Public Input No. 207-NFPA 70-2019 [Global Input]

"no less than"

change to

"not less than"

Statement of Problem and Substantiation for Public Input

The term "no less than" is used approximately 6 times in the NEC.
The term "not less than" is used approximately 881 times in the NEC.

Reason for the global change is for consistency, and to comply with the style manual. The "no less than's" can be found in:

Definitions, Overcurrent Protective Device, Branch-Circuit.
240.21(B)(4)(9)
430.109(F)
600.32(A)(4) [appears twice in this section]
691.1

Submitter Information Verification

Submitter Full Name: Nick Sasso

Organization: Clark County Building and Fire

Street Address:

City:

State:

Zip:

Submittal Date: Thu Dec 26 19:34:36 EST 2019

Committee: NEC-P01

Public Input No. 259-NFPA 70-2020 [Global Input]

"unless permitted by..."   or   "unless permitted by Article..."

change to

"unless permitted in..."

Statement of Problem and Substantiation for Public Input

Basically this is just clean up language, and to be in accordance with section 4.1.2 of the style manual. Let's pick one or the other. I believe that the correct language should be "unless permitted in..."

The unless permitted by's are located in:

300.13(A)

348.20(A)

356.20(A)

411.5(B)

625.46

626.26

725.136(A)

760.136(A)

The unless permitted in's are located in

225.30

230.2

348.20

356.20

411.5(B)

625.46

626.26

725.136(A)

760.136(A)

Submitter Information Verification

Submitter Full Name: Nick Sasso
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City:
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Zip:
Submittal Date: Wed Jan 08 14:31:09 EST 2020
Committee: NEC-P01

Public Input No. 276-NFPA 70-2020 [Global Input]

(capable of being) locked in the open position

to

(capable of being) lockable open

Statement of Problem and Substantiation for Public Input

There are approximately 21 references to, "capable of being locked in the open position..."
and
there are approximately 26 references to, "capable of being lockable open..."

Let's pick one. Reason for change is consistency throughout NEC

Submitter Information Verification

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State:	
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Submittal Date:	Sat Jan 11 17:27:37 EST 2020
Committee:	NEC-P01

Public Input No. 277-NFPA 70-2020 [Global Input]

(capable of being) lockable open

change to

(capable of being) locked in the open position

Statement of Problem and Substantiation for Public Input

There are approximately 26 references to, "capable of being lockable open..."

and

there are approximately 21 references to, "capable of being locked in the open position..."

Let's pick one. Reason for change is consistency throughout NEC. Personally, I prefer "capable of being locked in the open position."

Submitter Information Verification

Submitter Full Name: Nick Sasso

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Submittal Date: Sat Jan 11 17:33:21 EST 2020

Committee: NEC-P01

Public Input No. 368-NFPA 70-2020 [Global Input]

Please provide page headers with the appropriate identifiers to make use of the code less confusing.

Example 1: Chapter 1 Article 100 - Definitions - PART III - Haz Locs

Example 2: 110.31 Article 110 - Reqs for Electrical Installations -Part III - OVER 1000 VOLTS nom

Example 3: Annex C- Tables Informative Annex C - Table C-3 (FMC) cont.

Statement of Problem and Substantiation for Public Input

Earlier versions of the document included shorthand page headers that greatly improved user ease of finding the correct code sections. As written now the document is confusing with important distinctions hard to ferret out. For example the sections that are limited in application to certain voltages or locations may run for pages but the transition to that distinction is hard to find, and any page after the initial distinguishing information is not notated in any way to indicate that a limitation of scope applies.. Identifiers such as Part III Over 1000 volts is not prominently distinguished in the body of the text and is not reflected in the page heading on latter pages, leading to much confusion when using the document in the field. (Earlier versions also had the PART III or similar transitions prominently bold to make finding them easier.) Please accept my apology if this is submitted in the incorrect format or to the incorrect panel or group. This would appear to be a style request more than a code request but I did not find any public input option for style or page headers.

Submitter Information Verification

Submitter Full Name: Joe Kunkel

Organization: NU Electric Co

Street Address:

City:

State:

Zip:

Submittal Date: Sun Jan 26 12:24:46 EST 2020

Committee: NEC-P01

Public Input No. 454-NFPA 70-2020 [Global Input]

Type your content here: I would like to see one of the two things I have listed happen; either put all definitions in article 100 no matter how many times the term is used throughout the NEC or keep the NEC at the current format limiting article 100 for definitions of terms used more than twice in the NEC and using xxx.2 for definitions that are only used in that particular article. Do not use xxx.2 for anything besides definitions. Currently if an article does not contain any definitions, xxx.2 is used for anything. Example; 90.2 SCOPE, 110.2 APPROVAL, 200.2 GENERAL, plus many other articles, although this change would not in essence save lifes, it would add consistincey to the NEC, ...

Statement of Problem and Substantiation for Public Input

This would add consistency to the NEC,

Submitter Information Verification

Submitter Full Name:	Ray Pritchett
Organization:	NJATC
Affiliation:	Evansville Electrical Training Center IBEW Local 16
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Sun Feb 09 22:55:07 EST 2020
Committee:	NEC-P01

Public Input No. 2989-NFPA 70-2020 [Global Input]

Regarding the division of NEC Articles into "Parts";

Where "Parts" are used to sub-divide NEC Articles by topic, it is proposed to amend the Part description text with a set of brackets that enclose the span of paragraph numbers that is encompassed by the respective Part category.

For example, NEC Chapter 2, Article 210, Part III.

This "Part" text string is represented as;

Part III. Over 1000 Volts

The proposal is to revise this "Part" text string to;

Part III. Over 1000 Volts (210.50-.70)

And, to do the same for all "Parts" of all NEC Articles.

Statement of Problem and Substantiation for Public Input

BASIS FOR CODE REVISION: to facilitate quicker more efficient code searches by providing a context clue via association of the paragraphs that are correlated to the "Part" sub-category. Page-by-page code searches that miss seeing the keyword "Part" somewhere on the page, could now be less prone to such erroneous mis-associations

Submitter Information Verification

Submitter Full Name: John Blissett

Organization: Bernhard TME

Street Address:

City:

State:

Zip:

Submittal Date: Thu Sep 03 19:32:38 EDT 2020

Committee: NEC-P01

Public Input No. 3013-NFPA 70-2020 [Global Input]

Move all definitions in the code to Article 100, arrange them in alphabetical order and without any subdivisions.

Statement of Problem and Substantiation for Public Input

The National Electrical Code has definitions in multiple parts in Article 100 and many definitions scattered through out the code many of them in the .2 section of the articles.
Most of the other standards under NFPA have their definitions in one location and this will allow the NEC the same requirement. The Revisions to the NEC Style require all the definitions to be moved to Article 100.

Submitter Information Verification

Submitter Full Name:	David Williams
Organization:	Delta Charter Township
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City:	
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Submittal Date:	Thu Sep 03 21:41:22 EDT 2020
Committee:	NEC-P01

Public Input No. 3141-NFPA 70-2020 [Global Input]

Move all definitions in current (2020) NEC text to Article 100. Insert those definitions in alphabetical order. For definitions that apply in only one article, the article number in parentheses shall follow the definition. The CMP responsible for the definition shall be identified in parentheses at the end of the definition following any extract or article information.

Type your content here ...

Statement of Problem and Substantiation for Public Input

This revision provides a more usable code by providing a uniform process to find definitions. Users are currently required to look in multiple locations to determine if a term is defined. Other NFPA codes and standards utilize a single location for all definitions.

Submitter Information Verification

Submitter Full Name: Donald Cook

Organization: Shelby County Department of De

Affiliation: Self

Street Address:

City:

State:

Zip:

Submittal Date: Sat Sep 05 15:11:40 EDT 2020

Committee: NEC-P01

Public Input No. 3327-NFPA 70-2020 [Global Input]

Review the revisions to the new NEC Style Manual and make changes to comply with the Style Manual.

Statement of Problem and Substantiation for Public Input

The NEC Style Manual has been revised and every code making panel needs to review the manual and make changes to their code articles to comply with the Style Manual revisions.

Submitter Information Verification

Submitter Full Name:	David Williams
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Submittal Date:	Tue Sep 08 07:31:11 EDT 2020
Committee:	NEC-P01

Public Input No. 3328-NFPA 70-2020 [Global Input]

Review the Articles with multiple parts to comply with the revisions made to the NEC Style Manual. Make changes based on the Style Manual revisions.

Statement of Problem and Substantiation for Public Input

Section 2.1.4 was revised by adding the last two sentences. Where an article contains multiple parts and includes general installation requirements, such requirements shall be located in the first part titled “Part I. General”. Part titles shall be descriptive and as concise as possible.

Submitter Information Verification

Submitter Full Name:	David Williams
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Submittal Date:	Tue Sep 08 07:34:42 EDT 2020
Committee:	NEC-P01

Public Input No. 3329-NFPA 70-2020 [Global Input]

Revise the Definition Title Structure to comply with the NEC Style Manual.

Statement of Problem and Substantiation for Public Input

Review the Style Manual Revisions in 2.2.2.3 Definition Title Structure. Definitions that have sub-parts shall be listed alphabetically by the base term, with a comma and then the modifying descriptor.

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Submittal Date:	Tue Sep 08 07:36:42 EDT 2020
Committee:	NEC-P01

Public Input No. 3330-NFPA 70-2020 [Global Input]

Verify that all exceptions are written in completed sentences.

Statement of Problem and Substantiation for Public Input

The NEC Style Manual requires that all exceptions are written as complete sentences in accordance with 3.1.4.1.

Submitter Information Verification

Submitter Full Name:	David Williams
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Street Address:	
City:	
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Submittal Date:	Tue Sep 08 07:40:56 EDT 2020
Committee:	NEC-P01

Public Input No. 3331-NFPA 70-2020 [Global Input]

Revise the definitions in Article 100 to include an acronym, as desired, for subsequent use in the NEC without having to state the term.

Statement of Problem and Substantiation for Public Input

The permitted use of acronyms in the NEC has changed with the Style Manual revisions in 3.2.3. When a term is defined in Article 100 and includes an acronym, that acronym is permitted to be used elsewhere through out the code.

Submitter Information Verification

Submitter Full Name:	David Williams
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Submittal Date:	Tue Sep 08 07:43:12 EDT 2020
Committee:	NEC-P01

Public Input No. 3332-NFPA 70-2020 [Global Input]

Review the structure of all Informational Notes to comply with the revised NEC Style Manual.

Statement of Problem and Substantiation for Public Input

Sections 3.1.3.1 and 4.1.3 of the revised NEC Style Manual includes designed structure for references in Informational Notes.

Submitter Information Verification

Submitter Full Name:	David Williams
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Submittal Date:	Tue Sep 08 07:48:58 EDT 2020
Committee:	NEC-P01

Public Input No. 3333-NFPA 70-2020 [Global Input]

Review all references to articles or parts of articles to comply with the Style Manual.

Statement of Problem and Substantiation for Public Input

Section 4.1.4 References to a Part Within an Article. Except for Article 100, references shall not be made to an entire article. References to parts within articles shall be permitted.

Submitter Information Verification

Submitter Full Name:	David Williams
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Submittal Date:	Tue Sep 08 07:50:17 EDT 2020
Committee:	NEC-P01

Public Input No. 3335-NFPA 70-2020 [Global Input]

Review the use of Parts within an article and the section number for parts of an article.

Statement of Problem and Substantiation for Public Input

The code panels need to review the sections under their purview to comply with the revisions made to the NEC Style Manual. 2.4.2.1 Parts. If an article is subdivided into parts, it is recommended that the section numbering within each part start with the next decade as a minimum to allow for future growth. New or significantly reorganized articles shall follow this numbering convention. Where an article has multiple parts, Part I. shall be titled “General”.

Submitter Information Verification

Submitter Full Name: David Williams
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City:
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Submittal Date: Tue Sep 08 08:02:00 EDT 2020
Committee: NEC-P01

Public Input No. 3336-NFPA 70-2020 [Global Input]

More than one informational note in a section or subdivision shall be consectutively numbered.

Statement of Problem and Substantiation for Public Input

The numbering of informational notes need to comply with the changes made to the revised Style Manual.
2.4.3. Numbering Informational Notes. If there are two or more informational notes in a definition, section or subdivision, consecutive numbering of the informational notes shall only occur in that definition, section or subdivision.

Submitter Information Verification

Submitter Full Name:	David Williams
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Submittal Date:	Tue Sep 08 08:10:27 EDT 2020
Committee:	NEC-P01

Public Input No. 3490-NFPA 70-2020 [Global Input]

100 Definitions

Defined terminology associated with Manufacture and Construction activities.

1. The term "Construction" shall be defined as the process of deploying product or installation of a device, material, or item of equipment in accordance to its designated purpose. An owner or owner's agent (e.g. contractor) implements construction at a specific worksite location for either a permanent installation, or a temporary application as permitted by code. Installation shall comply with manufacturer terms and ratings unless permitted otherwise in this code. All code delegated responsibilities for testing, marking, labeling, identification, documentation, etc., which are not the clear accomplished responsibility of the manufacture production process, shall be the due diligence responsibility of those involved with the construction process, unless approved otherwise by the authority having jurisdiction.

Informational Note: construction applications include, but are not limited to, activities associated with activities involved with: install, field installed, field applied, field tested, field assembled, field evaluation, field wiring, field marking, field conversion, and field labeled.

2. The term "Fabricated" shall be defined to apply to equipment or an assembly that is neither necessarily listed nor mass-produced. For example, custom equipment, a custom assembly, or equipment that is altered from its original listing. Fabrication may occur in whole or part onsite or offsite. Component parts and materials may be listed, or may be required to be listed by this code or by the authority having jurisdiction. Generally, where fabricated products are permitted by this code, code compliant product qualification shall be by a Field Evaluation Body, where duties typically include: product testing, marking, labeling, identification, standards compliance, product documentation and instructions sufficient for the safe operation appropriate per the application criteria. Fabricated applications also include reconditioned equipment and retrofit equipment, as permitted by this code, wherever equipment is functionally restored to other than conformance to the original manufacturer's equipment ratings and life cycle projections. Fabricated equipment and systems that encompass, in part or whole, any associated construction activities and elements, shall absorb the associated due diligence responsibilities involved, except as approved otherwise by the authority having jurisdiction.

Informational Note: fabrication applications generally include, but are not limited to, activities associated with pre-fabricated equipment and systems: electrical system assemblies, mechanical system assemblies, and modular building assemblies. Where the assembly is listed as a unit, then the manufacture application responsibilities apply.

3. The term "Pre-fabricated" shall be defined to apply to those fabricated equipment assembly activities that occur at a site other than the permanent installation location.

4. The term "Manufacture" shall be defined as the factory assembly of a product, characteristically mass produced and distributed. Examples include: equipment, wire, devices, material, and compounds. The manufacture process includes production activities including: factory testing, marking, labeling, identification; NRTL Listing where applicable; standards compliance, product document publication for sales and designer specifications including those used for: shipping, install, field

testing, owner use, and maintenance. By definition, final assembly or other in-field activites of a product at its permanently installed location will not constitute an aspect of manufacture, unless performed by the manufacturer.

Informational Note 1: applications where a product's permanent or temporary installation occurs at a point-of-use location under direct supervision of the manufacturer, the requirement duties of both the manufacture process(es) and associated construction process shall be the responsibility of the manufacturer, except as approved otherwise by the authority having jurisdiction.

Informational Note 2: manufacture applications shall include modular equipment, where an assemblage of different products has been hybridized into a singular unit, when the unitized equipment is listed. Where the unitized equipment is not listed as a unit, then the fabricated application responsibilities apply.

Statement of Problem and Substantiation for Public Input

BASIS FOR CODE REVISION:
The term "construction" is used throughout NEC in reference to code requirements that are aimed at typically different segments of industry, which only occasionally overlap each other's general task sets. Product construction during manufacture is one application, versus product install during site construction. The code text describes both contexts as construction. Where practicable, it would improve functional clarity in code text requirements to employ distinct construction-like terms wherever reasonable and appropriate. The terms and definitions proposed are suggestions; to serve as a basis to move this discussion and consensus forward.
Where code requirements clearly intend compliance fulfillment to be about the product's activities prior to leaving the factory, distinct terminology can communicate this with added clarity. Similarly, where code compliance fulfillment clearly applies to the implementation of a product, as regards its permanent installation, a distinctly defined term for 'construction' will yield improved comprehension as to intended context. A third distinct category can also be established by definition that encompasses fabrication, to serve to encompass custom fabrication assemblies, reconditioned equipment, and retrofits.
Applications where the code responsibility can fall into gray areas for accountability between the three, can be attended to by a default assignment of responsibility. This explicit clarity helps ensure that enforceable code compliance responsibilities are clearly stated. Allowance for an exception, per AHJ acceptance, provides a mechanism to formally transfer an obligation of responsibility.
Where the code speaks to putting an identifying mark, or information, or color onto a cable or item of equipment, it more often refers to those which would intend to be understood as the responsibility of the manufacturer. The following two sets of code citations illustrate where the manufacturer is to provide a mark or color (first set) versus where the installer is to provide a mark or color. The third set of code citations is where it is intuitively apparent that either the manufacturer or installer could either be involved (or both involved) in providing a mark or color on the electrical equipment.
Example requirements for manufacturer marks or color include but are not necessarily limited to; 110.14(D), 110.28, 200.4(B), 200.6, 200.7, 200.9, 200.10(B), 200.10(D), 215.12(A), 215.12(B), 225.30(A)(7), 230.46, 230.66(A), 230.70(B), 230.77, 240.50(C), 240.81, 240.82, 240.83(A&B), 240.83(D), 240.85, 250.28(B), 250.110 Ex3, 250.119, 250.119(A), 250.119(B), 250.119(C), 250.126, 250.28(B), 250.112, 250.114, 250.119, 250.126, 300.11(B)(1), 300.11(B)(2), 310.3(D), Table 310.4(A), 310.6(ABC), 310.8(C)&(D), 310.10(C), 310.10(D), 311.14, 311.16(A), 311.16(B)(1&2)), 311.16(B4&C), 311.32, 314.16(C)(2), 322.56(B), 322.120(C), 336.120, 338.120, 368.12(E), 386.70, 388.70, 406.3(D), 406.3(E), 406.10(B), 406.13 (A-D), 409.110, 430.52(C)(5), 500.8, 501.5, 501.17, 501.105(B)(1), 501.130(A)(1, 502.6, 502.130(B)(1), 502.130(B)(2), 503.130(A), 504.80(C), 505.8, 505.20(B&C), 505.22, 505.26, 506.9(C)(1), 506.9(C)(2), 506.9(D), 517.18(A), 517.19(A), 517.61(C)(2), 530.21(B), 530.22(B), 545.22(A), 551.77(A), 552.10(B)(3), 552.10(E)(2), 555.8, 555.33(B)(2), 600.23(F), 600.33(A)(3), 600.33(A)(4), 690.12(C), 690.51, 694.22(A), 700.10(A), 705.12(D), 705.20, 706.15(C), 708.10(A)(2), 712.37, 725.3(P), 725.179, 760.3(O), 760.30, 760.176(G), 760.179(G)(1), 770.179, 800.182, 805.179, 820.179, 830.90(A)(2), 830.179(C&D), 840.170(B), and 840.170(E).
Example requirements for the installer to do the marks or color indications include but are not necessarily limited to; 200.4(B), 200.6, 210.5(C)(1), 210.5(C)(2), 210.12, 215.12(A), 215.12(C)(1), 215.12(C)(2), 225.30(B), 225.38(C), 225.52(D&E), 230.72(A), 300.5(D)(3), Table 300.50, 310.6(ABC), 311.14, 406.3(E),

406.10(B), 408.3(E)(2), 408.3(F)(1), 408.3(F)(2), 408.3(F)(3), 408.3(F)(4), 408.3(F)(5), 517.18(A), 517.19(A), 517.160(A)(5), 530.21(B), 530.22(B), 547.9(A)(10, 550.33(A), 552.43(C), 620.53, 620.55, 647.4(C), 647.7(A)(4), 668.21(C), 690.54, 690.55, 700.10(A), 712.25, 712.55, 725.124, 760.30, and 770.179(F).

Example requirements for either the manufacturer and/or the installer to do the marks or color indications include but are not necessarily limited to; 230.56, 250.21(C), 250.167(C), 408.3(E)(1), 409.102(B), 430.97(B), 430.109(A)(6), 430.109(E), 517.31(C)(1), 517.31(E), 517.42(E), 520.44(C)(3), 520.54(C), 520.54(J)(1), 520.54(K), 530.21(B), 530.22(B), 550.10(I), 690.1, 690.31(B)(1), 690.31(D)(2), 770.179(G), 805.90(A)(2), and 805.170(A).

As regards reconditioned equipment and retrofit equipment, the code is in its developing infancy as regards code requirements for marks, as they are few, yet likely to grow in upcoming code cycles. Having distinct groups for manufacture, installation, and fabrication also serves to help make obvious, the places in code that similar code requirements between them may be missing but warranted.

Similar to the topic above for equipment marks between manufacture, installation, and fabrication, are topics for labels and signage which are beyond marks.

In NEC Chapter 3,4 and 7 the term “manufacture specifications” can substituted for “construction specifications”. And in NEC Chapter 5 and 6, where specifications have other terminology variations based on product qualities, “manufacture specifications” can be used with such term descriptors for NEC consistency to augment transparency when a code specification is intended to apply to manufacture apart from installation criterion.

Another example benefit from having a distinction between manufacture, installation, and fabrication are for the code required documentation and whom is to provide it. Such as; instructions for shipping, install, or maintenance, versus installer instructions for operation sequence, equipment ratings guidance or site-specific diagnostic protocols.

Where an entity assumes multiple roles of manufacture, installation, and/or fabrication, they are intended to assume the respective responsibilities. And, what those responsibilities are will have improved certainty, when there are improvements to distinctions of terminology and nomenclature. Inspections and commissioning processes will similarly be improved for the same basis of improved enforceable clarity.

SIDEBAR: a supplemental suggestion, in the earnest of minimizing code text where practicable, is to utilize a letter or symbol icon, for use in NEC margins, that correlates to each of the three definitions for, manufacture, versus fabricated, versus construction. For example, a symbol icon for manufacturer (e.g. Hex Note enclosing an 'M'), versus those affiliated with the product install construction process (e.g. Hex Note with 'C'), versus the symbol for the fabrication process (e.g. Hex Note with 'F'). One example of benefit of deploying a symbolic nomenclature is the topic of labels, signage, and markings; which are often able to be grouped by: manufacturer, fabricated, or installer. Each instance in code for label, mark, or sign can include one or more of these three symbols in the margin alongside the code text without adding pages to the code. A raised bar of label and signage compliance is likely the result, plus an improved ease and capacity for enforcement by way of inspection or commissioning.

Submitter Information Verification

Submitter Full Name:	John Blissett
Organization:	Bernhard TME
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Tue Sep 08 17:16:57 EDT 2020
Committee:	NEC-P01

☑ By checking this box I affirm that I am John Blissett, and I agree to be legally bound by the above Copyright Assignment and the terms and conditions contained therein. I understand and intend that, by checking this box, I am creating an electronic signature that will, upon my submission of this form, have the same legal force and effect as a handwritten signature

Public Input No. 4390-NFPA 70-2020 [Global Input]

When an Article has Parts the revised Style Manual requires the following in 2.1.4.

Part titles shall be descriptive and as concise as possible.

Example:

Part I. General

Part II. Installation

Part III. Construction

Statement of Problem and Substantiation for Public Input

The revised Style Manual requires Article Part titles to be descriptive and concise as possible and provides examples for the code panels to use.

Submitter Information Verification

Submitter Full Name: David Williams

Organization: Delta Charter Township

Street Address:

City:

State:

Zip:

Submittal Date: Thu Sep 10 11:45:05 EDT 2020

Committee: NEC-P01

Public Input No. 4707-NFPA 70-2020 [Global Input]

Globally revise the use of term "Listed", and revise use of the term "Labeled"

To distinguish the NRTL (testing lab) context for the term "labeled" and "listed" from other NEC context uses of these words in all their forms; label, labels, labeling and labeled, it recommended to apply capitalization to the word "Labeled" and "Listed" when intended for this particular context of a testing organization. Capitalization as proper nouns will make this context more readily recognizable.

For additional distinctive clarity for this context of these terms ‘listed’ and "labeled", apply them with their "NRTL" modifier; and deploy "NRTL Listed" and "NRTL Labeled" throughout the Code text. Of course, all variants formed for grammatical correctness would also be amended and capitalized, such as "NRTL Listing" and "NRTL Label" etc.

In the definitions, it is appropriate to associate NRTL to "Nationally Recognized Testing Laboratory", which is generally the type of testing agency. Any other testing agency, where approved by an AHJ, is allowed. It is also appropriate to include a reference to the industry standard organization that acknowledged to govern this industry acceptance standard for each NRTL, the Occupational Safety and Health Administration (OSHA). With OSHA acknowledged as the official agency, it becomes a Code-legitimized reference, able to facilitate any follow-up enquiries regarding code compliance. To help facilitate back-checks has never been more suitable than in this age of ever-increasing pirating of product and other pretenders to suitability.

Wherever the term ‘Labeled’ is used as part of ‘NRTL Listed and Labeled’, it shall refer to the equipment mounted labeling that is pertinent to all of the equipment item’s application-specific Listing(s) and shall include the equipment ratings.

Wherever the term ‘Marked’ is used as part of ‘NRTL Listed and Marked’ or ‘NRTL Listed and Labeled and Marked’, ‘marked’ shall refer to the marking or labeling that is associated with the Listing and shall include the specific qualification of use mentioned in code. E.g. listed and labeled and marked as being suitable for use as service equipment.

Statement of Problem and Substantiation for Public Input

BASIS FOR CODE REVISION:

The term ‘Listing’ and ‘Listed’ will be capitalized and treated as a proper noun; short for ‘NRLT Listing’ and ‘NRTL Listed’. The term ‘Labeled’ will also be capitalized as a proper noun when used to indicate ‘NRTL Labeled’ or ‘Manufacturer Labeled’ as regards the manufacturer’s terms of use for the equipment. NFPA codes does not capitalize these three terms generally so they are indistinguishable from the other contexts for a list or label. Manufacturer terms of use regarding labeling can include ratings, Listing types, or other declarations of compliance to particular industry standards.

There Code text of NEC 110.3, Part (C) may have intended for equipment generally to be Listed, but technically it is not ever stated. All that is stated is the terms for who will do the testing and evaluation as regards a Listing.

The Occupational Safety and Health Administration (OSHA) is the official agency that recognizes qualified testing laboratories, of which there are 23 approved labs to date. OSHA confirms that NEC’s “electrical” sub-distinction of labs in NEC 110.3, Part (C) doesn’t formally exist as an industry recognized group. The ‘electrical’ testing laboratory distinction is an obscure reference used in two other places in the NEC [90.7, 490.48(A)], but not in the NEC's other (14) references of a testing laboratory. Underwriter Laboratories (UL) is the only distinct NRTL lab whose standards are cited in the NEC and there are hundreds of UL citations (see. NEC Informative Annex A). One relevant ATS example is cited in NEC; UL1008 for transfer switches up to 600V. And one relevant ATS example is not cited in NEC; UL1008A for 750V-46kV ATSs. Whether another NRTL lab other than UL may qualify NEC's intent as an "electrical lab" is unknown. The NEC requirements are functional without the "electrical" sub-distinction, and so this likely warrants deletion of "electrical" in an upcoming NEC code revision.

Though these code articles infer an expectation that an ATS shall be used, an ATS is not overtly mandated as required. Only when an ATS is used, then definitive code requirements apply, like a Listing for emergency use.

NEC Article 705 applies to Interconnected Power Production Sources that parallel with the normal source, which is typically the utility supplied power source. There is an incongruence of code due to what NEC 705 allows. That is whenever the 705 code language is interpreted as an absolute permission due to the omission of disallowances of use as an essential-class power system. The code requirement variance compared to similar applications is a risk, because it then grants an emergency power distribution topology absolution because the code language allows it. NEC Article 705 has no requirements for equipment to be Listed for any aspect.

NEC 705 applies to distribution gear that interconnects normal power (e.g. utility) with an alternate source of power (e.g. generator). The 705 distribution gear may serve in place of an automatic transfer switch because the code does not disallow that use. Yet code does not require it be listed for emergency use, nor does it even require the automated switching mechanisms to be electrically operated and mechanically held. The NEC 705 gear has latitude to have more than two sources and more than one load. The function of NEC 705 gear may be no less critical but it is more susceptible to dysfunction than an ATS. It is arguably more important even than any single automatic transfer switch as it can perform the duty of multiple transfer switches or be the power source to many ATSs. It is like using a string to support a chain. This example illustrates how language of one NEC article (705) can permit use of a power distribution topology that is inconsistent to all other instances of code text regarding transfer switching of emergency power, which would otherwise be fairly consistent.

Application Specific Code Requirements

A summary of code findings on power source selection for emergency applications is as follows;

1. FOR ALL CODIFIED POWER SYSTEM TYPES OTHER THAN NORMAL: An ATS shall be NRTL Listed for Emergency Use (and also identified for Standby Use). Exceptions are:

A. Optional Standby Power System (NEC 702; other Listing requirements may apply)

B. Fire Pump (NEC 695; other Listing applies)

C. Interconnected Power Production Sources (NEC 705)

D. Medium Voltage (see caveats below)

2. MEDIUM VOLTAGE CAVEATS:

A. NFPA 99 indicates an ATS <600V must be Listed for the purpose. No mention of requirements for other voltages >600V. Allowance for ATS >600V to not be Listed is one logical inference.

B. NFPA 110 states MV transfer of central plant or mechanical equipment is allowed using electrically interlocked medium voltage circuit breakers; but the equipment branch MV transfer switch is not to include life safety (LS), emergency (RE), or critical branch (CR) loads. By mention of critical branch this code regards healthcare but is not correlated by any healthcare code; neither by NFPA 99 nor by NEC 517. Allowance by Listing omission may be logically inferred for power system types not mentioned; SEPSS (NFPA 111), RSPSS (NEC 701), EQ (NEC 517), FPPSS (NEC 695), FCPSS (NEC 692), and EPSS (NFPA 110). Note that an MV transfer equipment is not disallowed for LS, RE, or CR if the MV switch is separated from mechanical loads. Also, there is no disallowance to separate loads if the MV ATS is Listed.

C. NFPA 70 (NEC) does not mandate a Listing requirement specific to distribution gear generally, including medium voltage (MV) equipment. NEC makes no mention of MV ATSs, nor provides any specific exemption for an MV ATS. That paralleling gear has no Listing requirement at all would apparently extend to MV types of paralleling gear.

