor installations for switchboards and panelboard must comply with the following:

**(a) Installation Requirements.**

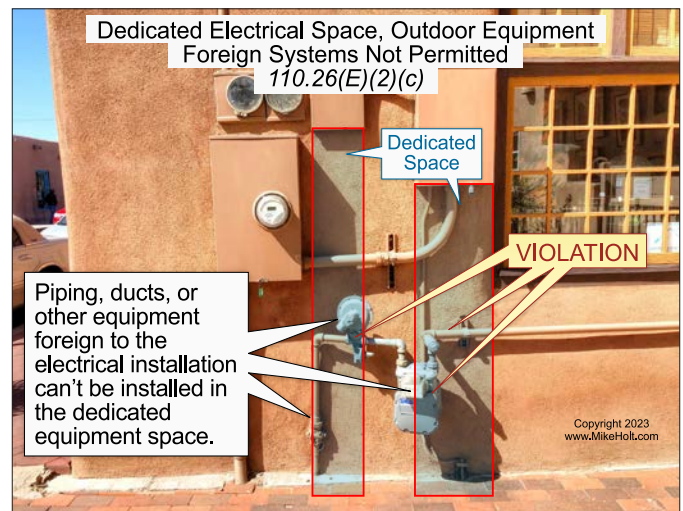
- (1) Installed in identified enclosures
- (2) Protected from accidental contact by unauthorized personnel or by vehicular traffic. ►Figure 110-41
- (3) Protected from accidental spillage or leakage from piping systems

**(b) Working Space.** The working clearance space includes the zone described in 110.26(A). Architectural appurtenances or other equipment are not permitted within this zone.



►Figure 110-41

**(c) Dedicated Equipment Space Outdoors.** The footprint space (width and depth of the equipment) of the outdoor dedicated space extending from grade to a height of 6 ft above the equipment must be dedicated for electrical installations. No piping, ducts, or other equipment foreign to the electrical installation can be installed in this dedicated space. ►Figure 110-42



►Figure 110-42

*Ex: Structural overhangs and roof extensions are permitted in this zone.*