3. FOR FIRE PUMP APPLICATIONS: A fire pump's local ATS and/or controller shall be NRTL Listed for electric motor-driven fire pump service. Other transfer equipment upstream of a fire pump ATS does not qualify it as a fire pump ATS also; so only the lower level ATS must meet these 'Fire Pump ATS' requirements.

4. GENERAL REQUIREMENTS: NRTL Listing types compound for each condition of use that applies; 'emergency', 'wet location', etc; whenever the NRTL Listed Use is an available product offering. An ATS must be NRTL Listed for all of the load types to be served. Field labeling by a Field Evaluation Body is an alternate compliance path for a Listing requirement generally, except where a Listing is overtly stated as the only compliance path such as for an ATS and select other NEC applications.

5. OPTIONAL STANDBY APPLICATIONS: Transfer equipment shall be NRTL 'Listed as Transfer Equipment' wherever supplemental circuit protection devices (CPD) are integral to the transfer equipment. No other Listing requirements apply for Optional Standby transfer equipment.

6. INTERCONNECTED POWER PRODUCTION SOURCES are a recognized transfer switch application apart from an ATS. NEC 705 scope only applies to multiple sources if the normal source (e.g. utility) is one of the sources. Where field labeling is provided, the NEC does not mandate any requirement for a Listing of any kind. Even if it is Listed, NEC doesn't require the gear to be NRTL 'Listed as Transfer Equipment' (as CPD optional standby transfer equipment must do), nor 'Listed for Emergency Use' (as all other emergency power transfer equipment must do). Where NEC 705 is applied to critical grade topologies, NEC suffers a glaring omission for any code-required NRTL type validation for a failsafe style of integrity, suitable for essential-class loads.

7. PARALLELING GEAR for automatic transfer switching of multiple sources (apart from an Article 705 type system) has no code article that governs its performance requirements. Only if the paralleling gear is connected to a normal (utility) source must it then comply with NEC 705. But even then the 705 requirements are not up to the usual code standards for critical or emergency gear and so it does not impose any failsafe standard for integrity including associated Listings.

Ironically, NEC 110.3(B) does state (by omission) that only the Listed or Labeled equipment needs to be used in accordance with the equipment manufacturer's instructions. Because the NEC makes no similar requirement of equipment that is not Listed nor Labeled, this equipment category escapes the stipulation to comply with the manufacturer's terms of use. This however is recognizable as nonsense, and an intonation of NEC intent must be interpolated.

NEC 110.3, Part (C) fails to identify that multiple Listings may be required for a product, and that one Listing may not be adequate. An individual separate Listing for each specific category of use is required whenever such Listing categories apply to the conditions of the equipment use.

NEC 110.3, Part (C) also fails to identify NEC's own exemptions for its general requirement that everything be Listed, and whether there are terms for when these exceptions are permitted or disallowed. One category is custom fabricated equipment, of which certain field assemblies may qualify as hybrid sub-category. One other category is equipment that has been reconditioned, refurbished or remanufactured. One final category is non-Listed equipment where NEC has outlined the specific terms of permitted use based on application. The problems arising from potential distinctions of allowances for non-Listed equipment is much more pronounced when the inconsistencies of Listing requirements by specific application are attempted to be put into a proper context (more on this in Chapter 8).

A best practice default for equipment selection is to choose a Listed product whenever one is available, and include each Listing application type that applies. Only when a Listed product cannot meet the design requirement should an alternative be considered; such as a custom fabricated product. Even then, such non-Listed applications shall be responsibly managed to best show coherence to all other code intent toward trustworthy integrity of; the components, the assembly work, and the resultant functionality. And where NEC outlines terms for use specific to "non-Listed" equipment (as done in Chapter 8), it shall be considered an acceptable form of compliance.

The NEC variations of terminology for Listed and for Labeled is diverse but the reason for this inconsistency is not always evident. The numeral in parenthesis is the number of occurrences found for each term in the NEC.

SIDEBAR: As the deadline for 2020 Public Comment is impending, the values and citations from here forward were not back-checked to 2020 NEC from the v2017 they were derived from .

1. Listed (1715), Listing (247), List (9)

2. Approved (473), Approving (2), Approval (44)

3. Labeled (65), Labeling (30), Labels (57), Label (55), Field Labeled (3), clearly Labeled (1)

4. Identified (2), Identifying (35), Identify (41)

5. Marked (647), Marking (555), Mark (31), Marks (3)

6. " Listed for" (332)

7. “Listed and Labeled” (21)

8. “Listed and Labeled for” (2)

9. “Listed or Labeled” (6)

10. “Listed, Labeled, and identified” (18)

11. “Listed, Labeled, or identified” (1)

12. “Prominently Labeled” (2)

13. “Listed, Labeled, and marked” (1)

14. “Listed and Labeled or field identified” (1)

Situation specific NEC requirements for equipment to be “Listed” vary case-by-case, whether by code article, or by site application type, or by equipment category. The way the requirements varied indicate that either code intent is not always consistent, or that the manner in which NEC requirements are written are a mixed bag of inconsistencies. In actuality, it is both.

The code citations below are selected to indicate general requirements and the requirements specific to switch transfer of emergency power sources. Other unrelated code citations are included to illustrate how the code may show consistency and how it shows inconsistency.

1. Listing Requirements by NEC Article

Every material item used for Trailer Parks (NEC 552), RVs (NEC 551), and mobile homes (NEC 550) must be Listed. But not a thing is mandated as needing to be Listed for hospitals (NEC 517), floating buildings (NEC 553), and certain other applications in NEC such as; Cablebus (370), Multioutlet Assemblies (380), Underfloor Raceways (390), Concealed Knob and Tube Wiring (394), Open Wiring on Insulators (398), Outdoor Overhead Conductors Over 1000V (399), Flexible Cords and Flexible Cables (400; though only nearly nil), Fixture Wires (402), Industrial Control Panels (409), Fixed Industrial Heating Equipment (455), Capacitors (460), Resistors and Reactors (470), Equipment Over 1000V (490), Integrated Electrical Systems (685), Interconnected Power Production Sources (705; aka paralleling gear), Circuits and Equipment Under 50V (720), and Energy Management Systems (750).

2. Listing Requirements by Equipment Category

For other NEC articles, the requirements for Listed equipment amounts to an honorable mention of oddities in bits and pieces; not because those bits are especially significant, or associated with criticality. NEC will mention a Listing requirement for the parenthetically consequential 1% and miss the more essential 99%. Switchgear (408) requires that insulated conductors are Listed, but NEC invokes no other requirements of anything else to do with switchgear to be Listed. There are times that NEC chapters or paragraphs only apply technically for any equipment which is Unlisted.

Most all raceways and cabling, but one, are required to be Listed from the 300 series articles of NEC. But at many points amongst the other code articles, only the fittings are indicated as needing to be Listed. The singular 300-series article for cablebus that was inadvertently skipped, is likely an oversight.

3. Listing Requirements by Application Type

Some aspects of Listings are meant to apply categorically, like a Wet Location Listing for any equipment in wet locations; but NEC consistency is sporadic and omissions prolific where they should apply. This inconsistency is similar to the requirements mentioned for sun exposure considerations.

At some points of code there are common applications with common importance factors but they are treated with uncommon requirements.

4. Observations of Inconsistent and Irrelevant Text

The terminologies for similar types of Listings has aspects of inconsistency, such as the five different terms used for an ATS to be Listed for Emergency Use. The verbiage variations could infer that these refined differences in text vary for good reason (with potentially varying requirements), but under scrutiny they do not.

There are code sentences that are superfluous because the Listing requirement for a subcomponent item being mentioned was already imposed generally at some other NEC article prior. Such as for particular conduit fittings to be Listed. To make matters worse, the requirements at one location in code doesn't always match the other location.

Other code text is a waste of language as the statement is redundant unto itself. Such as stating that use of equipment is okay if the Listing says it's okay. Or employing a double-negative to state that equipment is not to be used in a way that the Listing doesn't say is okay. As a side issue, such statements infer that there are "Listing Instructions" to follow for each Listing type. That such instructions exist and are published respective to Listing types is not affirmed to be an industry accepted understanding. How is it proposed that such reference materials are to be captured with consistent integrity by electrical system designers?

At times one or two specifications or features of the Listing itself, are mentioned with the NEC code text. But the exclusion of the other Listing features beckons follow-up questions as to why a partial redundant mention is relevant for some features of the Listing but not the others.

Some NEC text has inferences that a Listing requirement exists without an actual requirement of a Listing ever being stated overtly, only as an inference that the requirement already exists. Conditional statements employing logical grouping sometimes miss clear meaning due to commas missing at relevant points of the sentence.

The benefit that the above comments hope to achieve is in universal applications of Listing requirements as a categorical default wherever practicable, with caveats to follow as to exceptions or specialty additions, such that taken together, the Code edits would amount to less text and simpler forms of clarity. It would be an aide, perhaps suited to Chapter 9 indexes if nowhere else, to have a running list of all potential types of Listings that may be suited to electrical applications governed by NEC. Of course, such a reference list would be subject to on-going updates, but to see them all is perhaps the opportune way to know them.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 4586-NFPA 70-2020 [Definition: Labeled.]	similar topic
Public Input No. 4591-NFPA 70-2020 [Definition: Listed.]	similar topic

Public Input No. 4619-NFPA 70-2020 [Section No. 110.3(B)]	similar topic
Public Input No. 4624-NFPA 70-2020 [Section No. 110.3(C)]	similar topic

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Public Input No. 2120-NFPA 70-2020 [Article 100]

Article 100 Definitions

Scope. This article contains only those definitions essential to the application of this *Code*. It is not intended to include commonly defined general terms or commonly defined technical terms from related codes and standards. In general, only those terms that are used in two or more articles are defined in Article 100. Definitions are also found in XXX.2 sections of other articles.

Part I of this article contains definitions intended to apply wherever the terms are used throughout this *Code*. Part II contains definitions applicable to installations and equipment operating at over 1000 volts, nominal. Part III contains definitions applicable to Hazardous (Classified) Locations.

Part I. General

Accessible (as applied to equipment).

Capable of being reached for operation, renewal, and inspection. (CMP-1)

Accessible (as applied to wiring methods).

Capable of being removed or exposed without damaging the building structure or finish or not permanently closed in by the structure or finish of the building. (CMP-1)

Accessible, Readily (Readily Accessible).

Capable of being reached quickly for operation, renewal, or inspections without requiring those to whom ready access is requisite to take actions such as to use tools (other than keys), to climb over or under, to remove obstacles, or to resort to portable ladders, and so forth. (CMP-1)

> Informational Note: Use of keys is a common practice under controlled or supervised conditions and a common alternative to the ready access requirements under such supervised conditions as provided elsewhere in the NEC.

Adjustable Speed Drive.

Power conversion equipment that provides a means of adjusting the speed of an electric motor. (CMP-11)

> Informational Note: A variable frequency drive is one type of electronic adjustable speed drive that controls the rotational speed of an ac electric motor by controlling the frequency and voltage of the electrical power supplied to the motor.

Adjustable Speed Drive System.

A combination of an adjustable speed drive, its associated motor(s), and auxiliary equipment. (CMP-11)

Ampacity.

The maximum current, in amperes, that a conductor can carry continuously under the conditions of use without exceeding its temperature rating. (CMP-6)

Appliance.

Utilization equipment, generally other than industrial, that is normally built in standardized sizes or types and is installed or connected as a unit to perform one or more functions such as clothes washing, air-conditioning, food mixing, deep frying, and so forth. (CMP-17)

Approved.

Acceptable to the authority having jurisdiction. (CMP-1)

Arc-Fault Circuit Interrupter (AFCI).

A device intended to provide protection from the effects of arc faults by recognizing characteristics unique to arcing and by functioning to de-energize the circuit when an arc fault is detected. (CMP-2)

Askarel.

A generic term for a group of nonflammable synthetic chlorinated hydrocarbons used as electrical insulating media. (CMP-9)

> Informational Note: Askarels of various compositional types are used. Under arcing conditions, the gases produced, while consisting predominantly of noncombustible hydrogen chloride, can include varying amounts of combustible gases, depending on the askarel type.

Attachment Fitting.

A device that, by insertion into a locking support and mounting receptacle, establishes a connection between the conductors of the attached utilization equipment and the branch-circuit conductors connected to the locking support and mounting receptacle. (CMP-18)

> Informational Note: An attachment fitting is different from an attachment plug because no cord is associated with the fitting. An attachment fitting in combination with a locking support and mounting receptacle secures the associated utilization equipment in place and supports its weight.

Attachment Plug (Plug Cap) (Plug).

A device that, by insertion in a receptacle, establishes a connection between the conductors of the attached flexible cord and the conductors connected permanently to the receptacle. (CMP-18)

Authority Having Jurisdiction (AHJ).

An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure. (CMP-1)

> Informational Note: The phrase “authority having jurisdiction,” or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

Automatic.

Performing a function without the necessity of human intervention. (CMP-1)

Bathroom.

An area including a sink (basin) with one or more of the following: a toilet, a urinal, a tub, a shower, a bidet, or similar plumbing fixtures. (CMP-2)

Battery System.

Interconnected battery subsystems consisting of one or more storage batteries and battery chargers, and can include inverters, converters, and associated electrical equipment. (CMP-13)

Bonded (Bonding).

Connected to establish electrical continuity and conductivity. (CMP-5)

Bonding Conductor or Jumper.

A reliable conductor to ensure the required electrical conductivity between metal parts required to be electrically connected. (CMP-5)

Bonding Jumper, Equipment.

The connection between two or more portions of the equipment grounding conductor. (CMP-5)

Bonding Jumper, Main.

The connection between the grounded circuit conductor and the equipment grounding conductor, or the supply-side bonding jumper, or both, at the service. (CMP-5)

Bonding Jumper, Supply-Side.

A conductor installed on the supply side of a service or within a service equipment enclosure(s), or for a separately derived system, that ensures the required electrical conductivity between metal parts required to be electrically connected. (CMP-5)

Bonding Jumper, System.

The connection between the grounded circuit conductor and the supply-side bonding jumper, or the equipment grounding conductor, or both, at a separately derived system. (CMP-5)

Branch Circuit.

The circuit conductors between the final overcurrent device protecting the circuit and the outlet(s). (CMP-2)

Branch Circuit, Appliance.

A branch circuit that supplies energy to one or more outlets to which appliances are to be connected and that has no permanently connected luminaires that are not a part of an appliance. (CMP-2)

Branch Circuit, General-Purpose.

A branch circuit that supplies two or more receptacles or outlets for lighting and appliances. (CMP-2)

Branch Circuit, Individual.

A branch circuit that supplies only one utilization equipment. (CMP-2)

Branch Circuit, Motor.

The circuit conductors between the motor branch-circuit short-circuit and ground-fault protective device, including the controller. (CMP-11)

Informational Note: See 430.2 for definition of controller.

Branch Circuit, Multiwire.

A branch circuit that consists of two or more ungrounded conductors that have a voltage between them, and a grounded conductor that has equal voltage between it and each ungrounded conductor of the circuit and that is connected to the neutral or grounded conductor of the system. (CMP-2)

Building.

A structure that stands alone or that is separated from adjoining structures by fire walls. (CMP-1)

Cabinet.

An enclosure that is designed for either surface mounting or flush mounting and is provided with a frame, mat, or trim in which a swinging door or doors are or can be hung. (CMP-9)

Cable, Coaxial.

A cylindrical assembly composed of a conductor centered inside a metallic tube or shield, separated by a dielectric material, and usually covered by an insulating jacket. (CMP-16)

Cable, Optical Fiber.

A factory assembly or field assembly of one or more optical fibers having an overall covering. (CMP-16)

> Informational Note: A field-assembled optical fiber cable is an assembly of one or more optical fibers within a jacket. The jacket, without optical fibers, is installed in a manner similar to conduit or raceway. Once the jacket is installed, the optical fibers are inserted into the jacket, completing the cable assembly.

Cable, Optical Fiber, Composite.

A cable containing optical fibers and current-carrying electrical conductors. (CMP-16)

Cable, Optical Fiber, Conductive.

A factory assembly of one or more optical fibers having an overall covering and containing non–current-carrying conductive member(s) such as metallic strength member(s), metallic vapor barrier(s), metallic armor, or metallic sheath. (CMP-16)

Cable, Optical Fiber, Nonconductive.

A factory assembly of one or more optical fibers having an overall covering and containing no electrically conductive materials. (CMP-16)

Cable Routing Assembly.

A single channel or connected multiple channels, as well as associated fittings, forming a structural system that is used to support and route communications wires and cables, optical fiber cables, data cables associated with information technology and communications equipment, Class 2, Class 3, and Type PLTC cables, and power-limited fire alarm cables in plenum, riser, and general-purpose applications. (CMP-16)

Charge Controller.

Equipment that controls dc voltage or dc current, or both, and that is used to charge a battery or other energy storage device. (CMP-13)

Circuit Breaker.

A device designed to open and close a circuit by nonautomatic means and to open the circuit automatically on a predetermined overcurrent without damage to itself when properly applied within its rating. (CMP-10)

Informational Note: The automatic opening means can be integral, direct acting with the circuit breaker, or remote from the circuit breaker.

Adjustable (as applied to circuit breakers).

A qualifying term indicating that the circuit breaker can be set to trip at various values of current, time, or both, within a predetermined range.

Instantaneous Trip (as applied to circuit breakers).

A qualifying term indicating that no delay is purposely introduced in the tripping action of the circuit breaker.

Inverse Time (as applied to circuit breakers).

A qualifying term indicating that there is purposely introduced a delay in the tripping action of the circuit breaker, which delay decreases as the magnitude of the current increases.

Nonadjustable (as applied to circuit breakers).

A qualifying term indicating that the circuit breaker does not have any adjustment to alter the value of the current at which it will trip or the time required for its operation.

Setting (of circuit breakers).

The value of current, time, or both, at which an adjustable circuit breaker is set to trip.

Circuit Integrity (CI) Cable.

Cable(s) used for remote-control, signaling, or power-limited systems that supply critical circuits to ensure survivability for continued circuit operation for a specified time under fire conditions. (CMP-3)

Class 1 Circuit.

The portion of the wiring system between the load side of the overcurrent device or power-limited supply and the connected equipment. (CMP-3)

Informational Note: See 725.41 for voltage and power limitations of Class 1 circuits.

Class 2 Circuit.

The portion of the wiring system between the load side of a Class 2 power source and the connected equipment. Due to its power limitations, a Class 2 circuit considers safety from a fire initiation standpoint and provides acceptable protection from electric shock. (CMP-3)

Class 3 Circuit.

The portion of the wiring system between the load side of a Class 3 power source and the connected equipment. Due to its power limitations, a Class 3 circuit considers safety from a fire initiation standpoint. Since higher levels of voltage and current than for Class 2 are permitted, additional safeguards are specified to provide protection from an electric shock hazard that could be encountered. (CMP-3)

Clothes Closet.

A nonhabitable room or space intended primarily for storage of garments and apparel. (CMP-1)

Communications Equipment.

The electronic equipment that performs the telecommunications operations for the transmission of audio, video, and data, and includes power equipment (e.g., dc converters, inverters, and batteries), technical support equipment (e.g., computers), and conductors dedicated solely to the operation of the equipment. (CMP-16)

> Informational Note: As the telecommunications network transitions to a more data-centric network, computers, routers, servers, and their powering equipment, are becoming essential to the transmission of audio, video, and data and are finding increasing application in communications equipment installations.

Concealed.

Rendered inaccessible by the structure or finish of the building. (CMP-1)

> Informational Note: Wires in concealed raceways are considered concealed, even though they may become accessible by withdrawing them.

Conductor, Bare.

A conductor having no covering or electrical insulation whatsoever. (CMP-6)

Conductor, Covered.

A conductor encased within material of composition or thickness that is not recognized by this *Code* as electrical insulation. (CMP-6)

Conductor, Insulated.

A conductor encased within material of composition and thickness that is recognized by this *Code* as electrical insulation. (CMP-6)

Conduit Body.

A separate portion of a conduit or tubing system that provides access through a removable cover(s) to the interior of the system at a junction of two or more sections of the system or at a terminal point of the system.

Boxes such as FS and FD or larger cast or sheet metal boxes are not classified as conduit bodies. (CMP-9)

Connector, Pressure (Solderless).

A device that establishes a connection between two or more conductors or between one or more conductors and a terminal by means of mechanical pressure and without the use of solder. (CMP-1)

Continuous Load.

A load where the maximum current is expected to continue for 3 hours or more. (CMP-2)

Control Circuit.

The circuit of a control apparatus or system that carries the electric signals directing the performance of the controller but does not carry the main power current. (CMP-11)

Controller.

A device or group of devices that serves to govern, in some predetermined manner, the electric power delivered to the apparatus to which it is connected. (CMP-1)

Cooking Unit, Counter-Mounted.

A cooking appliance designed for mounting in or on a counter and consisting of one or more heating elements, internal wiring, and built-in or mountable controls. (CMP-2)

Coordination, Selective (Selective Coordination).

Localization of an overcurrent condition to restrict outages to the circuit or equipment affected, accomplished by the selection and installation of overcurrent protective devices and their ratings or settings for the full range of available overcurrents, from overload to the available fault current, and for the full range of overcurrent protective device opening times associated with those overcurrents. (CMP-10)

Copper-Clad Aluminum Conductors.

Conductors drawn from a copper-clad aluminum rod, with the copper metallurgically bonded to an aluminum core, where the copper forms a minimum of 10 percent of the cross-sectional area of a solid conductor or each strand of a stranded conductor. (CMP-6)

Cutout Box.

An enclosure designed for surface mounting that has swinging doors or covers secured directly to and telescoping with the walls of the enclosure. (CMP-9)

DC-to-DC Converter.

A device that can provide an output dc voltage and current at a higher or lower value than the input dc voltage and current. (CMP-4)

Dead Front.

Without live parts exposed to a person on the operating side of the equipment. (CMP-9)

Demand Factor.

The ratio of the maximum demand of a system, or part of a system, to the total connected load of a system or the part of the system under consideration. (CMP-2)

Device.

A unit of an electrical system, other than a conductor, that carries or controls electric energy as its principal function. (CMP-1)

Disconnecting Means.

A device, or group of devices, or other means by which the conductors of a circuit can be disconnected from their source of supply. (CMP-1)

Dormitory Unit.

A building or a space in a building in which group sleeping accommodations are provided for more than 16 persons who are not members of the same family in one room, or a series of closely associated rooms, under joint occupancy and single management, with or without meals, but without individual cooking facilities. (CMP 2)

Duty, Continuous.

Operation at a substantially constant load for an indefinitely long time. (CMP-1)

Duty, Intermittent.

Operation for alternate intervals of (1) load and no load; or (2) load and rest; or (3) load, no load, and rest. (CMP-1)

Duty, Periodic.

Intermittent operation in which the load conditions are regularly recurrent. (CMP-1)

Duty, Short-Time.

Operation at a substantially constant load for a short and definite, specified time. (CMP-1)

Duty, Varying.

Operation at loads, and for intervals of time, both of which may be subject to wide variation. (CMP-1)

Dwelling, One-Family.

A building that consists solely of one dwelling unit. (CMP-1)

Dwelling, Two-Family.

A building that consists solely of two dwelling units. (CMP-1)

Dwelling, Multifamily.

A building that contains three or more dwelling units. (CMP-1)

Dwelling Unit.

A single unit, providing complete and independent living facilities for one or more persons, including permanent provisions for living, sleeping, cooking, and sanitation. (CMP-2)

Effective Ground-Fault Current Path.

An intentionally constructed, low-impedance electrically conductive path designed and intended to carry current under ground-fault conditions from the point of a ground fault on a wiring system to the electrical supply source and that facilitates the operation of the overcurrent protective device or ground-fault detectors. (CMP-5)

Electric Power Production and Distribution Network.

Power production, distribution, and utilization equipment and facilities, such as electric utility systems that are connected to premises wiring and are external to and not controlled by an interactive system. (CMP-13)

Electric Sign.

A fixed, stationary, or portable self-contained, electrically operated and/or electrically illuminated utilization equipment with words or symbols designed to convey information or attract attention. (CMP-18)

Electric Vehicle (EV).

An automotive-type vehicle for on-road use, such as passenger automobiles, buses, trucks, vans, neighborhood electric vehicles, electric motorcycles, and the like, primarily powered by an electric motor that draws current from a rechargeable storage battery, fuel cell, photovoltaic array, or other source of electric current. Plug-in hybrid electric vehicles (PHEV) are electric vehicles having a second source of motive power. Off-road, self-propelled electric mobile equipment, such as industrial trucks, hoists, lifts, transports, golf carts, airline ground support equipment, tractors, boats, and the like, are not considered electric vehicles. (CMP-12)

Electrical Circuit Protective System

A system consisting of components and materials intended for installation as protection for specific electrical wiring systems with respect to the disruption of electrical circuit integrity upon exterior fire exposure. (CMP-16)

Electrical Datum Plane.

A specified distance above a water level above which electrical equipment can be installed and electrical connections can be made. (CMP-7)

Electric-Discharge Lighting.

Systems of illumination utilizing fluorescent lamps, high-intensity discharge (HID) lamps, or neon tubing. (CMP-18)

Electronically Actuated Fuse.

An overcurrent protective device that generally consists of a control module that provides current-sensing, electronically derived time–current characteristics, energy to initiate tripping, and an interrupting module that interrupts current when an overcurrent occurs. Such fuses may or may not operate in a current-limiting fashion, depending on the type of control selected. (CMP-10)

Enclosed.

Surrounded by a case, housing, fence, or wall(s) that prevents persons from accidentally contacting energized parts. (CMP-1)

Enclosure.

The case or housing of apparatus, or the fence or walls surrounding an installation to prevent personnel from accidentally contacting energized parts or to protect the equipment from physical damage. (CMP-1)

Informational Note: See Table 110.28 for examples of enclosure types.

Energized.

Electrically connected to, or is, a source of voltage. (CMP-1)

Equipment.

A general term, including fittings, devices, appliances, luminaires, apparatus, machinery, and the like used as a part of, or in connection with, an electrical installation. (CMP-1)

Equipotential Plane.

Accessible conductive parts bonded together to reduce voltage gradients in a designated area. (CMP-17)

Exposed (as applied to live parts).

Capable of being inadvertently touched or approached nearer than a safe distance by a person. (CMP-1)

> Informational Note: This term applies to parts that are not suitably guarded, isolated, or insulated.

Exposed (as applied to wiring methods).

On or attached to the surface or behind panels designed to allow access. (CMP-1)

Externally Operable.

Capable of being operated without exposing the operator to contact with live parts. (CMP-1)

Fault Current.

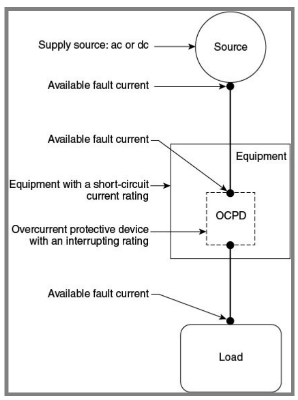
The current delivered at a point on the system during a short-circuit condition. (CMP-10)

Fault Current, Available (Available Fault Current).

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

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

Figure Informational Note Figure 100.1 Available Fault Current.



Feeder.

All circuit conductors between the service equipment, the source of a separately derived system, or other power supply source and the final branch-circuit overcurrent device. (CMP-10)

Festoon Lighting.

A string of outdoor lights that is suspended between two points. (CMP-18)

Field Evaluation Body (FEB).

An organization or part of an organization that performs field evaluations of electrical or other equipment. [**790,** 2018] (CMP-1)

> Informational Note: NFPA 790-2018, *Standard for Competency of Third-Party Field Evaluation Bodies*, provides guidelines for establishing the qualification and competency of a body performing field evaluations of electrical products and assembles with electrical components.

Field Labeled (as applied to evaluated products).

Equipment or materials to which has been attached a label, symbol, or other identifying mark of an FEB indicating the equipment or materials were evaluated and found to comply with requirements as described in an accompanying field evaluation report. [**790,** 2018] (CMP-1)

Fitting.

An accessory such as a locknut, bushing, or other part of a wiring system that is intended primarily to perform a mechanical rather than an electrical function. (CMP-1)

Free Air (as applied to conductors).

Open or ventilated environment that allows for heat dissipation and air flow around an installed conductor. (CMP-6)

Fuel Cell.

An electrochemical system that consumes fuel to produce an electric current. In such cells, the main chemical reaction used for producing electric power is not combustion. However, there may be sources of combustion used within the overall cell system, such as reformers/fuel processors. (CMP-4)

Fuel Cell System.

The complete aggregate of equipment used to convert chemical fuel into usable electricity and typically consisting of a reformer, stack, power inverter, and auxiliary equipment. (CMP-4)

Garage.

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 purposes. (CMP-1)

> Informational Note: For commercial garages, repair and storage, see Article 511.

Generating Capacity, Inverter.

The sum of parallel-connected inverter maximum continuous output power at 40°C in watts or kilowatts. (CMP-4)

Ground.

The earth. (CMP-5)

Ground Fault.

An unintentional, electrically conductive connection between an ungrounded conductor of an electrical circuit and the normally non–current-carrying conductors, metallic enclosures, metallic raceways, metallic equipment, or earth. (CMP-5)

Grounded (Grounding).

Connected (connecting) to ground or to a conductive body that extends the ground connection. (CMP-5)

Grounded, Solidly.

Connected to ground without inserting any resistor or impedance device. (CMP-5)

Grounded Conductor.

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

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

Ground-Fault Circuit Interrupter (GFCI).

A device intended for the protection of personnel that functions to de-energize a circuit or portion thereof within an established period of time when a ground-fault current exceeds the values established for a Class A device. (CMP-2)

> Informational Note: Class A ground-fault circuit interrupters trip when the ground-fault current is 6 mA or higher and do not trip when the ground-fault current is less than 4 mA. For further information, see UL 943, *Standard for Ground-Fault Circuit Interrupters.*

Ground-Fault Current Path.

An electrically conductive path from the point of a ground fault on a wiring system through normally non–current-carrying conductors, grounded conductors, equipment, or the earth to the electrical supply source. (CMP-5)

> Informational Note: Examples of ground-fault current paths are any combination of equipment grounding conductors, metallic raceways, metallic cable sheaths, electrical equipment, and any other electrically conductive material such as metal, water, and gas piping; steel framing members; stucco mesh; metal ducting; reinforcing steel; shields of communications cables; grounded conductors; and the earth itself.

Ground-Fault Protection of Equipment.

A system intended to provide protection of equipment from damaging line-to-ground fault currents by operating to cause a disconnecting means to open all ungrounded conductors of the faulted circuit. This protection is provided at current levels less than those required to protect conductors from damage through the operation of a supply circuit overcurrent device. (CMP-5)

Grounding Conductor, Equipment (EGC).

A conductive path(s) that is part of an effective ground-fault current path and connects normally non–current-carrying metal parts of equipment together and to the system grounded conductor or to the grounding electrode conductor, or both. (CMP-5)

> Informational Note No. 1: It is recognized that the equipment grounding conductor also performs bonding.

> Informational Note No. 2: See 250.118 for a list of acceptable equipment grounding conductors.

Grounding Electrode.

A conducting object through which a direct connection to earth is established. (CMP-5)

Grounding Electrode Conductor.

A conductor used to connect the system grounded conductor or the equipment to a grounding electrode or to a point on the grounding electrode system. (CMP-5)

Guarded.

Covered, shielded, fenced, enclosed, or otherwise protected by means of suitable covers, casings, barriers, rails, screens, mats, or platforms to remove the likelihood of approach or contact by persons or objects to a point of danger. (CMP-1)

Guest Room.

An accommodation combining living, sleeping, sanitary, and storage facilities within a compartment. (CMP-2)

Guest Suite.

An accommodation with two or more contiguous rooms comprising a compartment, with or without doors between such rooms, that provides living, sleeping, sanitary, and storage facilities. (CMP-2)

Habitable Room.

A room in a building for living, sleeping, eating, or cooking, but excluding bathrooms, toilet rooms, closets, hallways, storage or utility spaces, and similar areas. (CMP-2)

Handhole Enclosure.

An enclosure for use in underground systems, provided with an open or closed bottom, and sized to allow personnel to reach into, but not enter, for the purpose of installing, operating, or maintaining equipment or wiring or both. (CMP-9)

Hermetic Refrigerant Motor-Compressor.

A combination consisting of a compressor and motor, both of which are enclosed in the same housing, with no external shaft or shaft seals, with the motor operating in the refrigerant. (CMP-11)

Hoistway.

Any shaftway, hatchway, well hole, or other vertical opening or space in which an elevator or dumbwaiter is designed to operate. (CMP-12)

Hybrid System.

A system comprised of multiple power sources. These power sources could include photovoltaic, wind, micro-hydro generators, engine-driven generators, and others, but do not include electric power production and distribution network systems. Energy storage systems such as batteries, flywheels, or superconducting magnetic storage equipment do not constitute a power source for the purpose of this definition. The energy regenerated by an overhauling (descending) elevator does not constitute a power source for the purpose of this definition. (CMP-4)

Identified (as applied to equipment).

Recognizable as suitable for the specific purpose, function, use, environment, application, and so forth, where described in a particular *Code* requirement. (CMP-1)

> Informational Note: Some examples of ways to determine suitability of equipment for a specific purpose, environment, or application include investigations by a qualified testing laboratory (listing and labeling), an inspection agency, or other organizations concerned with product evaluation.

In Sight From (Within Sight From, Within Sight).

Where this *Code* specifies that one equipment shall be “in sight from,” “within sight from,” or “within sight of,” and so forth, another equipment, the specified equipment is to be visible and not more than 15 m (50 ft) distant from the other. (CMP-1)

Industrial Control Panel.

An assembly of two or more components consisting of one of the following: (1) power circuit components only, such as motor controllers, overload relays, fused disconnect switches, and circuit breakers; (2) control circuit components only, such as push buttons, pilot lights, selector switches, timers, switches, and control relays; (3) a combination of power and control circuit components. These components, with associated wiring and terminals, are mounted on, or contained within, an enclosure or mounted on a subpanel.

The industrial control panel does not include the controlled equipment. (CMP-11)

Information Technology Equipment (ITE).

Equipment and systems rated 1000 volts or less, normally found in offices or other business establishments and similar environments classified as ordinary locations, that are used for creation and manipulation of data, voice, video, and similar signals that are not communications equipment as defined in Part I of Article 100 and do not process communications circuits as defined in 805.2. (CMP-12)

> Informational Note: For information on listing requirements for both information technology equipment and communications equipment, see UL 60950-1-2014, *Information Technology Equipment — Safety — Part 1: General Requirements* or UL 62368-1-2014, *Audio/Video Information and Communication Technology Equipment Part 1: Safety Requirements*.

Information Technology Equipment Room.

A room within the information technology equipment area that contains the information technology equipment. [**75:**3.3.14] (CMP-12)

Innerduct.

A nonmetallic raceway placed within a larger raceway. (CMP-16)

Interactive Inverter.

An inverter intended for use in parallel with power source(s) such as an electric utility to supply common loads and capable of delivering power to the utility. (CMP-13)

Interactive System.

An electric power production system that is operating in parallel with and capable of delivering energy to an electric primary source supply system. (CMP-4)

Interrupting Rating.

The highest current at rated voltage that a device is identified to interrupt under standard test conditions. (CMP-10)

> Informational Note: Equipment intended to interrupt current at other than fault levels may have its interrupting rating implied in other ratings, such as horsepower or locked rotor current.

Intersystem Bonding Termination.

A device that provides a means for connecting intersystem bonding conductors for communications systems to the grounding electrode system. (CMP-16)

Inverter.

Equipment that changes dc to ac. (CMP-4)

Inverter Input Circuit.

Conductors connected to the dc input of an inverter. (CMP-13)

Inverter Output Circuit.

Conductors connected to the ac output of an inverter. (CMP-13)

Inverter, Multimode.

Equipment having the capabilities of both the interactive inverter and the stand-alone inverter. (CMP-4)

Island Mode.

The operational mode for stand-alone power production equipment or an isolated microgrid, or for a multimode inverter or an interconnected microgrid that is disconnected from an electric power production and distribution network or other primary power source. (CMP-4)

> Informational Note: Isolated microgrids are distinguished from interconnected microgrids, which are addressed in Article 705.

Isolated (as applied to location).

Not readily accessible to persons unless special means for access are used. (CMP-1)

Kitchen.

An area with a sink and permanent provisions for food preparation and cooking. (CMP-2)

Labeled.

Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner. (CMP-1)

> Informational Note: If a listed product is of such a size, shape, material, or surface texture that it is not possible to apply legibly the complete label to the product, the complete label may appear on the smallest unit container in which the product is packaged.

Laundry Area.

An area containing or designed to contain a laundry tray, clothes washer, or clothes dryer. (CMP-2)

Lighting Outlet.

An outlet intended for the direct connection of a lampholder or luminaire. (CMP-18)

Lighting Track (Track Lighting).

A manufactured assembly designed to support and energize luminaires that are capable of being readily repositioned on the track. Its length can be altered by the addition or subtraction of sections of track. (CMP-18)

Listed.

Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose. (CMP-1)

> Informational Note: The means for identifying listed equipment may vary for each organization concerned with product evaluation, some of which do not recognize equipment as listed unless it is also labeled. Use of the system employed by the listing organization allows the authority having jurisdiction to identify a listed product.

Live Parts.

Energized conductive components. (CMP-1)

Location, Damp.

Locations protected from weather and not subject to saturation with water or other liquids but subject to moderate degrees of moisture. (CMP-1)

> Informational Note: Examples of such locations include partially protected locations under canopies, marquees, roofed open porches, and like locations, and interior locations subject to moderate degrees of moisture, such as some basements, some barns, and some cold-storage warehouses.

Location, Dry.

A location not normally subject to dampness or wetness. A location classified as dry may be temporarily subject to dampness or wetness, as in the case of a building under construction. (CMP-1)

Location, Wet.

Installations underground or in concrete slabs or masonry in direct contact with the earth; in locations subject to saturation with water or other liquids, such as vehicle washing areas; and in unprotected locations exposed to weather. (CMP-1)

Luminaire.

A complete lighting unit consisting of a light source such as a lamp or lamps, together with the parts designed to position the light source and connect it to the power supply. It may also include parts to protect the light source or the ballast or to distribute the light. A lampholder itself is not a luminaire. (CMP-18)

Messenger or Messenger Wire.

A wire that is run along with or integral with a cable or conductor to provide mechanical support for the cable or conductor. (CMP-6)

Motor Control Center.

An assembly of one or more enclosed sections having a common power bus and principally containing motor control units. (CMP-11)

Multioutlet Assembly.

A type of surface, flush, or freestanding raceway designed to hold conductors and receptacles, assembled in the field or at the factory. (CMP-18)

Neutral Conductor.

The conductor connected to the neutral point of a system that is intended to carry current under normal conditions. (CMP-5)

Neutral Point.

The common point on a wye-connection in a polyphase system or midpoint on a single-phase, 3-wire system, or midpoint of a single-phase portion of a 3-phase delta system, or a midpoint of a 3-wire, direct-current system. (CMP-5)

> Informational Note: At the neutral point of the system, the vectorial sum of the nominal voltages from all other phases within the system that utilize the neutral, with respect to the neutral point, is zero potential.

Nonautomatic.

Requiring human intervention to perform a function. (CMP-1)

Nonlinear Load.

A load where the wave shape of the steady-state current does not follow the wave shape of the applied voltage. (CMP-1)

> Informational Note: Electronic equipment, electronic/electric-discharge lighting, adjustable-speed drive systems, and similar equipment may be nonlinear loads.

Outlet.

A point on the wiring system at which current is taken to supply utilization equipment. (CMP-1)

Outline Lighting.

An arrangement of incandescent lamps, electric-discharge lighting, or other electrically powered light sources to outline or call attention to certain features such as the shape of a building or the decoration of a window. (CMP-18)

Overcurrent.

Any current in excess of the rated current of equipment or the ampacity of a conductor. It may result from overload, short circuit, or ground fault. (CMP-10)

> Informational Note: A current in excess of rating may be accommodated by certain equipment and conductors for a given set of conditions. Therefore, the rules for overcurrent protection are specific for particular situations.

Overcurrent Protective Device, Branch-Circuit.

A device capable of providing protection for service, feeder, and branch circuits and equipment over the full range of overcurrents between its rated current and its interrupting rating. Such devices are provided with interrupting ratings appropriate for the intended use but no less than 5000 amperes. (CMP-10)

Overcurrent Protective Device, Supplementary.

A device intended to provide limited overcurrent protection for specific applications and utilization equipment such as luminaires and appliances. This limited protection is in addition to the protection provided in the required branch circuit by the branch-circuit overcurrent protective device. (CMP-10)

Overload.

Operation of equipment in excess of normal, full-load rating, or of a conductor in excess of its ampacity that, when it persists for a sufficient length of time, would cause damage or dangerous overheating. A fault, such as a short circuit or ground fault, is not an overload. (CMP-10)

Panelboard.

A single panel or group of panel units designed for assembly in the form of a single panel, including buses and automatic overcurrent devices, and equipped with or without switches for the control of light, heat, or power circuits; designed to be placed in a cabinet or cutout box placed in or against a wall, partition, or other support; and accessible only from the front. (CMP-9)

Photovoltaic (PV) System.

The total components, circuits, and equipment up to and including the PV system disconnecting means that, in combination, convert solar energy into electric energy. (CMP-4)

Pier.

A structure extending over the water and supported on a fixed foundation (fixed pier), or on flotation (floating pier), that provides access to the water. [**303:**3.3.17] (CMP-7)

Pier, Fixed.

Pier constructed on a permanent, fixed foundation, such as on piles, that permanently establishes the elevation of the structure deck with respect to land. [**303:**3.3.17.2] (CMP-7)

Pier, Floating.

Pier designed with inherent flotation capability that allows the structure to float on the water surface and rise and fall with water level changes. [**303:**3.3.17.3] (CMP-7)

Plenum.

A compartment or chamber to which one or more air ducts are connected and that forms part of the air distribution system. (CMP-3)

Power Outlet.

An enclosed assembly that may include receptacles, circuit breakers, fuseholders, fused switches, buses, and watt-hour meter mounting means; intended to supply and control power to mobile homes, recreational vehicles, park trailers, or boats or to serve as a means for distributing power required to operate mobile or temporarily installed equipment.(CMP-7)

Power Production Equipment.

Electrical generating equipment supplied by any source other than a utility service, up to the source system disconnecting means. (CMP-4)

> Informational Note: Examples of power production equipment include such items as generators, solar photovoltaic systems, and fuel cell systems.

Power-Limited Tray Cable (PLTC).

A factory assembly of two or more insulated conductors rated at 300 volts, with or without associated bare or insulated equipment grounding conductors, under a nonmetallic jacket. (CMP-3)

Premises Wiring (System).

Interior and exterior wiring, including power, lighting, control, and signal circuit wiring together with all their associated hardware, fittings, and wiring devices, both permanently and temporarily installed. This includes (a) wiring from the service point or power source to the outlets or (b) wiring from and including the power source to the outlets where there is no service point.

Such wiring does not include wiring internal to appliances, luminaires, motors, controllers, motor control centers, and similar equipment. (CMP-1)

> Informational Note: Power sources include, but are not limited to, interconnected or stand-alone batteries, solar photovoltaic systems, other distributed generation systems, or generators.

Prime Mover.

The machine that supplies the mechanical horsepower to a generator. (CMP-13)

Qualified Person.

One who has skills and knowledge related to the construction and operation of the electrical equipment and installations and has received safety training to recognize and avoid the hazards involved. (CMP-1)

> Informational Note: Refer to *NFPA 70E*-2018, *Standard for Electrical Safety in the Workplace*, for electrical safety training requirements.

Raceway.

An enclosed channel designed expressly for holding wires, cables, or busbars, with additional functions as permitted in this *Code*. (CMP-8)

> Informational Note: A raceway is identified within specific article definitions.

Raceway, Communications.

An enclosed channel of nonmetallic materials designed expressly for holding communications wires and cables; optical fiber cables; data cables associated with information technology and communications equipment; Class 2, Class 3, and Type PLTC cables; and power-limited fire alarm cables in plenum, riser, and general-purpose applications. (CMP-16)

Rainproof.

Constructed, protected, or treated so as to prevent rain from interfering with the successful operation of the apparatus under specified test conditions. (CMP-1)

Raintight.

Constructed or protected so that exposure to a beating rain will not result in the entrance of water under specified test conditions. (CMP-1)

Receptacle.

A contact device installed at the outlet for the connection of an attachment plug, or for the direct connection of electrical utilization equipment designed to mate with the corresponding contact device. A single receptacle is a single contact device with no other contact device on the same yoke or strap. A multiple receptacle is two or more contact devices on the same yoke or strap. (CMP-18)

> Informational Note: A duplex receptacle is an example of a multiple receptacle that has two receptacles on the same yoke or strap.

Receptacle Outlet.

An outlet where one or more receptacles are installed. (CMP-18)

Reconditioned.

Electromechanical systems, equipment, apparatus, or components that are restored to operating conditions. This process differs from normal servicing of equipment that remains within a facility, or replacement of listed equipment on a one-to-one basis. (CMP-10)

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

Remote-Control Circuit.

Any electrical circuit that controls any other circuit through a relay or an equivalent device. (CMP-3)

Retrofit Kit.

A general term for a complete subassembly of parts and devices for field conversion of utilization equipment. (CMP-18)

Sealable Equipment.

Equipment enclosed in a case or cabinet that is provided with a means of sealing or locking so that live parts cannot be made accessible without opening the enclosure. (CMP-1)

> Informational Note: The equipment may or may not be operable without opening the enclosure.

Separately Derived System.

An electrical source, other than a service, having no direct connection(s) to circuit conductors of any other electrical source other than those established by grounding and bonding connections. (CMP-5)

Service.

The conductors and equipment connecting the serving utility to the wiring system of the premises served. (CMP-10)

Service Cable.

Service conductors made up in the form of a cable. (CMP-10)

Service Conductors.

The conductors from the service point to the service disconnecting means. (CMP-10)

Service Conductors, Overhead.

The overhead conductors between the service point and the first point of connection to the service-entrance conductors at the building or other structure. (CMP-10)

Service Conductors, Underground.

The underground conductors between the service point and the first point of connection to the service-entrance conductors in a terminal box, meter, or other enclosure, inside or outside the building wall. (CMP-10)

> Informational Note: Where there is no terminal box, meter, or other enclosure, the point of connection is considered to be the point of entrance of the service conductors into the building.

Service Drop.

The overhead conductors between the serving utility and the service point. (CMP-10)

Service-Entrance Conductors, Overhead System.

The service conductors between the terminals of the service equipment and a point usually outside the building, clear of building walls, where joined by tap or splice to the service drop or overhead service conductors. (CMP-10)

Service-Entrance Conductors, Underground System.

The service conductors between the terminals of the service equipment and the point of connection to the service lateral or underground service conductors. (CMP-10)

> Informational Note: Where service equipment is located outside the building walls, there may be no service-entrance conductors or they may be entirely outside the building.

Service Equipment.

The necessary equipment, consisting of a circuit breaker(s) or switch(es) and fuse(s) and their accessories, connected to the serving utility and intended to constitute the main control and disconnect of the serving utility. (CMP-10)

Service Lateral.

The underground conductors between the utility electric supply system and the service point. (CMP-10)

Service Point.

The point of connection between the facilities of the serving utility and the premises wiring. (CMP-10)

> Informational Note: The service point can be described as the point of demarcation between where the serving utility ends and the premises wiring begins. The serving utility generally specifies the location of the service point based on the conditions of service.

Short-Circuit Current Rating.

The prospective symmetrical fault current at a nominal voltage to which an apparatus or system is able to be connected without sustaining damage exceeding defined acceptance criteria. (CMP-10)

Show Window.

Any window, including windows above doors, used or designed to be used for the display of goods or advertising material, whether it is fully or partly enclosed or entirely open at the rear and whether or not it has a platform raised higher than the street floor level. (CMP-2)

Signaling Circuit.

Any electrical circuit that energizes signaling equipment. (CMP-3)

Single-Pole Separable Connector.

A device that is installed at the ends of portable, flexible, single-conductor cable that is used to establish connection or disconnection between two cables or one cable and a single-pole, panel-mounted separable connector. (CMP-18)

Special Permission.

The written consent of the authority having jurisdiction. (CMP-1)

Stand-Alone System.

A system that is capable of supplying power independent of an electric power production and distribution network.(CMP-4)

Structure.

That which is built or constructed, other than equipment. (CMP-1)

Surge Arrester.

A protective device for limiting surge voltages by discharging or bypassing surge current; it also prevents continued flow of follow current while remaining capable of repeating these functions. (CMP-10)

Surge-Protective Device (SPD).

A protective device for limiting transient voltages by diverting or limiting surge current; it also prevents continued flow of follow current while remaining capable of repeating these functions and is designated as follows:

Type 1: Permanently connected SPDs intended for installation between the secondary of the service transformer and the line side of the service disconnect overcurrent device.

Type 2: Permanently connected SPDs intended for installation on the load side of the service disconnect overcurrent device, including SPDs located at the branch panel.

Type 3: Point of utilization SPDs.

Type 4: Component SPDs, including discrete components, as well as assemblies. (CMP-10)

> Informational Note: For further information on Type 1, Type 2, Type 3, and Type 4 SPDs, see UL 1449, *Standard for Surge Protective Devices*.

Switch, Bypass Isolation.

A manual, nonautomatic, or automatic operated device used in conjunction with a transfer switch to provide a means of directly connecting load conductors to a power source and of disconnecting the transfer switch. (CMP-13)

Switch, General-Use.

A switch intended for use in general distribution and branch circuits. It is rated in amperes, and it is capable of interrupting its rated current at its rated voltage. (CMP-9)

Switch, General-Use Snap.

A form of general-use switch constructed so that it can be installed in device boxes or on box covers, or otherwise used in conjunction with wiring systems recognized by this *Code*. (CMP-9)

Switch, Isolating.

A switch intended for isolating an electrical circuit from the source of power. It has no interrupting rating, and it is intended to be operated only after the circuit has been opened by some other means. (CMP-9)

Switch, Motor-Circuit.

A switch rated in horsepower that is capable of interrupting the maximum operating overload current of a motor of the same horsepower rating as the switch at the rated voltage. (CMP-11)

Switch, Transfer.

An automatic or nonautomatic device for transferring one or more load conductor connections from one power source to another. (CMP-13)

Switchboard.

A large single panel, frame, or assembly of panels on which are mounted on the face, back, or both, switches, overcurrent and other protective devices, buses, and usually instruments. These assemblies are generally accessible from the rear as well as from the front and are not intended to be installed in cabinets. (CMP-9)

Switchgear.

An assembly completely enclosed on all sides and top with sheet metal (except for ventilating openings and inspection windows) and containing primary power circuit switching, interrupting devices, or both, with buses and connections. The assembly may include control and auxiliary devices. Access to the interior of the enclosure is provided by doors, removable covers, or both. (CMP-9)

> Informational Note: All switchgear subject to *NEC* requirements is metal enclosed. Switchgear rated below 1000 V or less may be identified as “low-voltage power circuit breaker switchgear.” Switchgear rated over 1000 V may be identified as “metal-enclosed switchgear” or “metal-clad switchgear.” Switchgear is available in non–arc-resistant or arc-resistant constructions.

Thermal Protector (as applied to motors).

A protective device for assembly as an integral part of a motor or motor-compressor that, when properly applied, protects the motor against dangerous overheating due to overload and failure to start. (CMP-11)

Informational Note: The thermal protector may consist of one or more sensing elements integral with the motor or motor-compressor and an external control device.

Thermally Protected (as applied to motors).

A motor or motor-compressor that is provided with a thermal protector. (CMP-11)

Ungrounded.

Not connected to ground or to a conductive body that extends the ground connection. (CMP-5)

Uninterruptible Power Supply.

A power supply used to provide alternating current power to a load for some period of time in the event of a power failure. (CMP-13)

Informational Note: In addition, it may provide a more constant voltage and frequency supply to the load, reducing the effects of voltage and frequency variations.

Utilization Equipment.

Equipment that utilizes electric energy for electronic, electromechanical, chemical, heating, lighting, or similar purposes. (CMP-1)

Voltage (of a circuit).

The greatest root-mean-square (rms) (effective) difference of potential between any two conductors of the circuit concerned. (CMP-1)

Informational Note: Some systems, such as 3-phase 4-wire, single-phase 3-wire, and 3-wire direct current, may have various circuits of various voltages.

Voltage, Nominal.

A nominal value assigned to a circuit or system for the purpose of conveniently designating its voltage class (e.g., 120/240 volts, 480Y/277 volts, 600 volts). (CMP-1)

Informational Note No. 1: The actual voltage at which a circuit operates can vary from the nominal within a range that permits satisfactory operation of equipment.

Informational Note No. 2: See ANSI C84.1-2011, *Voltage Ratings for Electric Power Systems and Equipment (60 Hz).*

Informational Note No. 3: Certain battery units may be considered to be rated at nominal 48 volts dc, but may have a charging float voltage up to 58 volts. In dc applications, 60 volts is used to cover the entire range of float voltages.

Voltage to Ground.

For grounded circuits, the voltage between the given conductor and that point or conductor of the circuit that is grounded; for ungrounded circuits, the greatest voltage between the given conductor and any other conductor of the circuit. (CMP-1)

Watertight.

Constructed so that moisture will not enter the enclosure under specified test conditions. (CMP-1)

Weatherproof.

Constructed or protected so that exposure to the weather will not interfere with successful operation. (CMP-1)

Informational Note: Rainproof, raintight, or watertight equipment can fulfill the requirements for weatherproof where varying weather conditions other than wetness, such as snow, ice, dust, or temperature extremes, are not a factor.

Part II. Over 1000 Volts, Nominal

Electronically Actuated Fuse.

An overcurrent protective device that generally consists of a control module that provides current sensing, electronically derived time–current characteristics, energy to initiate tripping, and an interrupting module that interrupts current when an overcurrent occurs. Electronically actuated fuses may or may not operate in a current-limiting fashion, depending on the type of control selected. (CMP-10)

Fuse.

An overcurrent protective device with a circuit-opening fusible part that is heated and severed by the passage of overcurrent through it. (CMP-10)

> Informational Note: A fuse comprises all the parts that form a unit capable of performing the prescribed functions. It may or may not be the complete device necessary to connect it into an electrical circuit.

Controlled Vented Power Fuse.

A fuse with provision for controlling discharge circuit interruption such that no solid material may be exhausted into the surrounding atmosphere.

> Informational Note: The fuse is designed so that discharged gases will not ignite or damage insulation in the path of the discharge or propagate a flashover to or between grounded members or conduction members in the path of the discharge where the distance between the vent and such insulation or conduction members conforms to manufacturer's recommendations.

Expulsion Fuse Unit (Expulsion Fuse).

A vented fuse unit in which the expulsion effect of gases produced by the arc and lining of the fuseholder, either alone or aided by a spring, extinguishes the arc.

Nonvented Power Fuse.

A fuse without intentional provision for the escape of arc gases, liquids, or solid particles to the atmosphere during circuit interruption.

Power Fuse Unit.

A vented, nonvented, or controlled vented fuse unit in which the arc is extinguished by being drawn through solid material, granular material, or liquid, either alone or aided by a spring.

Vented Power Fuse.

A fuse with provision for the escape of arc gases, liquids, or solid particles to the surrounding atmosphere during circuit interruption.

Multiple Fuse.

An assembly of two or more single-pole fuses. (CMP-10)

Substation.

An assemblage of equipment (e.g., switches, interrupting devices, circuit breakers, buses, and transformers) through which electric energy is passed for the purpose of distribution, switching, or modifying its characteristics. (CMP-9)

Switching Device.

A device designed to close, open, or both, one or more electrical circuits. (CMP-1)

Circuit Breaker.

A switching device capable of making, carrying, and interrupting currents under normal circuit conditions, and also of making, carrying for a specified time, and interrupting currents under specified abnormal circuit conditions, such as those of short circuit.

Cutout.

An assembly of a fuse support with either a fuseholder, fuse carrier, or disconnecting blade. The fuseholder or fuse carrier may include a conducting element (fuse link) or may act as the disconnecting blade by the inclusion of a nonfusible member.

Disconnecting Means.

A device, group of devices, or other means whereby the conductors of a circuit can be disconnected from their source of supply.

Disconnecting (or Isolating) Switch (Disconnector, Isolator).

A mechanical switching device used for isolating a circuit or equipment from a source of power.

Interrupter Switch.

A switch capable of making, carrying, and interrupting specified currents.

Oil Cutout (Oil-Filled Cutout).

A cutout in which all or part of the fuse support and its fuse link or disconnecting blade is mounted in oil with complete immersion of the contacts and the fusible portion of the conducting element (fuse link) so that arc interruption by severing of the fuse link or by opening of the contacts will occur under oil.

Oil Switch.

A switch having contacts that operate under oil (or askarel or other suitable liquid).

Regulator Bypass Switch.

A specific device or combination of devices designed to bypass a regulator.

Part III. Hazardous (Classified) Locations (CMP-14).

Aircraft Painting Hangar.

An aircraft hangar constructed for the express purpose of spray/coating/dipping applications and provided with dedicated ventilation supply and exhaust.

Associated Apparatus.

Apparatus in which the circuits are not necessarily intrinsically safe themselves but that affects the energy in the intrinsically safe circuits and is relied on to maintain intrinsic safety. Such apparatus is one of the following:

(1) Electrical apparatus that has an alternative type of protection for use in the appropriate hazardous (classified) location

(2) Electrical apparatus not so protected that shall not be used within a hazardous (classified) location

Informational Note No. 1: Associated apparatus has identified intrinsically safe connections for intrinsically safe apparatus and also may have connections for nonintrinsically safe apparatus.

Informational Note No. 2: An example of associated apparatus is an intrinsic safety barrier, which is a network designed to limit the energy (voltage and current) available to the protected circuit in the hazardous (classified) location, under specified fault conditions.

Associated Nonincendive Field Wiring Apparatus.

Apparatus in which the circuits are not necessarily nonincendive themselves but that affect the energy in nonincendive field wiring circuits and are relied upon to maintain nonincendive energy levels. Such apparatus are one of the following:

(1) Electrical apparatus that has an alternative type of protection for use in the appropriate hazardous (classified) location

(2) Electrical apparatus not so protected that shall not be used in a hazardous (classified) location

Informational Note: Associated nonincendive field wiring apparatus has designated associated nonincendive field wiring apparatus connections for nonincendive field wiring apparatus and may also have connections for other electrical apparatus.

Combustible Dust.

Dust particles that are 500 microns or smaller (i.e., material passing a U.S. No. 35 Standard Sieve as defined in ASTM E11-2015, *Standard Specification for Woven Wire Test Sieve Cloth and Test Sieves*), and present a fire or explosion hazard when dispersed and ignited in air.

Informational Note: See ASTM E1226-2012a, *Standard Test Method for Explosibility of Dust Clouds*, or ISO 6184-1, *Explosion protection systems — Part 1: Determination of explosion indices of combustible dusts in air*, for procedures for determining the explosibility of dusts.

Combustible Gas Detection System.

A protection technique utilizing stationary gas detectors in industrial establishments.

Control Drawing.

A drawing or other document provided by the manufacturer of the intrinsically safe or associated apparatus, or of the nonincendive field wiring apparatus or associated nonincendive field wiring apparatus, that details the allowed interconnections between the intrinsically safe and associated apparatus or between the nonincendive field wiring apparatus or associated nonincendive field wiring apparatus.

Cord Connector.

A fitting intended to terminate a cord to a box or similar device and reduce the strain at points of termination and may include an explosionproof, a dust-ignitionproof, or a flameproof seal.

Different Intrinsically Safe Circuits.

Intrinsically safe circuits in which the possible interconnections have not been evaluated and identified as intrinsically safe.

Dust-Ignitionproof.

Equipment enclosed in a manner that excludes dusts and does not permit arcs, sparks, or heat otherwise generated or liberated inside of the enclosure to cause ignition of exterior accumulations or atmospheric suspensions of a specified dust on or in the vicinity of the enclosure.

Informational Note No. 1: For further information on dust-ignitionproof enclosures, see ANSI/UL 1203-2015, *Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Hazardous (Classified) Locations*.

Informational Note No. 2: Dust-ignitionproof enclosures are sometimes additionally marked Type 9 per NEMA 250-2014, *Enclosures for Electrical Equipment*.

Dusttight.

Enclosures constructed so that dust will not enter under specified test conditions.

Informational Note No. 1: For further information, see ANSI/UL 121201-2017, *Nonincendive Electrical Equipment for Use in Class I and II, Division 2 and Class III, Divisions 1 and 2 Hazardous (Classified) Locations*.

Informational Note No. 2: Enclosure Types 3, 3X, 3S, 3SX, 4, 4X, 5, 6, 6P, 12, 12K, and 13, per NEMA 250-2014, *Enclosures for Electrical Equipment* and ANSI/UL 50E-2015, *Enclosures for Electrical Equipment, Environmental Considerations*, are considered dusttight.

Electrical Resistance Trace Heating "60079-30-1".

Type of protection for the purpose of producing heat on the principle of electrical resistance and typically composed of one or more metallic conductors and/or an electrically conductive material, suitably electrically insulated and protected.

Informational Note: See ANSI/UL 60079-30-1-2017, *Explosive Atmospheres — Part 30-1: Electrical Resistance Trace Heating — General and Testing Requirements*.

Encapsulation "m".

Type of protection where electrical parts that could ignite an explosive atmosphere by either sparking or heating are enclosed in a compound in such a way that this explosive atmosphere cannot be ignited.

Informational Note: See ANSI/UL 60079-18-2015, *Explosive atmospheres — Part 18: Equipment protection by encapsulation "m".*

Explosionproof Equipment.

Equipment enclosed in a case that is capable of withstanding an explosion of a specified gas or vapor that may occur within it and of preventing the ignition of a specified gas or vapor surrounding the enclosure by sparks, flashes, or explosion of the gas or vapor within, and that operates at such an external temperature that a surrounding flammable atmosphere will not be ignited thereby. (CMP-14)

Informational Note No. 1: For further information, see ANSI/UL 1203-2015, *Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations.*

Informational Note No. 2: Explosionproof enclosures are sometimes additionally marked Type 7 per NEMA 250-2014, *Enclosures for Electrical Equipment*.

Flameproof “d”.

Type of protection where the enclosure will withstand an internal explosion of a flammable mixture that has penetrated into the interior, without suffering damage and without causing ignition, through any joints or structural openings in the enclosure of an external explosive gas atmosphere consisting of one or more of the gases or vapors for which it is designed.

Informational Note: See ANSI/UL 60079-1-2015, *Explosive Atmospheres — Part 1: Equipment Protection by Flameproof Enclosures “d”.*

Hermetically Sealed.

Equipment sealed against the entrance of an external atmosphere where the seal is made by fusion, for example, soldering, brazing, welding, or the fusion of glass to metal.

Informational Note: For further information, see ANSI/ISA-12.12.01-2013, *Nonincendive Electrical Equipment for Use in Class I and II, Division 2, and Class III, Divisions 1 and 2 Hazardous (Classified) Locations*.

Increased Safety “e”.

Type of protection applied to electrical equipment that does not produce arcs or sparks in normal service and under specified abnormal conditions, in which additional measures are applied so as to give increased security against the possibility of excessive temperatures and of the occurrence of arcs and sparks.

Informational Note: See ANSI/UL 60079-7–2017, *Explosive Atmospheres — Part 7: Equipment Protection by Increased Safety “e”.*

Inherently Safe Optical Radiation “op is”.

Type of protection to minimize the risk of ignition in explosive atmospheres from optical radiation where visible or infrared radiation is incapable of producing sufficient energy under normal or specified fault conditions to ignite a specific explosive atmosphere.

Informational Note: See ANSI/UL 60079-28-2017, *Explosive Atmospheres — Part 28: Protection of Equipment and Transmission Systems Using Optical Radiation*.

Intrinsic Safety “i”.

Type of protection where any spark or thermal effect is incapable of causing ignition of a mixture of flammable or combustible material in air under prescribed test conditions.

Informational Note: See UL 913-2015, *Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1 Hazardous (Classified) Locations*; and ANSI/UL 60079-11-2013, *Explosive Atmospheres — Part 11: Equipment protection by intrinsic safety “i”.*

Intrinsically Safe Apparatus.

Apparatus in which all the circuits are intrinsically safe.

Intrinsically Safe Circuit.

A circuit in which any spark or thermal effect is incapable of causing ignition of a mixture of flammable or combustible material in air under prescribed test conditions.

Informational Note: Test conditions are described in ANSI/UL 913-2013, *Standard for Safety, Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1, Hazardous (Classified) Locations*.

Intrinsically Safe System.

An assembly of interconnected intrinsically safe apparatus, associated apparatus, and interconnecting cables, in that those parts of the system that may be used in hazardous (classified) locations are intrinsically safe circuits.

> Informational Note: An intrinsically safe system may include more than one intrinsically safe circuit.

Limited Finishing Workstation.

An apparatus that is capable of confining the vapors, mists, residues, dusts, or deposits that are generated by a spray application process but does not meet the requirements of a spray booth or spray room, as herein defined. [**33:**3.3.18.1]

> Informational Note: See Section 14.3 of NFPA 33, *Standard for Spray Application Using Flammable or Combustible Materials*, for limited finishing workstations.

Liquid Immersion "o".

Type of protection where electrical equipment is immersed in a protective liquid in such a way that an explosive atmosphere that may be above the liquid or outside the enclosure cannot be ignited.

> Informational Note: See ANSI/UL 60079-6-2016, *Explosive Atmospheres — Part 6: Equipment protection by liquid immersion "o".*

Major Repair Garage.

A building or portions of a building where major repairs, such as engine overhauls, painting, body and fender work, and repairs that require draining of the motor vehicle fuel tank are performed on motor vehicles, including associated floor space used for offices, parking, or showrooms. [**30A:**3.3.12.1]

Membrane Enclosure.

A temporary enclosure used for the spraying of workpieces that cannot be moved into a spray booth where open spraying is not practical due to the proximity to other operations, finish quality, or concerns such as the collection of overspray.

> Informational Note: See Chapter 18 of NFPA 33-2016, *Standard for Spray Application Using Flammable or Combustible Materials*, for information on the construction and use of membrane enclosures.

Minor Repair Garage.

A building or portions of a building used for lubrication, inspection, and minor automotive maintenance work, such as engine tune-ups, replacement of parts, fluid changes (e.g., oil, antifreeze, transmission fluid, brake fluid, air-conditioning refrigerants), brake system repairs, tire rotation, and similar routine maintenance work, including associated floor space used for offices, parking, or showrooms. [**30A:**3.3.12.2]

Mobile Equipment.

Equipment with electrical components suitable to be moved only with mechanical aids or is provided with wheels for movement by person(s) or powered devices.

Motor Fuel Dispensing Facility.

That portion of a property where motor fuels are stored and dispensed from fixed equipment into the fuel tanks of motor vehicles or marine craft or into approved containers, including all equipment used in connection therewith. [**30A:**3.3.11]

> Informational Note: Refer to Articles 510 and 511 with respect to electrical wiring and equipment for other areas used as lubritoriums, service rooms, repair rooms, offices, salesrooms, compressor rooms, and similar locations.

Nonincendive Circuit.

A circuit, other than field wiring, in which any arc or thermal effect produced under intended operating conditions of the equipment, is not capable, under specified test conditions, of igniting the flammable gas–air, vapor–air, or dust–air mixture.

> Informational Note: Conditions are described in ANSI/ISA-12.12.01-2013, *Nonincendive Electrical Equipment for Use in Class I and II, Division 2, and Class III, Divisions 1 and 2 Hazardous (Classified) Locations*.

Nonincendive Component.

A component having contacts for making or breaking an incendive circuit and the contacting mechanism is constructed so that the component is incapable of igniting the specified flammable gas–air or vapor–air mixture. The housing of a nonincendive component is not intended to exclude the flammable atmosphere or contain an explosion.

> Informational Note: For further information, see ANSI/ISA-12.12.01-2013, *Nonincendive Electrical Equipment for Use in Class I and II, Division 2, and Class III, Divisions 1 and 2 Hazardous (Classified) Locations.*

Nonincendive Equipment.

Equipment having electrical/electronic circuitry that is incapable, under normal operating conditions, of causing ignition of a specified flammable gas–air, vapor–air, or dust–air mixture due to arcing or thermal means.

> Informational Note: For further information, see ANSI/ISA-12.12.01-2013, *Nonincendive Electrical Equipment for Use in Class I and II, Division 2, and Class III, Divisions 1 and 2 Hazardous (Classified) Locations*.

Nonincendive Field Wiring.

Wiring that enters or leaves an equipment enclosure and, under normal operating conditions of the equipment, is not capable, due to arcing or thermal effects, of igniting the flammable gas–air, vapor–air, or dust–air mixture. Normal operation includes opening, shorting, or grounding the field wiring.

Nonincendive Field Wiring Apparatus.

Apparatus intended to be connected to nonincendive field wiring.

> Informational Note: For further information, see ANSI/ISA-12.12.01-2013, *Nonincendive Electrical Equipment for Use in Class I and II, Division 2, and Class III, Divisions 1 and 2 Hazardous (Classified) Locations*.

Oil Immersion.

Electrical equipment immersed in a protective liquid in such a way that an explosive atmosphere that may be above the liquid or outside the enclosure cannot be ignited.

Optical Radiation.

Electromagnetic radiation at wavelengths in vacuum between the region of transition to X-rays and the region of transition to radio waves, that is approximately between 1 nm and 1000 μm.

> Informational Note: For additional information on types of protection that can be applied to minimize the risk of ignition in explosive atmospheres from optical radiation in the wavelength range from 380 nm to 10 μm, see ANSI/UL 60079-28-2017, *Explosive Atmospheres — Part 28: Protection of Equipment and Transmission Systems Using Optical Radiation*.

Optical System With Interlock "op sh".

Type of protection to minimize the risk of ignition in explosive atmospheres from optical radiation where visible or infrared radiation is confined inside optical fiber or other transmission medium with interlock cut-off provided to reliably reduce the unconfined beam strength to safe levels within a specified time in case the confinement fails and the radiation becomes unconfined.

> Informational Note: See ANSI/UL 60079-28-2017, *Explosive Atmospheres — Part 28: Protection of Equipment and Transmission Systems Using Optical Radiation*.

Outdoor Spray Area.

A spray area that is outside the confines of a building or that has a canopy or roof that does not limit the dissipation of the heat of a fire or dispersion of flammable vapors and does not restrict fire-fighting access and control. For the purpose of this standard, an outdoor spray area can be treated as an unenclosed spray area. [**33:**3.3.2.3.1]

Portable Equipment.

Equipment with electrical components suitable to be moved by a single person without mechanical aids.

Powder Filling "q".

Type of protection where electrical parts capable of igniting an explosive atmosphere are fixed in position and completely surrounded by filling material (glass or quartz powder) to prevent the ignition of an external explosive atmosphere.

> Informational Note: See ANSI/UL 60079-5-2016, *Explosive Atmospheres — Part 5: Equipment protection by powder filling "q".*

Pressurized.

The process of supplying an enclosure with a protective gas with or without continuous flow, at sufficient pressure to prevent the entrance of combustible dust or ignitible fibers/flyings.

Pressurized Enclosure "p".

Type of protection for electrical equipment that uses the technique of guarding against the ingress of the external atmosphere, which may be explosive, into an enclosure by maintaining a protective gas therein at a pressure above that of the external atmosphere.

> Informational Note: See ANSI/UL-60079-2-2017, *Explosive Atmospheres — Part 2: Equipment protection by pressurized enclosures "p".*

Process Seal.

A seal between electrical systems and flammable or combustible process fluids where a failure could allow the migration of process fluids into the premises' wiring system.

Protected Optical Fiber Cable.

Optical fiber cable protected from releasing optical radiation into the atmosphere during normal operating conditions and foreseeable malfunctions by additional armoring, conduit, cable tray, or raceway.

> Informational Note: See ANSI/UL 60079-28-2017, *Explosive Atmospheres — Part 28: Protection of Equipment and Transmission Systems Using Optical Radiation*.

Protected Optical Radiation "op pr".

Type of protection to minimize the risk of ignition in explosive atmospheres from optical radiation where visible or infrared radiation is confined inside optical fiber or other transmission medium under normal constructions or constructions with additional mechanical protection based on the assumption that there is no escape of radiation from the confinement.

> Informational Note: See ANSI/UL 60079-28-2017, *Explosive Atmospheres — Part 28: Protection of Equipment and Transmission Systems Using Optical Radiation*.

Protection by Enclosure "t".

Type of protection for explosive dust atmospheres where electrical equipment is provided with an enclosure providing dust ingress protection and a means to limit surface temperatures.

> Informational Note: For additional information, see ANSI/UL 60079-31-2015, *Explosive Atmospheres — Part 31: Equipment Dust Ignition Protection by Enclosure "t".*

Purged and Pressurized.

The process of (1) purging, supplying an enclosure with a protective gas at a sufficient flow and positive pressure to reduce the concentration of any flammable gas or vapor initially present to an acceptable level; and (2) pressurization, supplying an enclosure with a protective gas with or without continuous flow at sufficient pressure to prevent the entrance of a flammable gas or vapor, a combustible dust, or an ignitible fiber.

> Informational Note: For further information, see ANSI/NFPA 496-2013, *Purged and Pressurized Enclosures for Electrical Equipment*.

Simple Apparatus.

An electrical component or combination of components of simple construction with well-defined electrical parameters that does not generate more than 1.5 volts, 100 mA, and 25 mW, or a passive component that does not dissipate more than 1.3 watts and is compatible with the intrinsic safety of the circuit in which it is used.

Informational Note No. 1: The following apparatus are examples of simple apparatus:

(1) Passive components; for example, switches, instrument connectors, plugs and sockets, junction boxes, resistance temperature devices, and simple semiconductor devices such as LEDs

(2) Sources of stored energy consisting of single components in simple circuits with well-defined parameters; for example, capacitors or inductors, whose values are considered when determining the overall safety of the system

(3) Sources of generated energy; for example, thermocouples and photocells, that do not generate more than 1.5 volts, 100 mA, and 25 mW

Informational Note No. 2: For further information, refer to ANSI/UL 913-2013, *Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, III, Division 1, Hazardous (Classified) Locations*; and ANSI/UL 60079-11-2013, *Explosive Atmospheres — Part 11: Equipment Protection by Intrinsic Safety "i."*

Spray Area.

Any fully enclosed, partly enclosed, or unenclosed area in which dangerous quantities of flammable or combustible vapors, mists, residues, dusts, or deposits are present due to the operation of spray processes, including (1) any area in the direct path of a spray application process; (2) the interior of a spray booth, spray room, or limited finishing workstation, as herein defined; (3) the interior of any exhaust plenum, eliminator section, or scrubber section; (4) the interior of any exhaust duct or exhaust stack leading from a spray application process; (5) the interior of any air recirculation path up to and including recirculation particulate filters; (6) any solvent concentrator (pollution abatement) unit or solvent recovery (distillation) unit; and (7) the inside of a membrane enclosure. The following are not part of the spray area: (1) fresh air make-up units; (2) air supply ducts and air supply plenums; (3) recirculation air supply ducts downstream of recirculation particulate filters; and (4) exhaust ducts from solvent concentrator (pollution abatement) units. [**33:**3.3.2.3]

Informational Note: Unenclosed spray areas are locations outside of buildings or are localized operations within a larger room or space. Such are normally provided with some local vapor extraction/ventilation system. In automated operations, the area limits are the maximum area in the direct path of spray operations. In manual operations, the area limits are the maximum area of spray when aimed at 90 degrees to the application surface.

Spray Booth.

A power-ventilated enclosure for a spray application operation or process that confines and limits the escape of the material being sprayed, including vapors, mists, dusts, and residues that are produced by the spraying operation and conducts or directs these materials to an exhaust system. [**33:**3.3.15]

Informational Note: A spray booth is an enclosure or insert within a larger room used for spray/coating/dipping applications. A spray booth can be fully enclosed or have open front or face and can include separate conveyor entrance and exit. The spray booth is provided with a dedicated ventilation exhaust with supply air from the larger room or from a dedicated air supply.

Spray Room.

A power-ventilated fully enclosed room used exclusively for open spraying of flammable or combustible materials. [**33:**3.3.16]

Type of Protection "n".

Type of protection where electrical equipment, in normal operation, is not capable of igniting a surrounding explosive gas atmosphere and a fault capable of causing ignition is not likely to occur.

Informational Note: See ANSI/UL 60079-15-2013, *Explosive Atmospheres — Part 15: Equipment Protection by Type of Protection "n".*

Unclassified Locations.

Locations determined to be neither Class I, Division 1; Class I, Division 2; Zone 0; Zone 1; Zone 2; Class II, Division 1; Class II, Division 2; Class III, Division 1; Class III, Division 2; Zone 20; Zone 21; Zone 22; nor any combination thereof.

Unenclosed Spray Area.

Any spray area that is not confined by a limited finishing workstation, spray booth, or spray room, as herein defined. [**33:**3.3.2.3.2]

Ventilated.

Provided with a means to permit circulation of air sufficient to remove an excess of heat, fumes, or vapors.

Volatile Flammable Liquid.

A flammable liquid having a flash point below 38°C (100°F), or a flammable liquid whose temperature is above its flash point, or a Class II combustible liquid that has a vapor pressure not exceeding 276 kPa (40 psia) at 38°C (100°F) and whose temperature is above its flash point.

Statement of Problem and Substantiation for Public Input

Unlike a normal branch circuit that originates at the terminals of the last overcurrent device, a motor branch circuit includes the controller, such as a motor starter (contactor with thermal overloads), or a separately derived system such as an adjustable speed drive. In the case of a variable frequency drive, the drive has circuit protection components which a regular branch circuit does not have.

This is a companion proposal to one that revises the term "controller" in 430.2

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 2121-NFPA 70-2020 [Definition: Controller.]	Motor branch circuits

Submitter Information Verification

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Committee:	NEC-P11

Public Input No. 2450-NFPA 70-2020 [New Definition after Definition: Branch Circuit, Individual.]

Branch Circuit, Motor.

The circuit conductors, including equipment such as a motor controller, with or without an overload device, between the motor branch-circuit short-circuit ground-fault protective device, or motor overload and fault-current protection relay that supplies energy to an individual motor.

Statement of Problem and Substantiation for Public Input

The term "motor branch circuit" is used throughout the NEC, especially in Art. 430, yet it is not defined. As a member of CMP 11 for the 2020 cycle, it was brought to light that a controller (motor starter or ASD), is considered to be part of the motor branch circuit per ANSI product standards. There is a difference between an individual branch circuit and a motor branch circuit as it includes the motor controller. The motor controller may be a simple snap switch or an adjustable speed drive.

In addition, it is a common misconception that motor branch circuits are "motor feeders" probably due to years of incorrect use of the term in the industry. Adding this term to the definitions would clarify that 1) a motor starter or ASD is part of the motor branch circuit even though in the case of an ASD it is actually a separately derived system and, 2) clarify for users of the Code that there is a distinct difference between a motor "feeder" and a motor "branch circuit".

This is a companion proposal to a proposed revision of the definition for "controller".

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 2123-NFPA 70-2020 [Section No. 430.1]	Addition of a motor branch circuit to the Diagram.
Public Input No. 2118-NFPA 70-2020 [Section No. 430.224]	Addition of requirements for motor branch circuits and feeders

Submitter Information Verification

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Submittal Date: Sat Aug 22 23:35:20 EDT 2020
Committee: NEC-P11

Public Input No. 3297-NFPA 70-2020 [Section No. 409.1]

409.1 Scope.

This article covers industrial control panels intended for general use and operating at 1000 volts or less.

Informational Note 1 : ANSI/UL 508A, *Standard for Industrial Control Panels*, is a safety standard for industrial control panels.

Informational Note 2: See IEEE 3001.11 Recommended Practice for Application of Controllers and Automation to Industrial and Commercial Power Systems

Statement of Problem and Substantiation for Public Input

This is another slice of updated content from the legacy "Red Book" IEEE 141 and "Gray Book: IEEE 241 into the new IEEE 3000 Standards Collection. From the project prospectus:

"The selection and application of controllers and automation to industrial and commercial power systems is covered by this recommended practice. It is likely to be of greatest value to the power-oriented engineer with limited experience with this equipment. It can also be an aid to all engineers responsible for the electrical design of industrial and commercial power systems."

https://standards.ieee.org/standard/3001_11-2017.html

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Committee:	NEC-P11

Public Input No. 4215-NFPA 70-2020 [Section No. 409.3]

409.3 Other Articles.

In addition to the requirements of ~~Article 409~~ this article , industrial control panels that contain branch circuits for specific loads or components, or are for control of specific types of equipment addressed in other articles of this *Code*, shall be constructed and installed in accordance with the applicable requirements from the specific articles in Table 409.3.

Table 409.3 Other Articles

Equipment/Occupancy	Article	Section
Branch circuits	210	-
Luminaires	410	-
Motors, motor circuits, and controllers	430	-
Air-conditioning and refrigerating equipment	440	-
Capacitors	-	460.8, 460.9
Hazardous (classified) locations	500, 501, 502, 503, 504, 505	-
Commercial garages; aircraft hangars; motor fuel dispensing facilities; bulk storage plants; spray application, dipping, and coating processes; and inhalation anesthetizing locations	511, 513, 514, 515, 516, and 517 Part IV	-
Cranes and hoists	610	-
Electrically driven or controlled irrigation machines	675	-
Elevators, dumbwaiters, escalators, moving walks, wheelchair lifts, and stairway chair lifts	620	-
Industrial machinery	670	-
Resistors and reactors	470	-
Transformers	450	-
Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits	725	-

Statement of Problem and Substantiation for Public Input

Section 4.1.4 of the 2020 NEC(r) Style Manual prohibits references to an entire article, other than Article 100. As such, it is recommended that we change the reference here to "this article" to comply with the Style Manual.

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Committee: NEC-P11

Public Input No. 4297-NFPA 70-2020 [Section No. 409.21(B)]

(B) Location.

This protection shall be provided for each incoming supply circuit ~~by either of the following: An overcurrent~~ by an overcurrent protective device located in a separate enclosure, located ahead of the industrial control panel. ~~A single main overcurrent protective device located within the industrial control panel. Where overcurrent protection is provided as part of the industrial control panel, the supply conductors shall~~ The supply conductors to the seperate enclosure shall be considered as either feeders or taps as covered by 240.21 .

Statement of Problem and Substantiation for Public Input

Worker safety can be improved by locating the overcurrent protection and disconnecting means outside of the industrial control panel. Once the external disconnecting means is turned off, and an electrically safe work condition is attained, the chances of contacting an energized part within the industrial control panel are greatly reduced. This reduces the chances of both shock and arc-flash.

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Committee: NEC-P11

Public Input No. 1114-NFPA 70-2020 [New Section after 409.22(B)]

TITLE OF NEW CONTENT 409.26 Coarse Thread Screws.

Type your content here ...

Coarse thread screws shall not enter industrial control panel enclosures.

Statement of Problem and Substantiation for Public Input

Whether coarse thread screws are added before or after conductors or electrical components are installed or added to an existing installation, they are a recipe for disaster. Coarse thread screws are very convenient and are used this way and should be a violation. The closest the NEC comes to addressing this is 314.23(B)(1) which doesn't provide the same message as this public input.

The way the new entry is worded allows coarse thread screws to exit enclosures. For instance an electrical component could be mounted in an industrial control panel with coarse thread self-tapper screws zipped from the inside to the outside of the enclosure.

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Committee: NEC-P11

Public Input No. 3386-NFPA 70-2020 [New Section after 409.60]

409.70 Surge Protection

Industrial Control Panels with safety circuits shall have surge protection installed in accordance with Part II of Article 242.

Additional Proposed Changes

File Name	Description	Approved
Surge_Protection_Details.pdf	Surge Protection Information	

Statement of Problem and Substantiation for Public Input

The study, "Data Assessment for Electrical Surge Protective Devices" commissioned by the Fire Protection Research Foundation, 1 Batterymarch Park, Quincy, MA 02169-7471, provides results of a 2013 and 2014 survey of facility managers concerning surge damage. It shows that 26% had damage to safety interlocking systems on machines due to surges. These safety-interlocking systems are in place to protect workers from interactions with the machinery. There were 50% of the respondents had issues related to surge damage in other areas where industrial control panels may be used for Security, Fire, and other systems. Injuries were stated in 11% of the responses. This report lead to a number of proposals that were rejected at the time, but many have been accepted since as the continued voltage surge damages

"Surge Protection More than Accessory" Survey & report conducted by the Electrical Safety Foundation, Inc. (EFSI) in December 2017 provided the following information for industrial facilities. There is additional data found in the full report that expands on these results.

- Industrial facilities experienced voltage surges significant enough to cause equipment damage:
  - 23.6% Daily
  - 29.1% Weekly
  - 23.6% Monthly
  - 20.9% Annually
  - 2.7% Less than once a year
- Industrial facilities experience voltage surges significant enough to cause injury or death:
  - 17.3% Daily
  - 18.2% Weekly
  - 12.7% Monthly
  - 27.3% Annually
  - 24.5% Less than once a year
- What causes surge protection to be installed in a specific building?
  - Surge protection required by code 28.9%
  - Customer Specified Surge Protection 25.7%
  - Protect expensive equipment from damage 28.9%
  - Reduced downtime 16.2%
  - Other 0.2%
- Conditions that lead to voltage surges:
  - Faulty/damaged wiring 24.4%
  - Electrical equipment turning on/off 16.1%
  - Magnetic coupling 11.9%
  - Lightning strike 21.5%
  - Static electricity discharge 15.0%
  - Grid anomalies 11.9%

The conditions list shows that 40% of the conditions which cause surges within an Industrial facility occur within the facility.

"safety circuits" are used in this PI in order to coordinate with the proposed definition in the NEMA Public Input for 670.2.

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Public Input No. 1357-NFPA 70-2020 [Section No. 409.60]

409.60 Equipment Grounding Conductor .

Multisection industrial control panels shall be bonded together with an equipment grounding conductor or an equivalent equipment grounding bus sized in accordance with Table 250.122. Equipment grounding conductors shall be connected to this equipment grounding bus or to an equipment grounding termination point provided in a single-section industrial control panel.

Statement of Problem and Substantiation for Public Input

According to the NFPA Style Manual, the Section Title needs to reflect the content of the rule. The rule is about the equipment grounding conductor, not about 'Grounding.'

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Committee: NEC-P11

Public Input No. 4622-NFPA 70-2020 [Section No. 409.102]

409.102 Busbars~~ and Conductors.~~

Industrial control panels utilizing busbars shall comply with 409.102(A) and (B).

(A) Support and Arrangement.

Busbars shall be protected from physical damage and be held firmly in place.

(B) Phase Arrangement.

The phase arrangement on 3-phase horizontal common power and vertical buses shall be A, B, C from front to back, top to bottom, or left to right, as viewed from the front of the industrial control panel. The B phase shall be that phase having the higher voltage to ground on 3-phase, 4-wire, delta-connected systems. Other busbar arrangements shall be permitted for additions to existing installations, and the phases shall be permanently marked.

Statement of Problem and Substantiation for Public Input

The title of the section can be shortened to just "Busbars" since busbars are the only thing addressed. There are no requirements for other conductors in this section. This will provide clarity to this section.

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Committee:	NEC-P11

Public Input No. 3934-NFPA 70-2020 [New Section after 409.110]

Absence of Voltage Test & Indication

A means shall be provided to verify the absence of voltage in accordance with an acceptable industry practice that does not expose personnel to shock or arc flash hazards or live parts at the test point for the disconnecting means for any voltage supplies or stored energy sources that present a shock or arc flash hazard up to and including 10000 V that are likely to require examination, adjustment, servicing, or maintenance.

Informational Note: NFPA 70E-2021 Standard for Electrical Safety in the Workplace provides guidance for safely verifying the absence of voltage including the use of devices like a permanently mounted absence of voltage tester.

Statement of Problem and Substantiation for Public Input

Testing for absence of voltage is an important step that helps increase safety by detecting several conditions that could lead to an electrical incident:

- Power remains on if the wrong disconnecting means is utilized or the source is mislabeled (see examples from OSHA Summaries)
- Presence of stored electrical energy from a capacitor, present after the disconnect is opened and locked out (see examples from OSHA Summaries)
- Power remains present when the disconnect handle is in the off position if the disconnect experiences a mechanical failure (see Recall Notices below)

An easily accessible means to test for and visually convey the status of presence and absence of voltage that is part of the equipment installation at the point of work before accessing industrial control panels would prevent this type of incident (several examples are included below) and further the purpose of the code in practical safeguarding of persons and property by leveraging safety by design principles. Absence of Voltage Testers (AVT) listed to UL 1436 are permanently mounted testers that visually indicate when all voltages are less than 3 V (ac and dc) at the test point. This test is initiated before doors and covers are removed preventing accidental contact with energized parts. AVTs listed to UL 1436 have been recognized as an acceptable method to test for the absence of voltage in NFPA 70E since 2018 (120.5 (7) Exception 1).

Permanently mounted AVTs installed on or near the equipment increase the likelihood that the test for absence of voltage test occurs before the equipment is accessed when compared to portable voltage test instruments. Additionally, AVTs often have a feature to visually indicate when ac or dc voltage that would cause a shock hazard is present. In each of the incidents described below, the voltage presence indicators (for AC and DC) would have provided a visual warning that voltage was still present.

OSHA Fatality and Catastrophe Investigation Summaries
A keyword search of the OSHA Fatality and Catastrophe Investigation Summaries (https://www.osha.gov/pls/imis/accidentsearch.html) reveals several incidents resulting in severe injury or death that are attributed to failure to test for absence of voltage after de-energizing the disconnecting means. Some examples:

1. Report ID: 0728900

Employee #1 was on the roof of a customer's building, changing filters for the customer's air conditioning units. The employee had shut off the unit, but he did not lock out the unit or check its power supply for stored energy. As he reached into the unit, he came into contact with a capacitor charged to 280 volts and received an electric shock.

2. Report ID: 0420600

An employee turned off the known energy source to an air conditioning and heat unit at the panel box in a private residence. He pulled the disconnect switch in a box adjacent to the fan or blower assembly in the attic and was attempting to remove the air handler inside the blower housing. The heavy gold chain that the employee was wearing around his neck came in contact with or came in close proximity to a 10 microfarad, mfd, capacitor which can store 370 or more volts of alternating current. The chain burned an arc in his neck and carried sufficient current to his heart via the vascular tract to cause his death.

3. Report ID: 0316300

Employee #1 and his helper were installing a fan on a HVAC chiller unit. Employee asked his helper to open the circuit breaker to deenergize the unit, but Employee #1 never tested the fan circuit to ensure it was deenergized. Employee #1's helper opened the wrong breaker and when Employee #1 touched the conductors for the fan, he was electrocuted.

4. Report ID: 0452110

Employee #1 turned off breaker #22 in a panel box so that he could make a connection in a junction box. He was using a wire stripper to cut into the insulation around a conductor when he was electrocuted. The breakers in the panel box were not labeled, and breaker #22 did not control the current in the circuit on which Employee #1 was preparing to work. He also did not use a voltmeter or another type of instrument to test the circuit and confirm that the power was off.

5. Report ID 0522300

Employee #1 was working on an HVAC air handling unit that had not been cooling adequately. The "lockout" procedure did not include de-energization at the power supply or application of locks. Therefore, although the unit was shut off, it was still energized. Employee #1 was killed.

6. Report ID 0950632

Employee #1, an electrician, was wiring an electrical room to test for continuity at a construction site. Employee #1 and two coworkers, Coworker #1 and Coworker #2, were testing the continuity at the main panel outside. Coworker #1 went inside the building and had the tester inside the electrical room. Employee #1 and Coworker #2 went outside and opened up the main panel. Coworker #2 had a walkie-talkie and was standing behind Employee #1, relaying instructions from Coworker #1. Employee #1 thought that the power was down, and he did not check it prior to working on the panel. Employee #1 connected a length of wire from a grounded location on the frame to a connector that was hot, and there was an immediate flash arc. Employee #1 sustained second degree burns to his right arm, hand, and fingers, with a small area of third degree burns on his wrist. Employee #1 was transported to UCSD Burn Center, where he was hospitalized for eight days. The worksite where the accident occurred was a construction site where an existing building was undergoing remodeling into a medical facility.

7. Report ID 0213600

Employee #1, employed by an electrical contractor, was working at a building jobsite. He was testing wires with a voltage meter to verify voltage. Employee #1 hit a live wire with his hand and sustained an electrical shock. Emergency services were called, and Employee #1 was transported to the hospital. He was admitted and treated for a thermal burn to his index finger. Subsequent investigation determined that Employee #1 was not wearing gloves when he came into contact with the bare electrical wire.

Disconnect Recall Notices

Several brands of disconnects that are commonly used in industrial and commercial applications have experienced recalls due to defects that allow power to remain present when the disconnect handle is in the off position, posing a shock hazard. This failure mode is an example of why testing for absence of voltage is critical in all applications.

Recalls (https://www.cpsc.gov/Recalls)

1. Example 1

Company A recalled more than a million safety switches manufactured between January 1, 2014 and January 18, 2018 because the power can stay on when the safety switch handle is in the off position, posing an electric shock or electrocution hazard. The switches may be installed in or around commercial buildings, outbuildings, apartments and homes with air conditioning units.

2. Example 2

Company B issued a safety recall of 26 models of safety switches that may not disconnect power when the handle is in the “off” position. The affected devices cover certain models of 30A and 60A heavy-duty safety switches manufactured between Nov. 19, 2015, and Jan. 23, 2018.

3. Example 3

Company C recalled 19,000 toggle and rotary switches. When switched OFF, one electrical pole may remain energized, posing a risk of electrical shock hazard. The switches are typically used with HVAC units, electric distribution and control panels and industrial uses. Primarily the switches are used commercially, however they may also be found in residential applications.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 3835-NFPA 70-2020 [New Section after 110.25]	
Public Input No. 3908-NFPA 70-2020 [New Part after I.]	

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Committee:	NEC-P11

Public Input No. 2347-NFPA 70-2020 [Section No. 409.110]

409.110 Marking.

An industrial control panel shall be marked with the following information that is plainly visible after installation:

(1) Manufacturer's name, trademark, or other descriptive marking by which the organization responsible for the product can be identified.

(2) Supply voltage, number of phases, frequency, and ~~full-load current~~ designed current capacity for each incoming supply circuit.

(3) Industrial control panels supplied by more than one electrical source where more than one disconnecting means is required to disconnect all circuits 50-volts or more within the control panel shall be marked to indicate that more than one disconnecting means is required to de-energize the equipment. The location of the means necessary to disconnect all circuits 50-volts or more shall be documented and available.

(4) Short-circuit current rating of the industrial control panel based on one of the following:

(5) Short-circuit current rating of a listed and labeled assembly

(6) Short-circuit current rating established utilizing an approved method

Informational Note: ANSI/UL 508A, *Standard for Industrial Control Panels*, Supplement SB, is an example of an approved method.

Exception to (4): Short-circuit current rating markings are not required for industrial control panels containing only control circuit components.

(7) If the industrial control panel is intended as service equipment, it shall be marked to identify it as being suitable for use as service equipment.

(8) Electrical wiring diagram or the identification number of a separate electrical wiring diagram or a designation referenced in a separate wiring diagram.

(9) An enclosure type number shall be marked on the industrial control panel enclosure.

Statement of Problem and Substantiation for Public Input

The term "full-load current" for an incoming source supply circuit would or could vary with time and may warrant being accompanied by a calculation date if this is the intent of code. Because there are multiple power sources (aka supply circuits) referenced, it would appear that the intent is to include criterion for each separate circuit. If code intent is to denote the design intent for current capacity, then perhaps a different choice of terminology is warranted so as not to be confused with industry accepted definitions for full-load current. Or, if the intent is to list a singular full-load current for the industrial panel and label this value onto each supply circuit, the verbiage appears to warrant clarification to this purpose.

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Committee: NEC-P11

Public Input No. 2390-NFPA 70-2020 [Section No. 409.110]

409.110 Marking.

An industrial control panel shall be marked with ~~the following information~~ a permanent nameplate attached to the outside of the enclosure that is ~~plainly~~ visible after installation. The nameplate shall include the following information :

(1) Manufacturer's name, trademark, or other descriptive marking by which the organization responsible for the product can be identified.

(2) Supply voltage, number of phases, frequency, and full-load current for each incoming supply circuit.

(3) Industrial control panels supplied by more than one electrical source where more than one disconnecting means is required to disconnect all circuits 50-volts or more within the control panel shall be marked to indicate that more than one disconnecting means is required to de-energize the equipment. The location of the means necessary to disconnect all circuits 50-volts or more shall be documented and available.

(4) Short-circuit current rating of the industrial control panel based on one of the following:

  (5) Short-circuit current rating of a listed and labeled assembly

  (6) Short-circuit current rating established utilizing an approved method

Informational Note: ANSI/UL 508A, *Standard for Industrial Control Panels*, Supplement SB, is an example of an approved method.

Exception to (4): Short-circuit current rating markings are not required for industrial control panels containing only control circuit components.

(7) If the industrial control panel is intended as service equipment, it shall be marked to identify it as being suitable for use as service equipment.

(8) Electrical wiring diagram or the identification number of a separate electrical wiring diagram or a designation referenced in a separate wiring diagram.

(9) An enclosure type number shall be marked on the industrial control panel enclosure.

Statement of Problem and Substantiation for Public Input

The term “plainly visible” is not defined and creates confusion as to the location of the nameplate marking. Industrial machinery is required to have this marking located on the outside of the control equipment enclosure or on the machine immediately adjacent to the enclosure per NFPA 79 16.4.1. There is no reason why industrial control panels should require the nameplate marking location to be different than industrial machinery, since it contains critical application information. Additionally, this will support ease of inspection for the critical safety related equipment ratings, such as short-circuit current ratings.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 2394-NFPA 70-2020 [Section No. 670.3(A)]	

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Committee:	NEC-P11

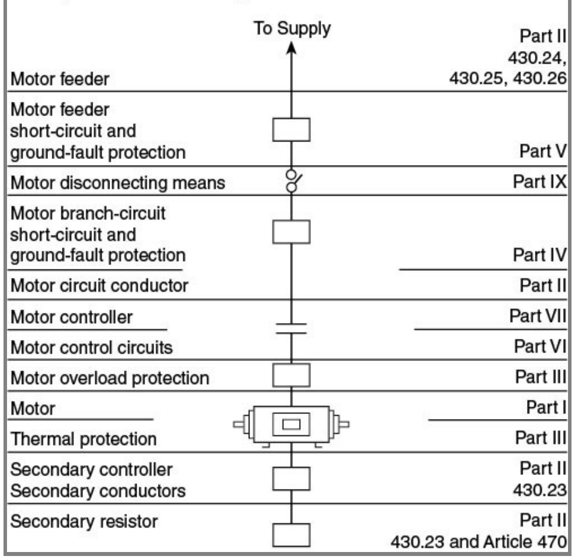
Public Input No. 167-NFPA 70-2019 [Section No. 430.1]

430.1 Scope.

This article covers motors, motor branch-circuit and feeder conductors and their protection, motor overload protection, motor control circuits, motor controllers, and motor control centers.

Figure 430.1 Article 430 Contents.

General, 430.1 through 430.18	Part I
Motor Circuit Conductors, 430.21 through 430.29	Part II
Motor and Branch-Circuit Overload Protection, 430.31 through 430.44	Part III
Motor Branch-Circuit Short-Circuit and Ground-Fault Protection, 430.51 through 430.58	Part IV
Motor Feeder Short-Circuit and Ground-Fault Protection, 430.61 through 430.63	Part V
Motor Control Circuits, 430.71 through 430.75	Part VI
Motor Controllers, 430.81 through 430.90	Part VII
Motor Control Centers, 430.92 through 430.99	Part VIII
Disconnecting Means, 430.101 through 430.113	Part IX
Adjustable-Speed Drive Systems, 430.120 through 430.131	Part X
Over 1000 Volts, Nominal, 430.221 through 430.227	Part XI
Protection of Live Parts—All Voltages, 430.231 through 430.233	Part XII
Grounding—All Voltages, 430.241 through 430.246	Part XIII
Tables, Tables 430.247 through 430.252	Part XIV



Informational Note No. 1: Installation requirements for motor control centers are covered in 110.26(E). Air-conditioning and refrigerating equipment are covered in Article 440.

Informational Note No. 2: Figure 430.1 is for information only.

Statement of Problem and Substantiation for Public Input

In 'Figure 430.1' there is essentially a 1-line diagram for a motor circuit. This diagram should say "From Supply" with the 'arrow' pointing toward the End Use Equipment. Everywhere else in the NEC the source of a circuit is the OCPD or separately derived system. In a logic diagram you go 'FROM the Supply Source' out 'TO End use equipment and devices'. In this case, the end use equipment happens to be a MOTOR, not a circuit originating from the motor.

Submitter Information Verification

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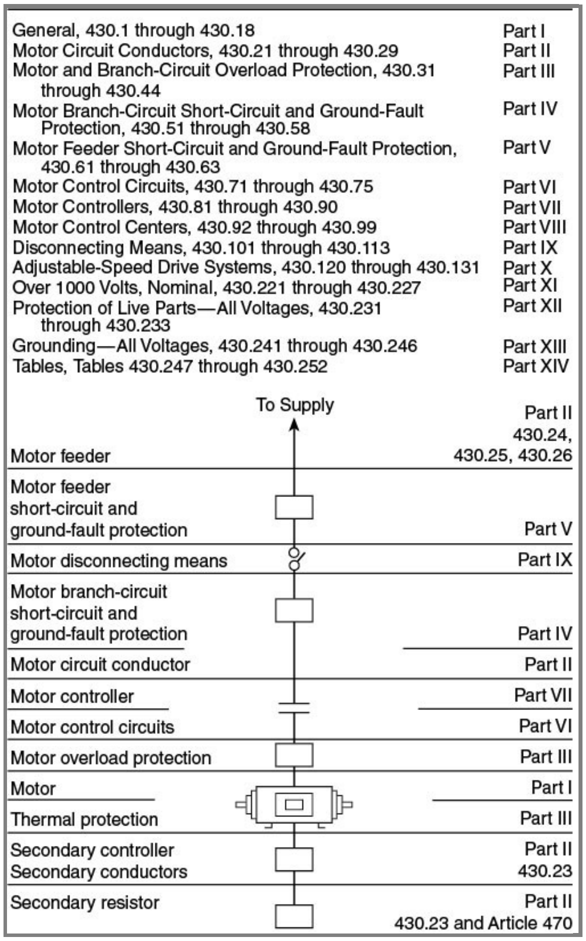
Public Input No. 2123-NFPA 70-2020 [Section No. 430.1]

430.1 Scope.

This article covers motors, motor branch-circuit and feeder conductors and their protection, motor overload protection, motor control circuits, motor controllers, and motor control centers.

~~**Figure 430.1 Article 430 Contents.**~~



<u>Delete existing Figure 430.1 and insert revised Figure 430.1 here. (see attached PDF file)</u>

Informational Note No. 1: Installation requirements for motor control centers are covered in 110.26(E). Air-conditioning and refrigerating equipment are covered in Article 440.

Informational Note No. 2: Figure 430.1 is for information only.

Additional Proposed Changes

File Name	Description	Approved
2023_NEC_Public_Input_Guidry_Paul_Fig._430.1.pdf	Figure 430.1	

Statement of Problem and Substantiation for Public Input

Existing Figure 430.1 single line diagram has several issues that are corrected with the proposed diagram.

1. It doesn't include applicable references for motors more than 1000 Volts

2. The motor disconnecting means is in the wrong place in the circuit
3. Revised motor circuit conductors to motor branch circuit conductors
4. Added reference for motor grounding to diagram

Remainder of Figure 430.1 to remain the same

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 2120-NFPA 70-2020 [Article 100]	Definition for motor branch circuit
Public Input No. 2450-NFPA 70-2020 [New Definition after Definition: Branch Circuit, Individual.]	

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Committee:	NEC-P11

General, 430.1 through 430.18	Part I
Motor Circuit Conductors, 430.21 through 430.29	Part II
Motor and Branch-Circuit Overload Protection, 430.31 through 430.44	Part III
Motor Branch-Circuit Short-Circuit and Ground-Fault Protection, 430.51 through 430.58	Part IV
Motor Feeder Short-Circuit and Ground-Fault Protection, 430.61 through 430.63	Part V
Motor Control Circuits, 430.71 through 430.75	Part VI
Motor Controllers, 430.81 through 430.90	Part VII
Motor Control Centers, 430.92 through 430.99	Part VIII
Disconnecting Means 430.101 through 430.113	Part IX
Adjustable-Speed Drive Systems, 430.120 through 430.131	Part X
Over 1000 Volts, Nominal, 432.221 through 430.227	Part XI
Protection of Live Parts - All Voltages, 430.231 through 430.233	Part XII
Grounding - All Voltages, 430.241 through 430.246	Part XIII
Tables, Tables 430.247 through 430.252	Part XIV

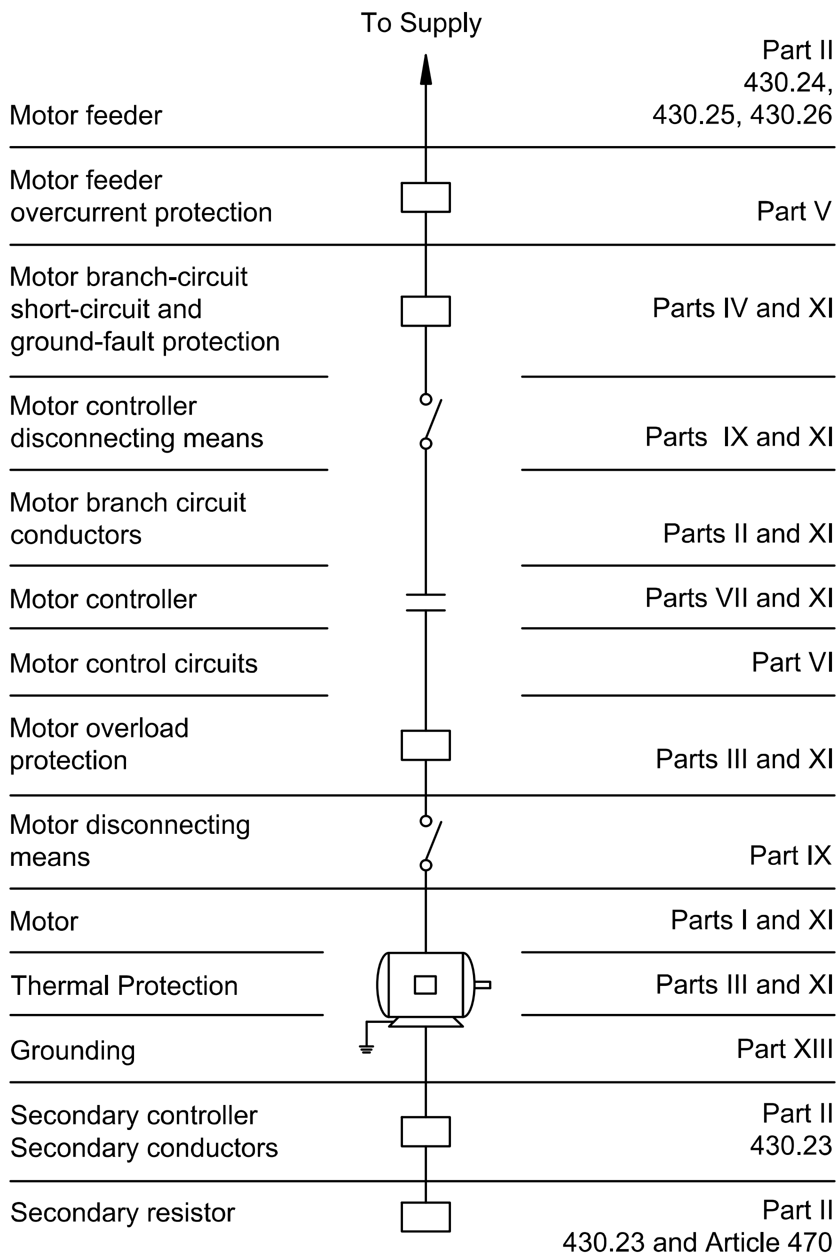


FIGURE 430.1 Article 430 Contents for Motors

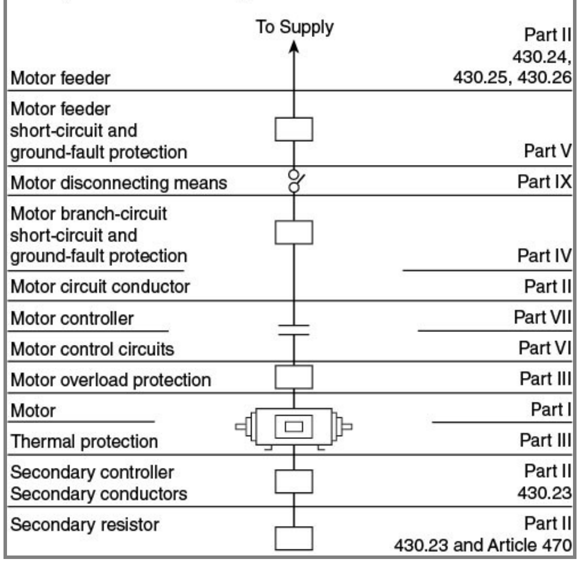
Public Input No. 3146-NFPA 70-2020 [Section No. 430.1]

430.1 Scope.

This article covers motors, motor branch-circuit and feeder conductors and their protection, motor overload protection, motor control circuits, motor controllers, and motor control centers.

Figure 430.1 Article 430 Contents.

General, 430.1 through 430.18	Part I
Motor Circuit Conductors, 430.21 through 430.29	Part II
Motor and Branch-Circuit Overload Protection, 430.31 through 430.44	Part III
Motor Branch-Circuit Short-Circuit and Ground-Fault Protection, 430.51 through 430.58	Part IV
Motor Feeder Short-Circuit and Ground-Fault Protection, 430.61 through 430.63	Part V
Motor Control Circuits, 430.71 through 430.75	Part VI
Motor Controllers, 430.81 through 430.90	Part VII
Motor Control Centers, 430.92 through 430.99	Part VIII
Disconnecting Means, 430.101 through 430.113	Part IX
Adjustable-Speed Drive Systems, 430.120 through 430.131	Part X
Over 1000 Volts, Nominal, 430.221 through 430.227	Part XI
Protection of Live Parts—All Voltages, 430.231 through 430.233	Part XII
Grounding—All Voltages, 430.241 through 430.246	Part XIII
Tables, Tables 430.247 through 430.252	Part XIV



Informational Note No. 1: Installation requirements for motor control centers are covered in 110.26(E). Air-conditioning and refrigerating equipment are covered in Article 440.

Informational Note No. 2: Figure 430.1 is for information only.

Informational Note No. 3: Additional guidance on motor supply circuits may be found in IEEE 3004.8-2016 - Recommended Practice for Motor Protection in Industrial and Commercial Power Systems

Statement of Problem and Substantiation for Public Input

This is another slice of updated content from the legacy "Red Book" IEEE 141 mapped into the new IEEE 3000 Standards Collection. From the project prospectus:

"The protection of motors used in industrial and commercial power systems is covered. It is likely to be of greatest value to the power-oriented engineer with limited experience in the area of protection and control. It can also be an aid to all engineers responsible for the electrical design of industrial and commercial power systems."

https://standards.ieee.org/standard/3004_8-2016.html

This content might also be appropriately located at the head of Part III Motor and Branch Circuit Overload Protection

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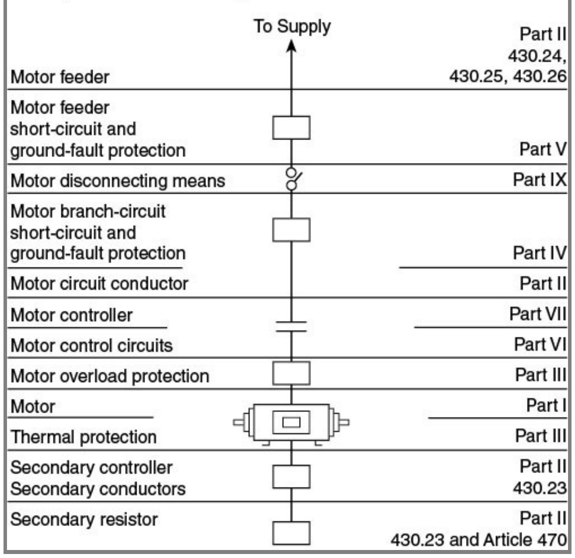
Public Input No. 3735-NFPA 70-2020 [Section No. 430.1]

430.1 Scope.

This article covers motors, motor branch-circuit and feeder conductors and their protection, motor overload protection, motor control circuits, motor controllers, and motor control centers.

Figure 430.1 Article 430 Contents.

General, 430.1 through 430.18	Part I
Motor Circuit Conductors, 430.21 through 430.29	Part II
Motor and Branch-Circuit Overload Protection, 430.31 through 430.44	Part III
Motor Branch-Circuit Short-Circuit and Ground-Fault Protection, 430.51 through 430.58	Part IV
Motor Feeder Short-Circuit and Ground-Fault Protection, 430.61 through 430.63	Part V
Motor Control Circuits, 430.71 through 430.75	Part VI
Motor Controllers, 430.81 through 430.90	Part VII
Motor Control Centers, 430.92 through 430.99	Part VIII
Disconnecting Means, 430.101 through 430.113	Part IX
Adjustable-Speed Drive Systems, 430.120 through 430.131	Part X
Over 1000 Volts, Nominal, 430.221 through 430.227	Part XI
Protection of Live Parts—All Voltages, 430.231 through 430.233	Part XII
Grounding—All Voltages, 430.241 through 430.246	Part XIII
Tables, Tables 430.247 through 430.252	Part XIV



Informational Note No. 1: Installation requirements for motor control centers are covered in 110.26(E). Air-conditioning and refrigerating equipment are covered in Article 440.

Informational Note No. 2: Figure 430.1 is for information only.

Statement of Problem and Substantiation for Public Input

This PI seeks to change the title of Article 430 to "Motors, Motor Circuits, and MOTOR Controllers." The capitalized text is my version of underlined text, because changing the title of Article 430 through Terraview would require selecting the entire article to add one word, which I assume the CMP would not appreciate. The reason for the PI is because the Code uses the term "controller" in both Article 100 and 430.2.

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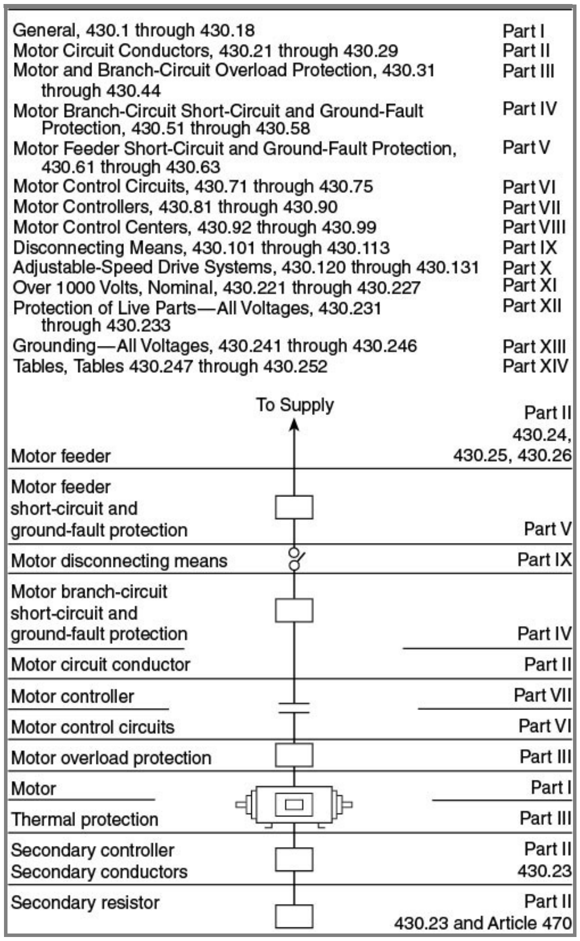
Public Input No. 4254-NFPA 70-2020 [Section No. 430.1]

430.1 Scope.

This article covers motors, motor branch-circuit and feeder conductors and their protection, motor overload protection, motor control circuits, motor controllers, and motor control centers.

Figure 430.1 Article 430 Contents.



Informational Note No. 1: See 110.26(E) for Installation requirements for motor control centers ~~are covered in 110.26(E)~~ .

Informational Note No. 2: See 440.1 for Air-conditioning and ~~refrigerating~~ Refrigerating equipment ~~are covered in Article~~ 440 .

Informational Note No. ~~2~~ 3 : Figure 430.1 is for information only.

Statement of Problem and Substantiation for Public Input

Section 4.1.4 of the 2020 NEC(R) Style Manual prohibits references to an entire article, with the exception of Article 100. As such, it is recommended to point to the Scope Statement of the other article as shown and separate the Informational Note #1 into two informational notes, since they are separate items. In addition, the informational notes were re-ordered to comply with Section 4.1.3 of the 2020 NEC(r) Style Manual.

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Committee:	NEC-P11

Public Input No. 2627-NFPA 70-2020 [New Section after 430.2]

TITLE OF NEW CONTENT

Type your content here ...

430.3 Reconditioning of Motors. The reconditioning and marking of motors shall be performed in accordance with instructions provided by a motor manufacturer and/or in accordance with a nationally recognized standard. Motors are reconditioned when they are rebuilt or serviced and then placed in commerce. Motors are not considered reconditioned when they are repaired or rewound and not placed in commerce.

Exception: Classified (Hazardous) Motors identified for use in Class I, Division 1 (or Zone 0 or 1) locations shall not be reconditioned. Classified Motors Class I, Division 1 (Zone 0 or 1) shall be permitted to repaired or rewound in accordance with instructions provided by a motor manufacturer and in accordance with a nationally recognized standard.

Informational Note: For information pertaining to the reconditioning, repair and rewinding of motors see ANSI/EASA AR100-2020, *Recommended Practice for the Repair of Rotating Electrical Apparatus.*

Statement of Problem and Substantiation for Public Input

It is a normal practice for motors to be repaired and rewound by established refurbishing companies in accordance to a nationally recognized standard (ANSI/EASA AR100). Reconditioned motors are necessary to keep facilities running without long downtimes. Reconditioned motors are also reconditioned by established refurbishing companies in accordance to the same nationally recognized standard (ANSI/EASA AR100). The nameplate information supplied on a motor is required to ensure the proper application and should not be removed unless the original ratings or characteristics are modified. This program has been successfully in place for many years.

It is not acceptable to recondition motors Classified for Class 1, Division 1, Zone 0 and Zone 1 locations.

The proposed language is similar to the language found in 408.8 and 490.49 for Switchgear.

Free download of ANSI/EASA AR100-2020, Recommended Practice for the Repair of Rotating Electrical Apparatus is available at the following link:
https://easa.com/DesktopModules/DnnSharp/SearchBoost/FileDownload.ashx?file=2125&sb-bhvr=1

This Public input was developed by EASA, ABB Inc., and Nidec Motors.

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Committee:	NEC-P11

Public Input No. 3213-NFPA 70-2020 [New Section after 430.2]

430.3 Reconditioned Motors. The reconditioning of motors shall be in accordance with instructions provided by a motor manufacturer. The motor nameplate shall not be required to be removed.

Reconditioned, rewound or repaired Classified (Hazardous) Motors identified for use in Class I, Division 1 (or Zone 0 or 1) locations shall be listed as reconditioned (or certified as reconditioned).

Rewound or repaired motors shall not be defined as reconditioned and any listing mark shall not be required to be removed or made permanently illegible.

Informational Note: For information pertaining to the rewinding and repair of motors see ANSI/EASA AR100-2015, Recommended Practice for the Repair of Rotating Electrical Apparatus.

Statement of Problem and Substantiation for Public Input

This public input is submitted on behalf of the task group formed in accordance with the direction of the NFPA Standards Council in Decision D#19-11. This task group was appointed to identify potential proposed changes to the 2020 edition of the NEC in the form of proposed Tentative Interim Amendments (TIAs) or to the 2023 edition of the NEC in the form of Public Inputs (PIs) that are within the Task Group's scope of activity as specified by the Standards Council.

These proposed Public Inputs relate to requirements covering the use of reconditioned electrical equipment throughout the NEC as a coordinated set of new or revised requirements. These Public Inputs should not be misconstrued by the CMPs as precluding equal consideration of other Public Inputs, with supporting information, submitted now or in the future by individuals.

The task group members are: G. Scott Harding (Chair), Tom Bishop, Casey Blevins, John Catlett, Dave Dagenais, James Dollard, Robert Fahey, Paul Grein, Howard Herndon, David Hittinger, Christel Hunter, Bob Jordan, David Kendall, Dave King, Jack Lyons, Ryan McClarnon, Robert Osborne, Chris Paxton, David Rosenfield, Michael Savage, Bill Schofield and Ron Widup. This task group of balanced interests provided the expertise to develop these public inputs. Multiple sub task groups were set up during the process with the results of the sub task group work shared with and voted on by the full task group.

Public Inputs are being submitted as follows:

- Revised to Article 100 definition of Reconditioned
- Revisions to Sections 110.21(A)(2), 240.88 and 210.15(3)
- New requirements/Sections 110.17, 110.20, 430.3 and 445.3

New Section 430.3

It is a normal practice for motors to be repaired and rewound by established service centers. Said repairs are accomplished in accordance with manufacturer's instructions and/or to the nationally recognized standard (ANSI/EASA AR100). Rewound or repaired motors are necessary to keep facilities running without long downtimes. The original nameplate information supplied on a motor is required to ensure the proper application and should not be removed unless the original ratings or characteristics are modified. This process for repairs has been successfully in place for many years.

Classified motors used in Class I, Division 1 (Zone 0 and Zone 1) locations are permitted to be reconditioned when recertified.

A free download of ANSI/EASA AR100-2015, Recommended Practice for the Repair of Rotating Electrical Apparatus is available to the public at the following link:
https://easa.com/Resources/Resource-library/ansieasa-standard-ar100-2015-recommended-practice-for-the-repair-of-rotating-electrical-apparatus-1

Note to NFPA Staff: ANSI/EASA AR100-2015 is the current edition of this standard. EASA is finalizing the

ANSI procedure for AR100 and it will be published as ANSI/EASA AR100-2020 in 2020, prior to the publication of the 2023 NEC and will be confirmed in the comment period.

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Public Input No. 3631-NFPA 70-2020 [Section No. 430.2]

(Relocate all definitions in the 430.2 to Article 100, arrange them in alphabetical order and without any subdivisions.)

430. **2** Definitions.

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

Controller.

Any switch or device that is normally used to start and stop a motor by making and breaking the motor circuit current.

Electronically Protected (as applied to motors).

A motor that is provided with electronic control that is an integral part of the motor and protects the motor against dangerous overheating due to failure of the electronic control, overload and failure to start.

Part-Winding Motors.

A part-winding start induction or synchronous motor is one that is arranged for starting by first energizing part of its primary (armature) winding and, subsequently, energizing the remainder of this winding in one or more steps. A standard part-winding start induction motor is arranged so that one-half of its primary winding can be energized initially, and, subsequently, the remaining half can be energized, both halves then carrying equal current.

Informational Note: A hermetic refrigerant motor-compressor is not considered a standard part-winding start induction motor.

System Isolation Equipment.

A redundantly monitored, remotely operated contactor-isolating system, packaged to provide the disconnection/isolation function, capable of verifiable operation from multiple remote locations by means of lockout switches, each having the capability of being padlocked in the “off” (open) position.

Valve Actuator Motor (VAM) Assemblies.

A manufactured assembly, used to operate a valve, consisting of an actuator motor and other components such as controllers, torque switches, limit switches, and overload protection.

Informational Note: VAMs typically have short-time duty and high-torque characteristics.

Statement of Problem and Substantiation for Public Input

"The National Electrical Code has definitions in multiple parts in Article 100 and many definitions scattered through out the code many of them in the .2 section of the articles.
Most of the other standards under NFPA have their definitions in one location and this will allow the NEC the same requirement. The revisions to the NEC Style Manual require all the definitions to be relocated to Article 100. "

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Committee:	NEC-P11

Public Input No. 2991-NFPA 70-2020 [Section No. 430.5]

430.5 Other Articles.

Motors and controllers shall also comply with the applicable provisions of Table 430.5.

Table 430.5 Other Articles

Equipment/Occupancy	Article	Section
Air-conditioning and refrigerating equipment	440	–
Capacitors	–	460.8, 460.9
Commercial garages; aircraft hangars; motor fuel dispensing facilities; bulk storage plants; spray application, dipping, and coating processes; and inhalation anesthetizing locations	511, 513, 514, 515, 516, and 517 Part IV	–
Cranes and hoists	610	–
Electrically driven or controlled irrigation machines	675	–
Elevators, dumbwaiters, escalators, moving walks, wheelchair lifts, and stairway chair lifts	620	–
Fire pumps	~~695~~ 703	–
Hazardous (classified) locations	500–503, 505, and 506	–
Industrial machinery	670	–
Motion picture projectors	–	540.11 and 540.20
Motion picture and television studios and similar locations	530	–
Resistors and reactors	470	–
Theaters, audience areas of motion picture and television studios, and similar locations	–	520.48
Transformers and transformer vaults	450	–

Statement of Problem and Substantiation for Public Input

This public input was prepared by the correlating committee task group focused on alternative energy requirements. This task group consisted of the following members: Derrick Atkins (CMP 5), Greg Ball (CMP 13) Ken Boyce (CMP 1), Bill Brooks (CMP 4), Bruce Campbell, Thomas Domitrovich (CMP 2, CMP 10), Jason Fisher (CMP 4), Scott Harding (CMP 5), Pete Jackson (CMP 8), David Kendall (CMP 8, CC), Chad Kennedy (CMP 13), Christine Porter (CMP 5, CC), Timothy Windey (CMP 13). This change aligns with an effort to re-organize the alternative energy sources NEC Articles into a series of articles closely located together. This reorganization places all sources alternate sources as follows: 689 On-Site Energy Sources 690 Solar Photovoltaic (PV) Systems 691 Large-Scale Photovoltaic (PV) Systems 692 Fuel Cell Systems 693 Generators 694 Wind Electric Systems 695 Energy Storage Systems 696 Storage Batteries This public input aligns with changes that movie 695 to 703. This input supports this effort and to better align with the fact that this Article is closely related to emergency systems. The requirements of this new 703 focus on more than just a fire pump and arguably more so focuses on fire pump systems which is closely aligned with Chapter 7 of the NEC. This moves makes way for alignment of alternative energy sources article arrangement. These articles are closely related to each other and this change is in alignment with the direction by the correlating committee to review alternative energy sources for conflicts and usability. This new alignment will create a similar structure as that found for hazardous locations. The new Article 689 is the a combination of Articles 705, 710 and 712 and will act to be the new general requirements for this series of alternative energy sources.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 2987-NFPA 70-2020 [Article 695]	Moving 695 to 703

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Committee: NEC-P11

Public Input No. 4668-NFPA 70-2020 [Section No. 430.6(A)]

(A) General Motor Applications.

For general motor applications, current ratings shall be determined based on 430.6(A)(1) and (A)(2).

(1) Table Values.

Other than for motors built for low speeds (less than 1200 RPM) or high torques, and for multispeed motors, the values given in Table 430.247, Table 430.248, Table 430.249, and Table 430.250 shall be used instead of the actual current rating marked on the motor nameplate to determine the ~~ampacity of conductors or ampere ratings of switches,~~ following:

(1) Ampacity of conductors

(2) Ampere ratings of switches

(3) Ampere ratings of branch-circuit short-circuit and ground-fault protection~~, instead of the actual current rating marked on the motor nameplate.~~ .

Where a motor is marked in amperes, but not horsepower, the horsepower rating shall be assumed to be that corresponding to the value given in Table 430.247, Table 430.248, Table 430.249, and Table 430.250, interpolated if necessary. ~~Motors built for low speeds (less than 1200 RPM) or high torques may have higher full-load currents, and multispeed motors will have full-load current varying with speed, in which case the nameplate current ratings shall be used.~~

Exception No. 1: Multispeed motors shall be in accordance with 430.22(B) and 430.52.

Exception No. 2: For equipment that employs a shaded-pole or permanent-split capacitor-type fan or blower motor that is marked with the motor type, the full load current for such motor marked on the nameplate of the equipment in which the fan or blower motor is employed shall be used instead of the horsepower rating to determine the ampacity or rating of the disconnecting means, the branch-circuit conductors, the controller, the branch-circuit short-circuit and ground-fault protection, and the separate overload protection. This marking on the equipment nameplate shall not be less than the current marked on the fan or blower motor nameplate.

Exception No. 3: For a listed motor-operated appliance that is marked with both motor horsepower and full-load current, the motor full-load current marked on the nameplate of the appliance shall be used instead of the horsepower rating on the appliance nameplate to determine the ampacity or rating of the disconnecting means, the branch-circuit conductors, the controller, the branch-circuit short-circuit and ground-fault protection, and any separate overload protection.

(2) Nameplate Values. The motor nameplate current ratings shall be used to determine the values for (2)(a) and (2)(b).

(a) Separate motor overload protection

~~shall be based on the motor nameplate current rating.~~

.

(b) For motors built for low speeds (less than 1200 RPM), high torques, or multispeed motors:

(1) Ampacity of conductors

(2) Ampere ratings of switches

(3) Ampere ratings of branch-circuit short-circuit and ground-fault protection.

Statement of Problem and Substantiation for Public Input

The existing language has some grammatical errors making it difficult to read. Also, (A)(1) is titled Table Values, but then spends a fair amount of time instructing the reader to use the nameplate values for high torque and low speed motors. Since (A)(2) addresses nameplate values that information is relocated there. This PI also re-configures this material into a list format for improved readability and clarity.

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Committee: NEC-P11

Public Input No. 99-NFPA 70-2019 [Section No. 430.6(A)(1)]

(1)_ Table Values.

Other than for motors built for low speeds (less than 1200 RPM) or high torques, and for multispeed motors, the values given in Table 430.247, Table 430.248, Table 430.249, and Table 430.250 shall be used to determine the ampacity of conductors or ampere ratings of switches, branch-circuit short-circuit and ground-fault protection, instead of the actual current rating marked on the motor nameplate. Where a motor is marked in amperes, but not horsepower, the horsepower rating shall be assumed to be that corresponding to the value given in Table 430.247, Table 430.248, Table 430.249, and Table 430.250, interpolated if necessary. ~~Motors~~ Motor nameplate kilowatt ratings shall not be used to determine conductor ampacity. Motors built for low speeds (less than 1200 RPM) or high torques may have higher full-load currents, and multispeed motors will have full-load current varying with speed, in which case the nameplate current ratings shall be used.

Exception No. 1: Multispeed motors shall be in accordance with 430.22(B) and 430.52.

Exception No. 2: For equipment that employs a shaded-pole or permanent-split capacitor-type fan or blower motor that is marked with the motor type, the full load current for such motor marked on the nameplate of the equipment in which the fan or blower motor is employed shall be used instead of the horsepower rating to determine the ampacity or rating of the disconnecting means, the branch-circuit conductors, the controller, the branch-circuit short-circuit and ground-fault protection, and the separate overload protection. This marking on the equipment nameplate shall not be less than the current marked on the fan or blower motor nameplate.

Exception No. 3: For a listed motor-operated appliance that is marked with both motor horsepower and full-load current, the motor full-load current marked on the nameplate of the appliance shall be used instead of the horsepower rating on the appliance nameplate to determine the ampacity or rating of the disconnecting means, the branch-circuit conductors, the controller, the branch-circuit short-circuit and ground-fault protection, and any separate overload protection.

Statement of Problem and Substantiation for Public Input

Foreign equipment manufactured outside the U.S., not compliant with U.S. product standards, and purchased to be used in the U.S., continues to become a source of conflict. Some ANSI/NEMA induction motors rated in kW, such as those found in VAMs, are covered by 430.6(D) with specific criteria which must be complied with. Art. 430 is based on ANSI/NEMA horsepower ratings and the Table ampacities for disconnecting means, switches, contactors, starters, motor branch-circuit short-circuit and ground-fault protective devices, etc.

In lieu of accepting this proposal, I recommend the NFPA Standards Council and the NEC Correlating Committee assign a task group to undertake a Code-wide change to address this issue. As ANSI/NEMA and foreign made equipment and standards continue to merge, it will be necessary at some point to address this issue with Art. 430 and 440 on a much larger scale as it makes sense to standardize globally on motor equipment ratings.

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Committee:	NEC-P11

Public Input No. 4259-NFPA 70-2020 [Section No. 430.6 [Excluding any Sub-Sections]]

The size of conductors supplying equipment covered by ~~Article 430~~ this article shall be selected from the ampacity tables in accordance with 310.15 or shall be calculated in accordance with 310.14(B). Where flexible cord is used, the size of the conductor shall be selected in accordance with 400.5. The required ampacity and motor ratings shall be determined as specified in 430.6(A), (B), (C), and (D).

Statement of Problem and Substantiation for Public Input

Section 4.1.4 of the 2020 NEC(R) Style Manual prohibits references to an entire article, with the exception of Article 100. As such, it is recommended to revise the test to "this article" to comply.

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Public Input No. 3096-NFPA 70-2020 [Section No. 430.7]

430.7 Marking on Motors and Multimotor Equipment.

(A) Usual Motor Applications.

A motor shall be marked with the following information:

(1) Manufacturer's name.

(2) Rated volts and full-load current. For a multispeed motor, full-load current for each speed, except shaded-pole and permanent-split capacitor motors where amperes are required only for maximum speed.

(3) Rated frequency and number of phases if an ac motor.

(4) Rated full-load speed.

(5) Rated temperature rise or the insulation system class and rated ambient temperature.

(6) Time rating. The time rating shall be 5, 15, 30, or 60 minutes, or continuous.

(7) Rated horsepower if ⅛ hp or more. For a multispeed motor ⅛ hp or more, rated horsepower for each speed, except shaded-pole and permanent-split capacitor motors ⅛ hp or more where rated horsepower is required only for maximum speed. Motors of arc welders are not required to be marked with the horsepower rating.

(8) Code letter or locked-rotor amperes if an alternating-current motor rated ½ hp or more. On polyphase wound-rotor motors, the code letter shall be omitted.

Informational Note: See 430.7(B).

(9) Design letter for design A, B, C, or D motors.

Informational Note: Motor design letter definitions are found in ANSI/NEMA MG 1-~~1993~~ 2016 , *Motors and Generators, Part 1, Definitions,* ~~and in IEEE 100-1996, *Standard Dictionary of Electrical and Electronic Terms*~~ .

(10) Secondary volts and full-load current if a wound-rotor induction motor.

(11) Field current and voltage for dc excited synchronous motors.

(12) Winding — straight shunt, stabilized shunt, compound, or series, if a dc motor. Fractional horsepower dc motors 175 mm (7 in.) or less in diameter shall not be required to be marked.

(13) A motor provided with a thermal protector complying with 430.32(A)(2) or (B)(2) shall be marked "thermally protected." Thermally protected motors rated 100 watts or less and complying with 430.32(B)(2) shall be permitted to use the abbreviated marking "T.P."

(14) A motor complying with 430.32(B)(4) shall be marked "impedance protected." Impedance-protected motors rated 100 watts or less and complying with 430.32(B)(4) shall be permitted to use the abbreviated marking "Z.P."

(15) Motors equipped with electrically powered condensation prevention heaters shall be marked with the rated heater voltage, number of phases, and the rated power in watts.

(16) Motors that are electronically protected from overloads in accordance with 430.32(A)(2) and (B)(2) shall be marked "electronically protected" or "E.P."

(B) Locked-Rotor Indicating Code Letters.

Code letters marked on motor nameplates to show motor input with locked rotor shall be in accordance with Table 430.7(B).

The code letter indicating motor input with locked rotor shall be in an individual block on the nameplate, properly designated.

Table 430.7(B) Locked-Rotor Indicating Code Letters

Code Letter	Kilovolt-Amperes per Horsepower with Locked Rotor
A	0–3.14
B	3.15–3.54
C	3.55–3.99
D	4.0–4.49
E	4.5–4.99
F	5.0–5.59
G	5.6–6.29
H	6.3–7.09
J	7.1–7.99
K	8.0–8.99
L	9.0–9.99
M	10.0–11.19
N	11.2–12.49
P	12.5–13.99
R	14.0–15.99
S	16.0–17.99
T	18.0–19.99
U	20.0–22.39
V	22.4 and up

(1) Multispeed Motors.

Multispeed motors shall be marked with the code letter designating the locked-rotor kilovolt-ampere (kVA) per horsepower (hp) for the highest speed at which the motor can be started.

Exception: Constant horsepower multispeed motors shall be marked with the code letter giving the highest locked-rotor kilovolt-ampere (kVA) per horsepower (hp).

(2) Single-Speed Motors.

Single-speed motors starting on wye connection and running on delta connections shall be marked with a code letter corresponding to the locked-rotor kilovolt-ampere (kVA) per horsepower (hp) for the wye connection.

(3) Dual-Voltage Motors.

Dual-voltage motors that have a different locked-rotor kilovolt-ampere (kVA) per horsepower (hp) on the two voltages shall be marked with the code letter for the voltage giving the highest locked-rotor kilovolt-ampere (kVA) per horsepower (hp).

(4) 50/60 Hz Motors.

Motors with 50- and 60-Hz ratings shall be marked with a code letter designating the locked-rotor kilovolt-ampere (kVA) per horsepower (hp) on 60 Hz.

(5) Part-Winding Motors.

Part-winding start motors shall be marked with a code letter designating the locked-rotor kilovolt-ampere (kVA) per horsepower (hp) that is based on the locked-rotor current for the full winding of the motor.

(C) Torque Motors.

Torque motors are rated for operation at standstill and shall be marked in accordance with 430.7(A), except that locked-rotor torque shall replace horsepower.

(D) Multimotor and Combination-Load Equipment.

(1) Factory-Wired.

Multimotor and combination-load equipment shall be provided with a visible nameplate marked with the manufacturer's name, the rating in volts, frequency, number of phases, minimum supply circuit conductor ampacity, and the maximum ampere rating of the circuit short-circuit and ground-fault protective device. The conductor ampacity shall be calculated in accordance with 430.24 and counting all of the motors and other loads that will be operated at the same time. The short-circuit and ground-fault protective device rating shall not exceed the value calculated in accordance with 430.53. Multimotor equipment for use on two or more circuits shall be marked with the preceding information for each circuit.

(2) Not Factory-Wired.

Where the equipment is not factory-wired and the individual nameplates of motors and other loads are visible after assembly of the equipment, the individual nameplates shall be permitted to serve as the required marking.

Statement of Problem and Substantiation for Public Input

This proposal harmonizes with the marking requirements in ANSI/NEMA MG 1-2016. The design A marking communicates that, among other things, there is no maximum value of locked-rotor current specified in ANSI/NEMA MG 1-2016 and that this maximum value must instead be determined from the manufacturer supplied marking of code letter or locked-rotor amperes that is required by 430.7(A)(8). IEEE 100-1996 is proposed to be removed from the Informational Note since that standard has been withdrawn.

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Committee:	NEC-P11

Public Input No. 3020-NFPA 70-2020 [Section No. 430.7(A)]

(A) Usual Motor Applications.

A motor shall be marked with the following information:

(1) Manufacturer's name.

(2) Rated volts and full-load current. For a multispeed motor, full-load current for each speed, except shaded-pole and permanent-split capacitor motors where amperes are required only for maximum speed.

(3) Rated frequency and number of phases if an ac motor.

(4) Rated full-load speed.

(5) Rated temperature rise or the insulation system class and rated ambient temperature.

(6) Time rating. The time rating shall be 5, 15, 30, or 60 minutes, or continuous.

(7) ~~Rated horsepower if~~ Power rating in horsepower or kilowatts if ⅛ hp or more. For a multispeed motor ⅛ hp or more, rated ~~horsepower~~ power for each speed, except shaded-pole and permanent-split capacitor motors ⅛ hp or more where rated horsepower or kilowatts is required only for maximum speed. Motors of arc welders are not required to be marked with ~~the horsepower~~ a power rating.

(8) Code letter or locked-rotor amperes if an alternating-current motor rated ½ hp or more. On polyphase wound-rotor motors, the code letter shall be omitted.

Informational Note: See 430.7(B).

(9) Design letter for design B, C, or D motors.

Informational Note: Motor design letter definitions are found in ANSI/NEMA MG 1-1993, *Motors and Generators, Part 1, Definitions,* and in IEEE 100-1996, *Standard Dictionary of Electrical and Electronic Terms*.

(10) Secondary volts and full-load current if a wound-rotor induction motor.

(11) Field current and voltage for dc excited synchronous motors.

(12) Winding — straight shunt, stabilized shunt, compound, or series, if a dc motor. Fractional horsepower dc motors 175 mm (7 in.) or less in diameter shall not be required to be marked.

(13) A motor provided with a thermal protector complying with 430.32(A)(2) or (B)(2) shall be marked "thermally protected." Thermally protected motors rated 100 watts or less and complying with 430.32(B)(2) shall be permitted to use the abbreviated marking "T.P."

(14) A motor complying with 430.32(B)(4) shall be marked "impedance protected." Impedance-protected motors rated 100 watts or less and complying with 430.32(B)(4) shall be permitted to use the abbreviated marking "Z.P."

(15) Motors equipped with electrically powered condensation prevention heaters shall be marked with the rated heater voltage, number of phases, and the rated power in watts.

(16) Motors that are electronically protected from overloads in accordance with 430.32(A)(2) and (B)(2) shall be marked "electronically protected" or "E.P."

Statement of Problem and Substantiation for Public Input

Some motors and motor controllers are rated in kilowatts. Allow equipment to be marked in horsepower or kilowatts or both. Some product standards allow the motor to be rated in kilowatts.

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Committee:	NEC-P11

Public Input No. 393-NFPA 70-2020 [Section No. 430.8]

430.8 Marking on Controllers.

A controller shall be marked with the manufacturer's name or identification, the voltage, the current or horsepower rating, the short-circuit current rating, and other necessary data to properly indicate the applications for which it is suitable. <u>A controller shall not be installed where the available fault current exceeds its marked short-circuit current rating.</u>

Exception No. 1: The short-circuit current rating is not required for controllers applied in accordance with 430.81(A) or (B).

Exception No. 2: The short-circuit <u>current</u> rating is not required to be marked on the controller when the short-circuit current rating of the controller is marked elsewhere on the assembly.

Exception No. 3: The short-circuit <u>current</u> rating is not required to be marked on the controller when the assembly into which it is installed has a marked short-circuit current rating.

Exception No. 4: Short-circuit <u>current</u> ratings are not required for controllers rated less than 2 hp at 300 V or less and listed exclusively for general-purpose branch circuits.

A controller that includes motor overload protection suitable for group motor application shall be marked with the motor overload protection and the maximum branch-circuit short-circuit and ground-fault protection for such applications.

Combination controllers that employ adjustable instantaneous trip circuit breakers shall be clearly marked to indicate the ampere settings of the adjustable trip element.

Where a controller is built in as an integral part of a motor or of a motor-generator set, individual marking of the controller shall not be required if the necessary data are on the nameplate. For controllers that are an integral part of equipment approved as a unit, the above marking shall be permitted on the equipment nameplate.

Informational Note: See 110.10 for information on circuit impedance and other characteristics.

Statement of Problem and Substantiation for Public Input

The proposed revision adds the term "current" so that the term "short-circuit current rating" is used consistently.

In addition, text has been added to require the controller short-circuit current rating to be adequate for the available fault current similar to requirements for other types of equipment.

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Public Input No. 4069-NFPA 70-2020 [Section No. 430.10(B)]

(B) Wire-Bending Space in Enclosures.

Minimum wire-bending space within the enclosures for motor controllers shall be in accordance with Table 430.10(B) where measured in a straight line from the end of the lug or wire connector (in the direction the wire leaves the terminal) to the wall or barrier. Where alternate wire termination means are substituted for that supplied by the manufacturer of the controller, they shall be of a type identified by the manufacturer for use with the controller and shall not reduce the minimum wire-bending space.

Table 430.10(B) Minimum Wire-Bending Space at the Terminals of Enclosed Motor Controllers

Size of Wire (AWG or kcmil)	Wires per Terminal*				
	1		-	2	
	mm	in.	-	mm	in.
10 and smaller	Not specified		-	—	—
8–6	38	1½	-	—	—
4–3	50	2	-	—	—
2	65	2½	-	—	—
1	75	3	-	—	—
1/0	125	5	-	125	5
2/0	150	6	-	150	6
3/0–4/0	175	7	-	175	7
250	200	8	-	200	8
300	250	10	-	250	10
350–500	300	12	-	300	12
600–700	350	14	-	400	16
750–900	450	18	-	475	19

*Where provision for three or more wires per terminal exists, the minimum wire-bending space shall be in accordance ~~with the requirements of~~ with Article 312.

Statement of Problem and Substantiation for Public Input

Deleting the words "the requirements of" does not change the meaning of the section.

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Submittal Date: Wed Sep 09 19:51:23 EDT 2020
Committee: NEC-P11

Public Input No. 4262-NFPA 70-2020 [Section No. 430.10(B)]

(B) Wire-Bending Space in Enclosures.

Minimum wire-bending space within the enclosures for motor controllers shall be in accordance with Table 430.10(B) where measured in a straight line from the end of the lug or wire connector (in the direction the wire leaves the terminal) to the wall or barrier. Where alternate wire termination means are substituted for that supplied by the manufacturer of the controller, they shall be of a type identified by the manufacturer for use with the controller and shall not reduce the minimum wire-bending space.

Table 430.10(B) Minimum Wire-Bending Space at the Terminals of Enclosed Motor Controllers

Size of Wire (AWG or kcmil)	Wires per Terminal*				
	1		-	2	
	mm	in.	-	mm	in.
10 and smaller	Not specified		-	—	—
8–6	38	1½	-	—	—
4–3	50	2	-	—	—
2	65	2½	-	—	—
1	75	3	-	—	—
1/0	125	5	-	125	5
2/0	150	6	-	150	6
3/0–4/0	175	7	-	175	7
250	200	8	-	200	8
300	250	10	-	250	10
350–500	300	12	-	300	12
600–700	350	14	-	400	16
750–900	450	18	-	475	19

*Where provision for three or more wires per terminal exists, the minimum wire-bending space shall be in accordance with the requirements of ~~Article~~ 312.6(B).

Statement of Problem and Substantiation for Public Input

Section 4.1.4 of the 2020 NEC(R) Style Manual prohibits references to an entire article, with the exception of Article 100. As the wire-bending space requirements are found in 312.6(B), it is recommended to point to the specific section to comply.

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Committee: NEC-P11

Public Input No. 3398-NFPA 70-2020 [New Section after 430.18]

430.19 Reconditioning of Equipment.

Reconditioning of equipment within the scope of this article shall be limited as described in 430.19(A) and (B). The reconditioning process shall use design qualified parts verified under applicable standards and be performed in accordance with any instructions provided by the manufacturer. If equipment has been damaged by fire, products of combustion, or water, it shall be specifically evaluated by its manufacturer or a qualified testing laboratory prior to being returned to service.

430.19(A) Shall not be permitted to be reconditioned. Replacement of listed components or accessories are not considered reconditioning.

- Adjustable Speed Drives
- Relays (Overload, Electronic, and Digital)

430.19 (B) Shall be permitted to be reconditioned. Reconditioned equipment shall be field labeled as *reconditioned* , and previously applied listing marks, if any, within the portions reconditioned shall be removed.

- Motor Control Centers

Additional Proposed Changes

File Name	Description	Approved
NEMA_Position_on_Refurbishing_Electrical_Equipment.pdf	NEMA Paper	

Statement of Problem and Substantiation for Public Input

The addition of a section into article 430 covering reconditioning is essential to the inclusion of what should and should not be reconditioned in this article. The NEC CC task group on reconditioning is submitting several PI's to clarify definitions and general requirements. The Article 430 products detailed in this PI are based on the NEMA white paper on reconditioning. I have included a copy of this white paper for CMP-11's review.

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Public Input No. 774-NFPA 70-2020 [New Section after 430.18]

TITLE OF NEW CONTENT

Type your content here ...

430.19 Electromagnetic Pulse (EMP) Protection. Where motors, motor circuits, and controllers are utilized for the manufacturing, production, transportation, distribution, sales and business systems in facilities that are required to be EMP-protected, EMP protection for motors, motor circuits, and controllers against the effects of electromagnetic pulses shall be provided. See 709.7 for levels of electromagnetic pulse protection. This requirement shall become effective January 1, 2026.

Statement of Problem and Substantiation for Public Input

A devastating electromagnetic pulse (EMP), caused by a sun-spot or a nuclear bomb exploded high in the atmosphere, can impress 50,000 volts per meter on unprotected electrical and electronic equipment. It is similar to a radio wave impressing a very small voltage on a radio antenna, only orders of magnitude larger. The problem is that a significant EMP will fry every electrical/electronic component or piece of equipment that is not protected.

The EMP won't directly harm or injure people, but because there is no longer a working electrical infrastructure, which may take years to repair/rebuild, people will die from the lack of clean water, medicine, food, fuel, and eventual rioting due to the breakdown of society. Unclassified studies, referenced at the end of this substantiation, have estimated from 66% to 90% of the US population will die within one year if a significant sun spot were to occur or if a nuclear explosion were to occur 25 to 250 miles over the Midwest.

Our US military already "hardens" systems/buildings so that our country's critical defensive capabilities are not completely destroyed. There are two major methods of protecting electrical/electronic systems. The first is that surge protective devices are installed on all "incoming" power and communications cables, shunting overvoltages to ground. The second is that Faraday cages are installed around equipment/rooms, preventing the EMP from reaching critical equipment/components.

The NEC® needs to address EMP protection for equipment, systems and special occupancies that are critical to our survival. Electrical and electronic equipment can and must be protected, as has been achieved by our military. Unfortunately, there are no requirements to protect civilian electrical and electronic equipment/systems from EMPs.

The NEC Correlating Committee has informally advised that an EMP Protection Article, if passed and adopted into the NEC®, would be most appropriately located after Article 708 (COPS). Thus, Public Input 756 has suggested a new Article 709 under jurisdiction of CMP 13, which already has purview over Emergency Systems (Article 700), Legally Required Standby Systems (Article 701), Optional Standby Systems (Article 702), and Critical Operations Power Systems (Article 708).

Levels of protection and associated protection requirements listed in the Public Input(s) are based upon the unclassified National Cybersecurity and Communications Integration Center report "Electromagnetic Pulse (EMP) Protection and Resilience Guidelines for Critical Infrastructure and Equipment". This study explains electromagnetic pulses and provides the necessary protective measures. It also contains estimates of the costs associated with properly protecting our electrical infrastructure.
The following table contains critical infrastructure components/special occupancies and the maximum time for outages caused by an EMP. Electrical components/infrastructure that is not functioning for periods longer than shown in this table may begin to cause injury or death to people and harm to society/economy.

Critical Infrastructure Component/Special Occupancy	Permitted Outage Time
Branch banking facilities	10 hours
Critical Operations Power Systems	10 minutes
Data centers	10 minutes
Direct current microgrids	10 hours
Drug stores/distribution centers	10 hours
Electrically driven or controlled irrigation machines	1 week
Elevators, dumbwaiters, escalators, moving walks, platform lifts, and stairway chairlifts	See facility

requirements
Emergency systems 10 hours
Energy storage systems 10 hours
Fire alarm systems 1 week
Fire houses/stations 10 hours
Fire pumps 10 hours
Food processing and storage facilities 10 hours
Fuel cell systems 10 hours
Generators 10 hours
Grocery stores 10 hours
Hardware stores/home centers 10 hours
Healthcare facilities See NFPA 99
Information technology equipment 10 minutes
Interconnected electric power production sources 10 minutes
Jails and prisons 10 minutes
Large-scale photovoltaic (PV) electric supply stations 10 hours
Legally required standby systems 10 hours
Modular data centers 10 minutes
Motor fuel dispensing facilities 1 week
Motors, motor circuits, and controllers See facility requirements
Nuclear reactors 10 seconds
Optional standby systems 1 week
Petrochemical plants/facilities 10 hours
Pharmaceutical plants/facilities 10 hours
Police stations 10 minutes
Solar photovoltaic (PV) systems 10 hours
Stand-alone systems 10 hours
Storage batteries See facility requirements
Transformers See facility requirements
Waste water treatment facilities 10 minutes
Water supply facilities 10 hours
Wind electric systems 10 hours

An effectivity date of January 1, 2026 is chosen to allow time for engineering and industry to adequately pan and prepare for the required changes.

Opponents of EMP protection requirements will likely charge that it is too costly to protect our critical infrastructure, and that the NEC® is not a war-time document. A close reading of 90.1 reveals that there is no mention of the “cost” of safeguarding persons and property. Neither does 90.1 mention that safeguarding persons and property is only required during peacetime. Additionally, a significant EMP event, caused by a sunspot, would be an act of God, not an act of war.

The novel, “One Second After”, provides an understanding of what happens when the majority of all unprotected electrical and electronic equipment/systems is destroyed during an EMP event. An audio version of this book is available in two parts, for free, on YouTube.

This link provides the unclassified report “Electromagnetic Pulse (EMP) Protection and Resilience Guidelines for Critical Infrastructure and Equipment”
https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=3&ved=2ahUKEwjQhp2-77DoAhXBHM0KHboOB2QQFjACegQIBRAC&url=https%3A%2F%2Fwww.cisa.gov%2Fsites%2Fdefault%2Ffiles%2Fpublications%2F19_0307_CISA_EMP-Protection-Resilience-Guidelines.pdf&usg=AOvVaw2n7jLtJAUJtOJKHPMqWsTE

This link provides the study predicting up to 90% of our population could die from an EMP event
http://www.firstempcommission.org/uploads/1/1/9/5/119571849/nuclear_emp_attack_scenarios_and_combined-arms_cyber_warfare_by_peter_pry_july_2017.pdf

This link provides unclassified guidelines for facility EMP protection
https://info.publicintelligence.net/DHS-FacilitiesGuidelinesEMP.pdf

These links provide Parts 1 and 2 of a national plan for EMP protection.
https://interferencetechnology.com/a-national-plan-for-emp-protection-part-1/
https://interferencetechnology.com/national-plan-emp-protection-part-2-protection-buildings/

We have all just witnessed the chaos and pain caused by not having the "protections" in place to quickly defeat the Covid-19 virus. As unfortunate, costly, painful, and deadly as Covid-19 was, it would be child's play when compared to a significant EMP event if our critical electrical/electronic infrastructure remains unprotected. Quite simply, NEC® requirements to protect electrical and electronic equipment from an EMP event, could literally save millions of American lives.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 756-NFPA 70-2020 [New Section after 708.64]	
Public Input No. 756-NFPA 70-2020 [New Section after 708.64]	

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Committee: NEC-P11

Public Input No. 4267-NFPA 70-2020 [Section No. 430.21]

430.21 General.

Part II specifies ampacities of conductors that are capable of carrying the motor current without overheating under the conditions specified.

Part II shall not apply to motor circuits rated over 1000 volts, nominal.

Informational Note No 1 : For over 1000 volts, nominal, see Part XI.

~~Articles 250 , 300 , and 310~~ Chapter 2 and Chapter 3 requirements shall not apply to conductors that form an integral part of equipment, such as motors, motor controllers, motor control centers, or other factory-assembled control equipment.

Informational Note No 2 : See 110.14(C) and 430.9(B) for equipment device terminal requirements.

Statement of Problem and Substantiation for Public Input

Section 4.1.4 of the 2020 NEC(R) Style Manual prohibits references to an entire article, with the exception of Article 100. The reference to Articles 250, 300 and 310 was revised to the more generic "Chapter 2 and Chapter 3 requirements" to comply. In addition, the informational notes were numbered to comply with the new requirements in 2.4.3 of the NEC(r) Style Manual.

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Public Input No. 2150-NFPA 70-2020 [Section No. 430.24]

430.24 Several Motors or a Motor(s) and Other Load(s).

Conductors supplying several motors, or a motor(s) and other load(s), shall have an ampacity not less than the sum of each of the following:

(1) 125 percent of the full-load current rating of the highest rated motor, as determined by 430.6(A)

(2) Sum of the full-load current ratings of all the other motors in the group, as determined by 430.6(A)

(3) 100 percent of the noncontinuous non-motor load

(4) 125 percent of the continuous non-motor load

Where two or more motors have the same full-load current, only one of the motor currents shall be considered the highest rated for the above calculations .

Informational Note: See Informative Annex D, Example No. D8.

Exception No. 1: Where one or more of the motors of the group are used for short-time, intermittent, periodic, or varying duty, the ampere rating of such motors to be used in the summation shall be determined in accordance with 430.22(E). For the highest rated motor, the greater of either the ampere rating from 430.22(E) or the largest continuous duty motor full-load current multiplied by 1.25 shall be used in the summation.

Exception No. 2: The ampacity of conductors supplying motor-operated fixed electric space-heating equipment shall comply with 424.4(B).

Exception No. 3: Where the circuitry is interlocked so as to prevent simultaneous operation of selected motors or other loads, the conductor ampacity shall be permitted to be based on the summation of the currents of the motors and other loads to be operated simultaneously that results in the highest total current.

Statement of Problem and Substantiation for Public Input

This revision is necessary to clarify the calculation process when 2 or more motors have the same current rating. For example: A feeder with three 22-amp motors. Should ALL of them be considered the "highest rated"? (22A X 3 X 125%); Should NONE of them be considered "highest rated"? (22A X 3); I believe the intent is to only consider ONE of them as the the "highest rated". [(22A X 125%) + 22A + 22A).

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 2151-NFPA 70-2020 [Section No. 440.33]	

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Submittal Date: Tue Aug 04 06:48:35 EDT 2020

Committee: NEC-P11

Public Input No. 1307-NFPA 70-2020 [Section No. 430.31]

Part III. Motor and Branch Circuit Protection

430.31 General .

~~Part III~~

Part III specifies overload devices intended to protect motors, motor-control apparatus, and motor branch-circuit conductors against excessive heating due to motor overloads and failure to start.

Informational Note No. 1: See Informative Annex D, Example No. D8.

Informational Note No. 2: See the definition of *Overload* in Article 100.

(A) **Where Hazards Exist** . These provisions shall not require overload protection where a power loss would cause a hazard, such as in the case of fire pumps.

Informational Note: For protection of fire pump supply conductors, see 695.7.

~~Part III~~ (B) **Not over 1000 Volts** . Part III shall not apply to motor circuits rated over 1000 volts, nominal.

Informational Note: For over 1000 volts, nominal, see Part XI.

Statement of Problem and Substantiation for Public Input

Revising the section into parts will comply with the NEC Style Manual and clarify where the informational notes apply.

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Public Input No. 2992-NFPA 70-2020 [Section No. 430.31]

430.31 General.

Part III specifies overload devices intended to protect motors, motor-control apparatus, and motor branch-circuit conductors against excessive heating due to motor overloads and failure to start.

Informational Note No. 1: See Informative Annex D, Example No. D8.

Informational Note No. 2: See the definition of *Overload* in Article 100.

These provisions shall not require overload protection where a power loss would cause a hazard, such as in the case of fire pumps.

Informational Note: For protection of fire pump supply conductors, see ~~695~~ 703 .7.

Part III shall not apply to motor circuits rated over 1000 volts, nominal.

Informational Note: For over 1000 volts, nominal, see Part XI.

Statement of Problem and Substantiation for Public Input

This public input was prepared by the correlating committee task group focused on alternative energy requirements. This task group consisted of the following members: Derrick Atkins (CMP 5), Greg Ball (CMP 13) Ken Boyce (CMP 1), Bill Brooks (CMP 4), Bruce Campbell, Thomas Domitrovich (CMP 2, CMP 10), Jason Fisher (CMP 4), Scott Harding (CMP 5), Pete Jackson (CMP 8), David Kendall (CMP 8, CC), Chad Kennedy (CMP 13), Christine Porter (CMP 5, CC), Timothy Windey (CMP 13). This change aligns with an effort to re-organize the alternative energy sources NEC Articles into a series of articles closely located together. This reorganization places all sources alternate sources as follows: 689 On-Site Energy Sources 690 Solar Photovoltaic (PV) Systems 691 Large-Scale Photovoltaic (PV) Systems 692 Fuel Cell Systems 693 Generators 694 Wind Electric Systems 695 Energy Storage Systems 696 Storage Batteries This public input aligns with changes that movie 695 to 703. This input supports this effort and to better align with the fact that this Article is closely related to emergency systems. The requirements of this new 703 focus on more than just a fire pump and arguably more so focuses on fire pump systems which is closely aligned with Chapter 7 of the NEC. This moves makes way for alignment of alternative energy sources article arrangement. These articles are closely related to each other and this change is in alignment with the direction by the correlating committee to review alternative energy sources for conflicts and usability. This new alignment will create a similar structure as that found for hazardous locations. The new Article 689 is the a combination of Articles 705, 710 and 712 and will act to be the new general requirements for this series of alternative energy sources.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 2987-NFPA 70-2020 [Article 695]	moving 695 to 703

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Submittal Date: Thu Sep 03 19:47:20 EDT 2020

Committee: NEC-P11

Public Input No. 3446-NFPA 70-2020 [Section No. 430.31]

430.31 General.

Part III specifies overload devices intended to protect motors, motor-control apparatus, and motor branch-circuit conductors against excessive heating due to motor overloads and failure to start.

Informational Note No. 1: See Informative Annex D, Example No. D8.

Informational Note No. 2: See Article 100, for the definition of *Overload* ~~in Article 100~~ .

These provisions shall not require overload protection where a power loss would cause a hazard, such as in the case of fire pumps.

Informational Note ~~: For~~ No. 3: See 695.7, for protection of fire pump supply conductors~~, see 695~~ . ~~7.~~

Part III shall not apply to motor circuits rated over 1000 volts, nominal.

Informational Note ~~: For~~ No. 4: See Part XI, for over 1000 volts, nominal~~, see Part XI~~ .

Statement of Problem and Substantiation for Public Input

The 3rd and 4th Informational Notes were numbered to comply with the Revised NEC Style Manual per 2.4.3.
Informational Notes 2, 3 and 4 were revised to comply with the Revised NEC Style Manual for the structure of Information Notes per 4.1.3.

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Committee: NEC-P11

Public Input No. 4272-NFPA 70-2020 [Section No. 430.42 [Excluding any Sub-Sections]]

Overload protection for motors used on general-purpose branch circuits as permitted in Part II of Article 210 shall be provided as specified in 430.42(A), (B), (C), or (D).

Statement of Problem and Substantiation for Public Input

Section 4.1.4 of the 2020 NEC(R) Style Manual prohibits references to an entire article, with the exception of Article 100. It is suggested that the CMP point to the specific part of the article they intend to, here, which is thought to be Part II of Article 210 as shown.

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Committee:	NEC-P11

Public Input No. 2721-NFPA 70-2020 [Section No. 430.51]

430.51 General.

Part IV specifies devices intended to protect the motor branch-circuit conductors, the motor control apparatus, and the motors against overcurrent due to short circuits or ground faults. These rules add to or amend Article 240. The devices specified in Part IV do not include the types of devices required by 210.8, 230.95, and 590.6.

Informational Note 1 : See Informative Annex D, Example D8.

Informational Note 2: See IEEE 3004.8 Recommended Practice for Motor Protection in Industrial and Commercial Power Systems

Informational Note 3: See IEEE 3002.7 Recommended Practice for Conducting Motor-Starting Studies and Analysis of Industrial and Commercial Power Systems

Part IV shall not apply to motor circuits rated over 1000 volts, nominal.

Informational Note: For over 1000 volts, nominal, see Part XI.

Statement of Problem and Substantiation for Public Input

Content that formerly existed in the legacy Color Books (Red Book Std. 141 and Gray Book Std. 241) have been mapped into smaller titles such as these two. IEEE Color Books have been in the process of this transformation for at least two NEC cycles now. The transformation into smaller blocks of content is similar to the IEC best practice titles and aligns with the scope of this section of the NEC.

From the prospectus of these titles:

3004.8-2016: The protection of motors used in industrial and commercial power systems is covered. It is likely to be of greatest value to the power-oriented engineer with limited experience in the area of protection and control. It can also be an aid to all engineers responsible for the electrical design of industrial and commercial power systems.

https://standards.ieee.org/standard/3004_8-2016.html

3002.7 2018: Activities related to motor-starting studies including design considerations for new systems, analytical studies for existing systems, as well as operational and model-validation considerations for industrial and commercial power systems are described. Motor-starting analysis includes evaluation of motor-starting current and voltage drop. Accuracy of calculation results primarily relies on system modeling assumptions and methods used. The use of computer-aided analysis software, with a list of desirable capabilities recommended to conduct a modern motor-starting study, is emphasized. Examples of system data requirements and result-analysis techniques are presented. Benefits obtained from motor-starting studies are discussed, and various types of computer-aided motor-starting studies are examined. Data or information required for these studies, as well as the expected results of a motor-starting study effort, are also reviewed.

https://standards.ieee.org/standard/3002_7-2018.html

This proposal is intended to align IEEE and NFPA electrical safety standards.

Submitter Information Verification

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Public Input No. 4274-NFPA 70-2020 [Section No. 430.51]

430.51 General.

Part IV specifies devices intended to protect the motor branch-circuit conductors, the motor control apparatus, and the motors against overcurrent due to short circuits or ground faults. These rules add to or amend ~~Article 240~~ the overcurrent protection requirements found elsewhere in the Code . The devices specified in Part IV do not include the types of devices required by 210.8, 230.95, and 590.6.

Informational Note No.1 : See Informative Annex D, Example D8.

Part IV shall not apply to motor circuits rated over 1000 volts, nominal.

Informational Note No. 2 : For over 1000 volts, nominal, see Part XI.

Statement of Problem and Substantiation for Public Input

Section 4.1.4 of the 2020 NEC(R) Style Manual prohibits references to an entire article, with the exception of Article 100. As such, it is recommended to change the reference to Article 240 to "the overcurrent protection requirements found elsewhere in the Code" to comply. In addition, the informational notes were numbered to comply with the new requirements in Section 2.4.3 of the 2020 NEC(r) Style Manual.

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Public Input No. 3097-NFPA 70-2020 [Section No. 430.52(C)]

(C) Rating or Setting.

(1) In Accordance with Table 430.52.

A protective device that has a rating or setting not exceeding the value calculated according to the values given in Table 430.52 shall be used.

Table 430.52 Maximum Rating or Setting of Motor Branch-Circuit Short-Circuit and Ground-Fault Protective Devices

Type of Motor	Percentage of Full-Load Current			
	Nontime Delay Fuse[1]	Dual Element (Time-Delay) Fuse[1]	Instantaneous Trip Breaker	Inverse Time Breaker[2]
Single-phase motors	300	175	800	250
AC polyphase motors other than wound-rotor	300	175	800	250
Squirrel cage — other than Design B energy- ~~efficient~~ efficient and Design B premium efficiency	300	175	800	250
Design B energy-efficient or Design B premium efficiency	300	175	1100	250
Synchronous[3]	300	175	800	250
Wound-rotor	150	150	800	150
DC (constant voltage)	150	150	250	150

Note: For certain exceptions to the values specified, see 430.54.

[1]The values in the Nontime Delay Fuse column apply to time-delay Class CC fuses.

[2]The values given in the last column also cover the ratings of nonadjustable inverse time types of circuit breakers that may be modified as in 430.52(C)(1), Exceptions No. 1 and No. 2.

[3]Synchronous motors of the low-torque, low-speed type (usually 450 rpm or lower), such as are used to drive reciprocating compressors, pumps, and so forth, that start unloaded, do not require a fuse rating or circuit-breaker setting in excess of 200 percent of full-load current.

Exception No. 1: Where the values for branch-circuit short-circuit and ground-fault protective devices determined by Table 430.52 do not correspond to the standard sizes or ratings of fuses, nonadjustable circuit breakers, thermal protective devices, or possible settings of adjustable circuit breakers, a higher size, rating, or possible setting that does not exceed the next higher standard ampere rating shall be permitted.

Exception No. 2: Where the rating specified in Table 430.52, or the rating modified by Exception No. 1, is not sufficient for the starting current of the motor:

(1) The rating of a nontime-delay fuse not exceeding 600 amperes or a time-delay Class CC fuse shall be permitted to be increased but shall in no case exceed 400 percent of the full-load current.

(2) The rating of a time-delay (dual-element) fuse shall be permitted to be increased but shall in no case exceed 225 percent of the full-load current.

(3) The rating of an inverse time circuit breaker shall be permitted to be increased but shall in no case exceed 400 percent for full-load currents of 100 amperes or less or 300 percent for full-load currents greater than 100 amperes.

(4) The rating of a fuse of 601–6000 ampere classification shall be permitted to be increased but shall in no case exceed 300 percent of the full-load current.

Informational Note: See Informative Annex D, Example D8, and Figure 430.1.

(2) Overload Relay Table.

Where maximum branch-circuit short-circuit and ground-fault protective device ratings are shown in the manufacturer's overload relay table for use with a motor controller or are otherwise marked on the equipment, they shall not be exceeded even if higher values are allowed as shown above.

(3) Instantaneous Trip Circuit Breaker.

An instantaneous trip circuit breaker shall be used only if adjustable and if part of a listed combination motor controller having coordinated motor overload and short-circuit and ground-fault protection in each conductor, and the setting is adjusted to no more than the value specified in Table 430.52.

Informational Note No. 1: Instantaneous trip circuit breakers are also known as motor-circuit protectors (MCPs).

Informational Note No. 2: For the purpose of this article, instantaneous trip circuit breakers may include a damping means to accommodate a transient motor inrush current without nuisance tripping of the circuit breaker.

Exception No. 1: Where the setting specified in Table 430.52 is not sufficient for the starting current of the motor, the setting of an instantaneous trip circuit breaker shall be permitted to be increased but shall in no case exceed 1300 percent of the motor full-load current for other than Design B energy-efficient <u>and Design B premium efficiency</u> motors and no more than 1700 percent of motor full-load current for Design B energy-efficient <u>or Design B premium efficiency</u> motors. Trip settings above 800 percent for other than Design B energy-efficient <u>and Design B premium efficiency</u> motors and above 1100 percent for Design B energy-~~efficient~~ <u>efficient or Design B premium efficiency</u> motors shall be permitted where the need has been demonstrated by engineering evaluation. In such cases, it shall not be necessary to first apply an instantaneous-trip circuit breaker at 800 percent or 1100 percent.

Informational Note <u>No.1</u> : For additional information on the requirements for a motor to be classified "energy efficient," see NEMA MG 1-2016, <u>Supplements-2018,</u> *Motors and Generators,* Part 12.59.

<u>Informational Note No.2: For additional information on the requirements for a motor to be classified "premium efficiency" see NEMA MG1-2016, Supplements-2018, Motors and Generators, Part 12.60.</u>

Exception No. 2: Where the motor full-load current is 8 amperes or less, the setting of the instantaneous-trip circuit breaker with a continuous current rating of 15 amperes or less in a listed combination motor controller that provides coordinated motor branch-circuit overload and short-circuit and ground-fault protection shall be permitted to be increased to the value marked on the controller.

(4) Multispeed Motor.

For a multispeed motor, a single short-circuit and ground-fault protective device shall be permitted for two or more windings of the motor, provided the rating of the protective device does not exceed the above applicable percentage of the nameplate rating of the smallest winding protected.

Exception: For a multispeed motor, a single short-circuit and ground-fault protective device shall be permitted to be used and sized according to the full-load current of the highest current winding, where all of the following conditions are met:

(1) Each winding is equipped with individual overload protection sized according to its full-load current.

(2) The branch-circuit conductors supplying each winding are sized according to the full-load current of the highest full-load current winding.

(3) The controller for each winding has a horsepower rating not less than that required for the winding having the highest horsepower rating.

(5) Power Electronic Devices.

Semiconductor fuses intended for the protection of electronic devices shall be permitted in lieu of devices listed in Table 430.52 for power electronic devices, associated electromechanical devices (such as bypass contactors and isolation contactors), and conductors in a solid-state motor controller system, provided that the marking for replacement fuses is provided adjacent to the fuses.

(6) Self-Protected Combination Controller.

A listed self-protected combination controller shall be permitted in lieu of the devices specified in Table 430.52. Adjustable instantaneous-trip settings shall not exceed 1300 percent of full-load motor current for other than Design B energy-efficient and Design B premium efficiency motors and not more than 1700 percent of full-load motor current for Design B energy-efficient ot Design B premium efficiency motors.

Informational Note: Proper application of self-protected combination controllers on 3-phase systems, other than solidly grounded wye, particularly on corner grounded delta systems, considers the self-protected combination controllers' individual pole-interrupting capability.

(7) Motor Short-Circuit Protector.

A motor short-circuit protector shall be permitted in lieu of devices listed in Table 430.52 if the motor short-circuit protector is part of a listed combination motor controller having coordinated motor overload protection and short-circuit and ground-fault protection in each conductor and it will open the circuit at currents exceeding 1300 percent of motor full-load current for other than Design B energy-efficient and Design B premium efficiency motors and 1700 percent of motor full-load motor current for Design B energy-efficient or Design B premium efficiency motors.

Informational Note: A motor short-circuit protector, as used in this section, is a fused device and is not an instantaneous trip circuit breaker.

Statement of Problem and Substantiation for Public Input

Premium efficiency motors (which are energy-efficient motors with a higher level of efficiency) have largely replaced energy-efficient motors in installations in the US since they have been mandated for many applications from 1 – 200 Hp since December 19, 2010 and for the vast majority of applications from 1 – 500 Hp since June 1, 2016 by the energy conservation standards in 431.25 of Title 10, Chapter II Subchapter D of
the US CFR. Design B premium efficiency motors have a higher efficiency than Design B energy-efficient motors and, therefore, tend to have a starting current that is equal to or greater than that of Design B energy-efficient motors. It follows that the exception which allows the setting of an instantaneous trip circuit breaker to be increased for Design B energy-efficient motors should also apply to Design B premium efficiency motors. It also follows that the adjustable instantaneous-trip settings for self-protected combination controllers, which apply to Design B energy-efficient motors, should also apply to Design B premium efficiency motors. It also follows that the motor short-circuit protectors that are applicable to Design B energy-efficient motors should also be applicable to Design B premium efficiency motors. There are no anticipated safety concerns associated with this PI and additionally, it is anticipated that this proposed expansion of the highest allowable instantaneous trip settings will reduce nuisance tripping occurrences on the large, already-existing base of applications incorporating Design B premium efficiency motors. In Informational Note No. 1, the reference to NEMA MG 1 Part 12.59 has been updated to the most recent version.

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Public Input No. 1585-NFPA 70-2020 [Section No. 430.52(C)(1)]

(1) In Accordance with Table 430.52.

A protective device that has a rating or setting not exceeding the value calculated according to the values given in Table 430.52 shall be used.

Table 430.52 Maximum Rating or Setting of Motor Branch-Circuit Short-Circuit and Ground-Fault Protective Devices

Type of Motor	**Percentage of Full-Load Current**			
	Nontime Delay Fuse[1]	**Dual Element (Time-Delay) Fuse[1]**	**Instantaneous Trip Breaker**	**Inverse Time Breaker[2]**
Single-phase motors	300	175	800	250
AC polyphase motors other than wound-rotor	300	175	800	250
Squirrel cage — other than Design B energy-efficient	300	175	800	250
Design B energy-efficient	300	175	1100	250
Synchronous[3]	300	175	800	250
Wound-rotor	150	150	800	150
DC (constant voltage)	150	150	250	150

Note: For certain exceptions to the values specified, see 430.54.

[1]The values in the Nontime Delay Fuse column apply to time-delay Class CC fuses.

[2]The values given in the last column also cover the ratings of nonadjustable inverse time types of circuit breakers that may be modified as in 430.52(C)(1), Exceptions No. 1 and No. 2.

[3]Synchronous motors of the low-torque, low-speed type (usually 450 rpm or lower), such as are used to drive reciprocating compressors, pumps, and so forth, that start unloaded, do not require a fuse rating or circuit-breaker setting in excess of 200 percent of full-load current.

Exception No. 1: Where the values for branch-circuit short-circuit and ground-fault protective devices determined by Table 430.52 do not correspond to the standard sizes or ratings of fuses, nonadjustable circuit breakers, thermal protective devices, or possible settings of adjustable circuit breakers, a higher size, rating, or possible setting that does not exceed the next higher standard ampere rating, according to 240.6, shall be permitted.

Exception No. 2: Where the rating specified in Table 430.52, or the rating modified by Exception No. 1, is not sufficient for the starting current of the motor:

(1) The rating of a nontime-delay fuse not exceeding 600 amperes or a time-delay Class CC fuse shall be permitted to be increased but shall in no case exceed 400 percent of the full-load current.

(2) The rating of a time-delay (dual-element) fuse shall be permitted to be increased but shall in no case exceed 225 percent of the full-load current.

(3) The rating of an inverse time circuit breaker shall be permitted to be increased but shall in no case exceed 400 percent for full-load currents of 100 amperes or less or 300 percent for full-load currents greater than 100 amperes.

(4) The rating of a fuse of 601–6000 ampere classification shall be permitted to be increased but shall in no case exceed 300 percent of the full-load current.

Informational Note: See Informative Annex D, Example D8, and Figure 430.1.

Statement of Problem and Substantiation for Public Input

The exception allows upsizing to the next standard size fuse or circuit breaker, by adding the reference to

240.6 which lists the standard size fuses and circuit breakers, the user is directed to the list of standard size fuses and circuit breakers so that an accurate selection can be made to ensure safe installation.

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Public Input No. 413-NFPA 70-2020 [Section No. 430.52(C)(1)]

(1) In Accordance with Table 430.52.

A protective device that has a rating or setting not exceeding the value calculated according to the values given in Table 430.52 shall be used.

Table 430.52 Maximum Rating or Setting of Motor Branch-Circuit Short-Circuit and Ground-Fault Protective Devices

	Percentage of Full-Load Current			
Type of Motor	Nontime Delay Fuse[1]	Dual Element (Time-Delay) Fuse[1]	Instantaneous Trip Breaker	Inverse Time Breaker[2]
Single-phase motors	300	175		
~~800~~				
1300	250			
AC polyphase motors other than wound-rotor	300	175		
~~800~~				
1300	250			
Squirrel cage — other than Design B energy-efficient	300	175		
~~800~~				
1300	250			
Design B energy-efficient	300	175		
~~1100~~				
1700	250			
Synchronous[3]	300	175		
~~800~~				
1300	250			
Wound-rotor	150	150		
~~800~~				
1300	150			
DC (constant voltage)	150	150	250	150

Note: For certain exceptions to the values specified, see 430.54.

[1]The values in the Nontime Delay Fuse column apply to time-delay Class CC fuses.

[2]The values given in the last column also cover the ratings of nonadjustable inverse time types of circuit breakers that may be modified as in 430.52(C)(1), Exceptions No. 1 and No. 2.

[3]Synchronous motors of the low-torque, low-speed type (usually 450 rpm or lower), such as are used to drive reciprocating compressors, pumps, and so forth, that start unloaded, do not require a fuse rating or circuit-breaker setting in excess of 200 percent of full-load current.

Exception No. 1: Where the values for branch-circuit short-circuit and ground-fault protective devices determined by Table 430.52 do not correspond to the standard sizes or ratings of fuses, nonadjustable circuit breakers, thermal protective devices, or possible settings of adjustable circuit breakers, a higher size, rating, or possible setting that does not exceed the next higher standard ampere rating shall be permitted.

Exception No. 2: Where the rating specified in Table 430.52, or the rating modified by Exception No. 1, is not sufficient for the starting current of the motor:

(1) The rating of a nontime-delay fuse not exceeding 600 amperes or a time-delay Class CC fuse shall be permitted to be increased but shall in no case exceed 400 percent of the full-load current.

(2) *The rating of a time-delay (dual-element) fuse shall be permitted to be increased but shall in no case exceed 225 percent of the full-load current.*

(3) *The rating of an inverse time circuit breaker shall be permitted to be increased but shall in no case exceed 400 percent for full-load currents of 100 amperes or less or 300 percent for full-load currents greater than 100 amperes.*

(4) *The rating of a fuse of 601–6000 ampere classification shall be permitted to be increased but shall in no case exceed 300 percent of the full-load current.*

Informational Note: See Informative Annex D, Example D8, and Figure 430.1.

Statement of Problem and Substantiation for Public Input

Standard industrial motors have peak inrush currents which commonly exceed 800% of full load current (1100% for Design B Energy Efficient). In addition, many imported pieces of equipment include European motors which have even higher peak inrush currents. The Code should recognize this and just state the maximum setting for instantaneous only trip circuit breakers. The text of Article 430.52(C)(3) and exceptions should be similarly revised.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 414-NFPA 70-2020 [Section No. 430.52(C)(3)]	should be changed together
Public Input No. 414-NFPA 70-2020 [Section No. 430.52(C)(3)]	

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Public Input No. 414-NFPA 70-2020 [Section No. 430.52(C)(3)]

(3) Instantaneous Trip Circuit Breaker.

An instantaneous trip circuit breaker shall be used only if adjustable and if part of a listed combination motor controller having coordinated motor overload and short-circuit and ground-fault protection in each conductor, and the setting is adjusted to no more than the value specified in Table 430.52.

Informational Note No. 1: Instantaneous trip circuit breakers are also known as motor-circuit protectors (MCPs).

Informational Note No. 2: For the purpose of this article, instantaneous trip circuit breakers may include a damping means to accommodate a transient motor inrush current without nuisance tripping of the circuit breaker.

~~*Exception No. 1: Where the setting specified in Table 430.52 is not sufficient for the starting current of the motor, the setting of an instantaneous trip circuit breaker shall be permitted to be increased but shall in no case exceed 1300 percent of the motor full-load current for other than Design B energy-efficient motors and no more than 1700 percent of motor full-load current for Design B energy-efficient motors. Trip settings above 800 percent for other than Design B energy-efficient motors and above 1100 percent for Design B energy-efficient motors shall be permitted where the need has been demonstrated by engineering evaluation. In such cases, it shall not be necessary to first apply an instantaneous-trip circuit breaker at 800 percent or 1100 percent.*~~

~~Informational Note~~ Informational Note No. 3 : For additional information on the requirements for a motor to be classified "energy efficient," see NEMA MG 1-2016, *Motors and Generators,* Part 12.59.

Exception No. ~~2~~ 1 : Where the motor full-load current is 8 amperes or less, the setting of the instantaneous-trip circuit breaker with a continuous current rating of 15 amperes or less in a listed combination motor controller that provides coordinated motor branch-circuit overload and short-circuit and ground-fault protection shall be permitted to be increased to the continuous current rating value marked on the controller.

Statement of Problem and Substantiation for Public Input

see related comment for proposed change in Table 430.52 With motor peak inrush values commonly exceeding 800% or 1100%, Exception 1 of the current 430.52(C)(3) is typically always used. I've heard many anecdotal stories of users simply turning the setting to the maximum value, regardless of whether or not it exceeds 1300% or 1700%. If there is no safety issue with permitting a maximum setting of 1300% or 1700% by exception, then there is little value in attempting to start the motor with a setting of 800% or 1100%. Since peak inrush current can be affected by the angle of the voltage at the time of the contactor closure or the system voltage level, a successful start at 800% or 1100% during the initial set-up, may result in a nuisance trip in the future. A future trip of the circuit breaker would require the cause of the trip to be investigated and the condition of the controller to be assessed prior to an attempt to restart. The act of investigation the condition of the controller (likely in an energized motor control center) could result a greater safety issue than just allowing a setting up to 1300% or 1700% in the first place.
If there is a concern in regard to the motor overload opening a contactor at high currents, then perhaps the initial setting of an instantaneous trip circuit breaker could be increased to 1000% from 800% since contactors are subjected to a 1000% current withstand test, with the contactor ultimately being opened by the overload relay.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 413-NFPA 70-2020 [Section No. 430.52(C)(1)]	needs to be changed together
Public Input No. 413-NFPA 70-2020 [Section No. 430.52(C)(1)]	

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Public Input No. 2587-NFPA 70-2020 [Section No. 430.61]

430.61 General.

Part V specifies protective devices intended to protect feeder conductors supplying motors against overcurrents due to short circuits or ~~grounds~~ ground-faults .

Informational Note: See Informative Annex D, Example D8.

Statement of Problem and Substantiation for Public Input

The correct term is ground-fault and not grounds.

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Public Input No. 2251-NFPA 70-2020 [Section No. 430.62(A)]

(A) Specific Load.

A feeder supplying a specific fixed motor load(s) and consisting of conductor sizes based on 430.24 shall be provided with a protective device having a rating or setting not greater than the largest rating or setting of the branch-circuit short-circuit and ground-fault protective device for any motor supplied by the feeder [based on the maximum permitted value for the specific type of ~~a protective~~ feeder protective device employed in accordance with 430.52, or 440.22(A) for hermetic refrigerant motor-compressors], plus the sum of the full-load currents of the other motors of the group.

Where the same rating or setting of the branch-circuit short-circuit and ground-fault protective device is used on two or more of the branch circuits supplied by the feeder, one of the protective devices shall be considered the largest for the above calculations.

Exception No. 1: Where ~~one or more instantaneous trip circuit breakers or motor short-circuit protectors are used for motor branch-circuit short-circuit and ground-fault protection as permitted in 430.52(C) ,~~ the ~~procedure provided above for determining the maximum rating of the~~ feeder ~~protective device shall apply with the following provision: For the purpose of the calculation, each instantaneous trip circuit breaker or motor short-circuit protector shall be assumed to have a rating not exceeding the maximum percentage of motor full-load current permitted by Table 430.52 for the type of feeder protective device employed. Exception No. 2: Where the feeder~~ overcurrent protective device also provides overcurrent protection for a motor control center, the provisions of 430.94 shall apply.

Informational Note: See Informative Annex D, Example D8.

Statement of Problem and Substantiation for Public Input

The feeder OCPD should be calculated with the multiplier from Table 430.52 for the type of OCPD protecting the feeder, and exception No 1 should be deleted for the following reasons:

1. Due to the differing trip curves of OCPD's, when a different type of OCPD is used for the feeder than for some or all of the branch circuits, the feeder OCPD may trip on an inrush current that can be tolerated by the branch OCPD, if the multiplier for the type of OCPD used for the branch is used in the feeder OCPD calculation. This creates the possibility of opening the feeder and all of the motors connected when no fault has occured, or the fault has occured in only one of the derived branch circuits. This change clarifies what I believe is the intent of the article, and is already common installation practice.

2. The exception proposed to be removed explains the appropriate procedure for sizing the feeder OCPD, but gives the impression that this method is only to be used if ITCB's are used to protect the branch circuits. This further confuses the intent of the article.

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Public Input No. 4279-NFPA 70-2020 [Section No. 430.72(C)(1)]

(1) ~~Compliance with Article 725~~ Class 1 Power-Limited, Class 2, or Class 3 Circuits .

Where the transformer supplies a Class 1 power-limited circuit, Class 2, or Class 3 remote-control circuit complying with the requirements of ~~Article~~ 725.35 , protection shall comply with Part II of Article 725.

Statement of Problem and Substantiation for Public Input

Section 4.1.4 of the 2020 NEC(R) Style Manual prohibits references to an entire article, with the exception of Article 100. As such, it is recommended to change the section heading to "Class I Power-Limited, Class 2, or Class 3 Circuits" and point the user to 725.35 and Part II of Article 725 to comply while keeping the requirement unchanged.

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Committee: NEC-P11

Public Input No. 4284-NFPA 70-2020 [Section No. 430.72(C)(2)]

(2) ~~Compliance with Article 450~~ Transformers .

Protection shall be permitted to be provided in accordance with 450.3.

Statement of Problem and Substantiation for Public Input

Section 4.1.4 of the 2020 NEC(R) Style Manual prohibits references to an entire article, with the exception of Article 100. As such, it is recommended to change the heading of this section to "Transformers" to comply.

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Public Input No. 3615-NFPA 70-2020 [Section No. 430.95]

430.95 Bonding of Service Equipment~~.~~

~~Where used as service equipment, each motor control center shall be provided with a single main disconnecting means to disconnect all ungrounded service conductors~~ .

~~*Exception: A second service disconnect shall be permitted to supply additional equipment.*~~

Where a grounded conductor is provided, the motor control center shall be provided with a main bonding jumper, sized in accordance with 250.28(D), within one of the sections for connecting the grounded conductor, on its supply side, to the motor control center equipment ground bus.

Exception: High-impedance grounded neutral systems shall be permitted to be connected as provided in 250.36.

Statement of Problem and Substantiation for Public Input

Article 230 includes general requirements for service equipment, including the number of service disconnects allowed for various pieces of equipment (Section 230.71). The first portion of Section 430.95 should be removed and instead the topic should be addressed in Article 230. See Related PI to revise 230.71.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 3619-NFPA 70-2020 [Section No. 230.71(B)]	
Public Input No. 3619-NFPA 70-2020 [Section No. 230.71(B)]	

Submitter Information Verification

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Committee: NEC-P11

Public Input No. 1360-NFPA 70-2020 [Section No. 430.96]

430.96 Equipment Grounding Conductor .

Multisection motor control centers shall be connected together with an equipment grounding conductor or an equivalent equipment grounding bus sized in accordance with Table 250.122. Equipment grounding conductors shall be connected to this equipment grounding bus or to a grounding termination point provided in a single-section motor control center.

Statement of Problem and Substantiation for Public Input

According to the NFPA Style Manual, the Section Title needs to reflect the content of the rule. The rule is about the equipment grounding conductor, not about 'Grounding.'

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Public Input No. 4285-NFPA 70-2020 [Section No. 430.97(C)]

(C) Minimum Wire-Bending Space.

The minimum wire-bending space at the motor control center terminals and minimum gutter space shall be as required in ~~Article~~ 312. 6(B) .

Statement of Problem and Substantiation for Public Input

Section 4.1.4 of the 2020 NEC(R) Style Manual prohibits references to an entire article, with the exception of Article 100. As such, it is recommended to change to point the user to the specific section in 312 that applies, in this 312.6(B).

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Committee: NEC-P11

Public Input No. 3941-NFPA 70-2020 [New Section after 430.99]

Absence of Voltage Test & Indication

A means shall be provided to verify the absence of voltage in accordance with an acceptable industry practice that does not expose personnel to shock or arc flash hazards or live parts at the disconnecting means for any voltage supplies or stored energy sources that present an shock or arc flash hazard up to and including 1000V.

Informational Note: NFPA 70E-2021 Standard for Electrical Safety in the Workplace provides guidance for safely verifying the absence of voltage including the use of devices like a permanently mounted absence of voltage tester.

Statement of Problem and Substantiation for Public Input

Testing for absence of voltage is an important step that helps increase safety by detecting several conditions that could lead to an electrical incident:

- Power remains on if the wrong disconnecting means is utilized or the source is mislabeled (see examples from OSHA Summaries)
- Presence of stored electrical energy from a capacitor, present after the disconnect is opened and locked out (see examples from OSHA Summaries)
- Power remains present when the disconnect handle is in the off position if the disconnect experiences a mechanical failure (see Recall Notices below)

An easily accessible means to test for and visually convey the status of presence and absence of voltage that is part of the equipment installation at the point of work before accessing motor control center mains, bus, and units would prevent this type of incident (several examples are included below) and further the purpose of the code in practical safeguarding of persons and property by leveraging safety by design principles. Absence of Voltage Testers (AVT) listed to UL 1436 are permanently mounted testers that visually indicate when all voltages are less than 3 V (ac and dc) at the test point. This test is initiated before doors and covers are removed preventing accidental contact with energized parts. AVTs listed to UL 1436 have been recognized as an acceptable method to test for the absence of voltage in NFPA 70E since 2018 (120.5 (7) Exception 1).

Permanently mounted AVTs installed on or near the equipment increase the likelihood that the test for absence of voltage test occurs before the equipment is accessed when compared to portable voltage test instruments. Additionally, AVTs often have a feature to visually indicate when ac or dc voltage that would cause a shock hazard is present. In each of the incidents described below, the voltage presence indicators (for AC and DC) would have provided a visual warning that voltage was still present.

OSHA Fatality and Catastrophe Investigation Summaries
A keyword search of the OSHA Fatality and Catastrophe Investigation Summaries (https://www.osha.gov /pls/imis/accidentsearch.html) reveals several incidents resulting in severe injury or death that are attributed to failure to test for absence of voltage after de-energizing the disconnecting means. An example from a motor control center:

Report ID 0729700
An employee was repairing the head switch of the primary motor control center at an oil pumping site. The oil pump motor control center and the saltwater motor control center were not labeled as to what circuits were either controlled by them and/or passed through them. The motor control center was secured in anticipation of replacing the head switch. The employee opened a nearby junction box to perform the initial disconnection of wiring to the switch. The employee came into contact with a 480 volt unused circuit that passed through the motor control center. This 480 volt circuit was not de-energized by the cutout used to secure the motor control center and the employee did not test the circuits within the junction box to ensure they were all de-energized and sustained extensive electrical burns to the right hand and less serious burns to the left.

Note: there are other examples with similar incidents from components in other equipment that are sometimes located within a motor control center.

Disconnect Recall Notices
Several brands of disconnects that are commonly used in industrial and commercial applications have experienced recalls due to defects that allow power to remain present when the disconnect handle is in the off position, posing a shock hazard. This failure mode is an example of why testing for absence of voltage is critical in all applications.
Recalls (https://www.cpsc.gov/Recalls)
1. Example 1
Company A recalled more than a million safety switches manufactured between January 1, 2014 and January 18, 2018 because the power can stay on when the safety switch handle is in the off position, posing an electric shock or electrocution hazard. The switches may be installed in or around commercial buildings, outbuildings, apartments and homes with air conditioning units.
2. Example 2
Company B issued a safety recall of 26 models of safety switches that may not disconnect power when the handle is in the “off” position. The affected devices cover certain models of 30A and 60A heavy-duty safety switches manufactured between Nov. 19, 2015, and Jan. 23, 2018.
3. Example 3
Company C recalled 19,000 toggle and rotary switches. When switched OFF, one electrical pole may remain energized, posing a risk of electrical shock hazard. The switches are typically used with HVAC units, electric distribution and control panels and industrial uses. Primarily the switches are used commercially, however they may also be found in residential applications.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 3835-NFPA 70-2020 [New Section after 110.25]	
Public Input No. 3908-NFPA 70-2020 [New Part after I.]	

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Public Input No. 2356-NFPA 70-2020 [Section No. 430.102(A)]

(A) Controller.

An individual disconnecting means shall be provided for each controller and shall disconnect the controller. The disconnecting means shall be located in sight from the controller location.

Exception No. 1: For motor circuits over 1000 volts, nominal, a controller disconnecting means lockable in accordance with 110.25 shall be permitted to be out of sight of the controller, provided that the controller is marked with a warning label giving the location of the disconnecting means.

Exception No. 2: A single disconnecting means shall be permitted for a group of coordinated controllers that drive several parts of a single machine or piece of apparatus. The disconnecting means shall be located in sight from the controllers, and both the disconnecting means and the controllers shall be located in sight from the machine or apparatus.

Exception No. 3: The disconnecting means shall not be required to be in sight from valve actuator motor (VAM) assemblies containing the controller where such a location introduces additional or increased hazards to persons or property and conditions (1) and (2) are met.

(1) The valve actuator motor assembly is marked with ~~a warning label~~ a label giving the location of the disconnecting means.

(2) The disconnecting means is lockable in accordance with 110.25.

Statement of Problem and Substantiation for Public Input

The NEC invokes, by informational note, an abiding by the ANSI standard Z535.4 Sign and Label Requirements as in 110.16(B), 110.21(B). This standard reserves the use of the term "warning" to indicate a potentially hazardous situation which, if not avoided, could result in death or serious injury. Similarly, other terms in this standard have specific boundaries for use; danger, caution, notice, instruction. For consistency of code text, the word "warning" should be deleted.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 2341-NFPA 70-2020 [Section No. 430.113]	related topic
Public Input No. 2400-NFPA 70-2020 [Section No. 600.6(A)(2)]	related topic
Public Input No. 2401-NFPA 70-2020 [Section No. 110.21(B)]	related topic
Public Input No. 2400-NFPA 70-2020 [Section No. 600.6(A)(2)]	
Public Input No. 2401-NFPA 70-2020 [Section No. 110.21(B)]	

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Public Input No. 3099-NFPA 70-2020 [Section No. 430.110(C)(1)]

(1) Horsepower Rating.

The rating of the disconnecting means shall be determined from the sum of all currents, including resistance loads, at the full-load condition and also at the locked-rotor condition. The combined full-load current and the combined locked-rotor current so obtained shall be considered as a single motor for the purpose of this requirement as follows.

The full-load current equivalent to the horsepower rating of each motor shall be selected from Table 430.247, Table 430.248, Table 430.249, or Table 430.250. These full-load currents shall be added to the rating in amperes of other loads to obtain an equivalent full-load current for the combined load.

The locked-rotor current equivalent to the horsepower rating of each motor shall be selected from Table 430.251(A) or Table 430.251(B). The locked-rotor currents shall be added to the rating in amperes of other loads to obtain an equivalent locked-rotor current for the combined load. Where two or more motors or other loads cannot be started simultaneously, the largest sum of locked-rotor currents of a motor or group of motors that can be started simultaneously and the full-load currents of other concurrent loads shall be permitted to be used to determine the equivalent locked-rotor current for the simultaneous combined loads. In cases where different current ratings are obtained when applying these tables, the largest value obtained shall be used.

Exception No.1 : The locked-rotor current equivalent to the horsepower rating of each polyphase motor with design letter A shall be the motor's marked value of locked-rotor ameres or in absence of thise marking, determined by obtaining the maximum value within the range of kilvolt-amperes per horsepower with locked rotor in Table 430.7(B) associated with the motor's marked value of code letter and then multiplying this maximum value this range by the product (577.35 *motor's marked value of rated horsepower) and then dividing this resulting value by the motor's marked value of rated volts.

Exception No. 2: Where part of the concurrent load is resistance load, and where the disconnecting means is a switch rated in horsepower and amperes, the switch used shall be permitted to have a horsepower rating that is not less than the combined load of the motor(s), if the ampere rating of the switch is not less than the locked-rotor current of the motor(s) plus the resistance load.

Statement of Problem and Substantiation for Public Input

As the footnote for Table 430.251(B) states, Design A motors are not limited by any code or standard to a maximum value of locked-rotor current. Typically, Design A motors have a value of locked-rotor current that is significantly higher than their Design B, C, and D counterparts. 430.110(C) presently does not address how to determine the locked-rotor current equivalent to the horsepower rating for Design A motors that are a part of combination loads and this omission could result in the selection of undersized disconnecting means. While the locked-rotor current of Design A motors is not limited by any code or standard, it is limited by the manufacturer-selected value of locked-rotor amperes or code letter that appears on the motor’s markings as required by 430.7(A)(8). It is proposed to utilize in 430.110(C)(1) this marking to determine the locked-rotor current equivalent to the horsepower rating for Design A motors that are a part of combination loads.

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Public Input No. 2341-NFPA 70-2020 [Section No. 430.113]

430.113 Energy from More Than One Source.

Motor and motor-operated equipment receiving electric energy from more than one source shall be provided with disconnecting means from each source of electric energy immediately adjacent to the equipment served. Each source shall be permitted to have a separate disconnecting means. Where multiple disconnecting means are provided, a permanent ~~warning~~ sign shall be provided on or adjacent to each disconnecting means indicating that multiple sources must be shut off to remove all power to the equipment . The sign at each disconnect shall identify the other specific circuits..

Exception No. 1: Where a motor receives electric energy from more than one source, the disconnecting means for the main power supply to the motor shall not be required to be immediately adjacent to the motor, provided that the controller disconnecting means is lockable in accordance with 110.25.

Exception No. 2: A separate disconnecting means shall not be required for a Class 2 remote-control circuit conforming with Article 725, rated not more than 30 volts, and isolated and ungrounded.

Statement of Problem and Substantiation for Public Input

1) remove the word "warning"; the NEC invokes, by informational note, an abiding by the ANSI standard Z535.4 Sign and Label Requirements as in 110.16(B), 110.21(B). This standard reserves the use of the term "warning" to indicate a potentially hazardous situation which, if not avoided, could result in death or serious injury. Similarly, other terms in this standard have boundaries for use; danger, caution, notice, instruction. Other code text, that advocates signage to indicate multiple sources of power, does not characteristically invoke the term "warning"; 225.37, 225.52(F), 409.110(3), 422.30, 424.19, 520.54(C), 547.9(D), 620.52, 620.55, 690.4(D), 705.10, 706.21(A).
2) Also, whenever any of these five label/sign header terms of ANSI standard Z535.4 are used, the standard advocates consistency in text color and background color. So whenever code text uses these terms to describe a label or sign requirement, the ANSI standard Z535.4 should be referenced in an informational note to further the consistency within NEC code text. It may be prudent to formalize a single consistent label header for this category of signage that applies to multiple source of power, whether or not one of the five ANSI standard Z535.4 terms are used.

Informational Note: ANSI Z535.4-2011, Product Safety Signs and Labels, provides guidelines for the design and durability of safety signs and labels for application to electrical equipment.

3) Include clarification that the signage required should reference the identification of the source of the other circuits involved, similar to what is typically done among other similar requirements of; 225.37, 225.52(F), 409.110(3), 422.30, 424.19, 520.54(C), 547.9(D), 620.52, 620.55, 690.4(D), 705.10, 706.21(A).

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 2356-NFPA 70-2020 [Section No. 430.102(A)]	
Public Input No. 2400-NFPA 70-2020 [Section No. 600.6(A)(2)]	
Public Input No. 2401-NFPA 70-2020 [Section No. 110.21(B)]	

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Committee:	NEC-P11

Public Input No. 4288-NFPA 70-2020 [Section No. 430.113]

430.113 Energy from More Than One Source.

Motor and motor-operated equipment receiving electric energy from more than one source shall be provided with disconnecting means from each source of electric energy immediately adjacent to the equipment served. Each source shall be permitted to have a separate disconnecting means. Where multiple disconnecting means are provided, a permanent warning sign shall be provided on or adjacent to each disconnecting means.

Exception No. 1: Where a motor receives electric energy from more than one source, the disconnecting means for the main power supply to the motor shall not be required to be immediately adjacent to the motor, provided that the controller disconnecting means is lockable in accordance with 110.25.

Exception No. 2: A separate disconnecting means shall not be required for a Class 2 remote-control circuit conforming with Parts I and III of Article 725, rated not more than 30 volts, and isolated and ungrounded.

Statement of Problem and Substantiation for Public Input

Section 4.1.4 of the 2020 NEC(R) Style Manual prohibits references to an entire article, with the exception of Article 100. As such, it is recommended to change the reference to Parts I and III of Article 725 as 725.35 requires compliance with those specific parts for Class II circuits.

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Public Input No. 2059-NFPA 70-2020 [Section No. 430.120]

430.120 General.

The installation provisions of Part I through Part IX are applicable unless modified or supplemented by Part X.

Power conversion equipment used in adjustable-speed drive systems with input ratings of 1000 V or lower, and output ratings of over 1000 V, or vice versa, shall comply with Part X for circuits rated 1000 V or lower, and Part XI for circuits rated over 1000 V .

Statement of Problem and Substantiation for Public Input

Substantiation:
Variable speed drive systems may use power conversion equipment that includes internal transformers, such that the output voltage does not match the input voltage. When only one of these voltages is over 1000 V, the requirements of Part XI are only applicable to the higher voltage circuits. This proposal makes it clear which portions of Part X and Part XI need to be considered for the circuits of different voltages.

NOTE TO CMP: For some reason, TerraView shows the first sentence in this PI underlined as if it were new text, but it is the existing text in section 430.120. This PI is only intended to add the new text shown in the second paragraph (starting with "Power conversion...") The original text (starting with "The installation...) should remain as the first sentence in section 430.120.

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Public Input No. 524-NFPA 70-2020 [Section No. 430.122]

430.122 Conductors — Minimum Size, Properties, and Ampacity.

(A) Branch/Feeder Circuit Conductors.

Circuit conductors supplying power conversion equipment included as part of an adjustable-speed drive system shall have an ampacity not less than 125 percent of the rated input current to the power conversion equipment.

Informational Note ~~No. 1~~ : Power conversion equipment can have multiple power ratings and corresponding input currents.

~~Informational Note No. 2: Circuit conductors on the output of an adjustable-speed drive system are susceptible to breakdown under certain conditions due to the characteristics of the output waveform of the drive. Factors affecting the conductors include but are not limited to the output voltage, frequency, and current, the length of the conductors, the spacing between the conductors, and the dielectric strength of the conductor insulation. Methods to mitigate breakdown include consideration of one or more of these factors.~~

(B) Output ~~Conductors~~ Conductor Properties and Ampacity .

The conductors between the power conversion equipment and the motor shall have an ampacity equal to or larger than 125 percent of the motor full-load current as determined by 430.6(A) or (B). The conductors shall be listed as suitable for use as adjustable speed drive output conductors, and shall have a voltage rating greater than or equal to the larger of:

(1) The peak value of the motor nameplate RMS voltage rating

(2) The peak value, as determined by multiplying the ratio of the RMS voltage to frequency, according to the motor nameplate ratings, by the maximum frequency the motor is expected to be operated at, where applications require a frequency above the motor nameplate rating, and the motor is listed for use in this manner

Exception: If the power conversion equipment is listed and marked as "Suitable for Output Motor Conductor Protection," the conductor between the power conversion equipment and the motor shall have an ampacity equal to or greater than the larger of:

(1) 125 percent of the motor full load current as determined by 430.6(A) or (B)

(2) The ampacity of the minimum conductor size marked on the power conversion equipment

Informational Note No. 1 : The minimum ampacity required of output conductors is often different than that of the conductors supplying the power conversion equipment. See 430.130 and 430.131 for branch circuit protection requirements.

Informational Note No. 2: Circuit conductors on the output of an adjustable-speed drive system are susceptible to breakdown under certain conditions due to the characteristics of the output waveform of the drive. Factors affecting the conductors include but are not limited to the output voltage, frequency, and current, the length of the conductors, the spacing between the conductors, and the dielectric strength of the conductor insulation. Methods to mitigate breakdown include consideration of one or more of these factors.

(C) Bypass Device.

For an adjustable-speed drive system that utilizes a bypass device, the conductor ampacity shall not be less than required by 430.6. The ampacity of circuit conductors supplying power conversion equipment included as part of an adjustable-speed drive system that utilizes a bypass device shall be the larger of either of the following:

(1) 125 percent of the rated input current to the power conversion equipment

(2) 125 percent of the motor full-load current rating as determined by 430.6

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

Conductors supplying several motors or a motor and other loads, including power conversion equipment, shall have ampacity in accordance with 430.24, using the rated input current of the power conversion equipment for purposes of calculating ampacity.

Statement of Problem and Substantiation for Public Input

As stated by the IN No. 2, added to 430.122(A) in the 2020 NEC, increasing studies have shown premature failure in the output conductors on an adjustable speed drive, correlating with the type of conductor used. For example, in a 480-volt-rated, 60Hz drive application, the PWM voltage at 60Hz is transmitted at the peak voltage, or 684V of a 480-volt, 60Hz waveform. The use of THHN conductors, for example, in this application, would not be acceptable, as the voltage rating of 600V is already exceeded. Furthermore, the high-capacitance, low-resistance properties of THHN can create voltage spikes in the conductors in excess of 1200V. XHHW-2 insulation is rated at 1000V, and its conductor properties are better suited to handle the PWM output from an adjustable speed drive. A cable assembly that is listed as suitable for use as output conductors for an adjustable speed drive, or conductors that are listed for this purpose, would cut down on the premature failure rates of these installations. The titles of 430.122 and 430.122(B) is changed to reflect the requirement for the properties of the output conductors as a whole to be considered, and 430.122(A), IN No. 2 is moved to 430.122(B), to align with the proper subdivision.

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Public Input No. 2086-NFPA 70-2020 [Sections 430.122(A), 430.122(B)]

Sections 430.122(A), 430.122(B)

(A) Branch/Feeder Circuit Conductors.

Circuit conductors supplying power conversion equipment included as part of an adjustable-speed drive system shall have an ampacity not less than 125 percent of the rated input current to the power conversion equipment.

Informational Note No. 1: Power conversion equipment can have multiple power ratings and corresponding input currents.

~~Informational Note No. 2: Circuit conductors on the output of an adjustable-speed drive system are susceptible to breakdown under certain conditions due to the characteristics of the output waveform of the drive. Factors affecting the conductors include but are not limited to the output voltage, frequency, and current, the length of the conductors, the spacing between the conductors, and the dielectric strength of the conductor insulation. Methods to mitigate breakdown include consideration of one or more of these factors.~~

(B) Output Conductors.

The conductors between the power conversion equipment and the motor shall have an ampacity equal to or larger than 125 percent of the motor full-load current as determined by 430.6(A) or (B).

Exception: If the power conversion equipment is listed and marked as “Suitable for Output Motor Conductor Protection,” the conductor between the power conversion equipment and the motor shall have an ampacity equal to or greater than the larger of:

(1) 125 percent of the motor full load current as determined by 430.6(A) or (B)

(2) The ampacity of the minimum conductor size marked on the power conversion equipment

Informational Note: The minimum ampacity required of output conductors is often different than that of the conductors supplying the power conversion equipment. See 430.130 and 430.131 for branch circuit protection requirements.

Informational Note No. 2: Circuit conductors on the output of an adjustable-speed drive system are susceptible to breakdown under certain conditions due to the characteristics of the output waveform of the drive. Factors affecting the conductors include but are not limited to the output voltage, frequency, and current, the length of the conductors, the spacing between the conductors, and the dielectric strength of the conductor insulation. Methods to mitigate breakdown include consideration of one or more of these factors.

Statement of Problem and Substantiation for Public Input

During the 2020 code cycle, 430.122(A) informational note no. 2 and section 430.122(B) Output Conductors were added. Informational note no. 2 to 430.122(A) pertains to output conductors of an adjustable-speed drive system and was proposed to be added to 430.122(A) because at the time, 430.122(B) did not exist. Now that 430.122(B) has been added with requirements related to conductors on the output of an adjustable-speed drive system, information note no. 2 of 430.122(A) would be more appropriate as an informational note to 430.122(B). This public input is to move informational note no. 2 from 430.122(A) to 430.122(B).

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Public Input No. 2543-NFPA 70-2020 [Section No. 430.122(B)]

(B) Output Conductors.

The conductors between the power conversion equipment and the motor shall have an ampacity equal to or larger than 125 percent of the motor full-load current as determined by 430.6(A) or (B).

Exception: If the power conversion equipment is listed and marked as “Suitable for Output Motor Conductor Protection,” the conductor between the power conversion equipment and the motor shall have an ampacity equal to or greater than the larger of:

(1) 125 percent of the motor full load current as determined by 430.6(A) or (B)

(2) The ampacity of the minimum conductor size marked on the power conversion equipment

Informational Note No1 : The minimum ampacity required of output conductors is often different than that of the conductors supplying the power conversion equipment. See 430.130 and 430.131 for branch circuit protection requirements.

Informational Note No. 2: Circuit conductors on the output of an adjustable-speed drive system are susceptible to breakdown under certain conditions due to the characteristics of the output waveform of the drive. Factors affecting the conductors include but are not limited to the output voltage, frequency, and current, the length of the conductors, the spacing between the conductors, and the dielectric strength of the conductor insulation. Methods to mitigate breakdown include consideration of one or more of these factors. One method of mitigating the aforementioned issues is to use output conductor cables, constructed of thermoset insulated conductors, that have been evaluated for use with adjustable speed drive systems.

Additional Proposed Changes

File Name	Description	Approved
VFD_Cable_PI_Rev_2_.docx	Word Document of the Proposed PI with supporting substantiation for the proposal.	

Statement of Problem and Substantiation for Public Input

This Public Input is intended to be reviewed in two parts. Rationale for each part of the public input is provided below.

1) During the 2020 code cycle, 430.122(A) informational note no. 2 and section 430.122(B) Output Conductors were added. Informational note no. 2 to 430.122(A) pertains to output conductors of an adjustable-speed drive system and was proposed to be added to 430.122(A) because at the time, 430.122(B) did not exist. Now that 430.122(B) has been added with requirements related to conductors on the output of an adjustable-speed drive system, information note no. 2 of 430.122(A) would be more appropriate as an informational note to 430.122(B). This public input is to delete informational note no. 2 from 430.122(A) and add it to 430.122(B).

2) The addition to the informational note starting at the sentence “one method” serves to further clarify a method of mitigation for cables when used with adjustable speed drives. The inclusion of thermoset insulated conductors is supported by NEMA ICS 7.2-2015 “Application Guide for AC Adjustable Speed Drive Systems” section 5.4.4.2.1, which highlights differences in Partial Discharge Inception voltages between thermoplastic and thermoset insulated wires when used in adjustable speed drive applications.

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VFD Cable PI

ARTICLE 430- MOTORS, MOTOR CIRCUITS, AND CONTROLLERS

430.122(B) Output Conductors.

The conductors between the power conversion equipment and the motor shall have an ampacity equal to or larger than 125 percent of the motor full-load current as determined by 430.6(A) or (B).

Exception: If the power conversion equipment is listed and marked as "Suitable for Output Motor Conductor Protection," the conductor between the power conversion equipment and the motor shall have an ampacity equal to or greater than the larger of:

(1) 125 percent of the motor full load current as determined by 430.6(A) or (B)

(2) The ampacity of the minimum conductor size marked on the power conversion equipment

Informational Note No. 1: The minimum ampacity required of output conductors is often different than that of the conductors supplying the power conversion equipment. See 430.130 and 430.131 for branch circuit protection requirements.

Informational Note No. 2: Circuit conductors on the output of an adjustable-speed drive system are susceptible to breakdown under certain conditions due to the characteristics of the output waveform of the drive. Factors affecting the conductors include but are not limited to the output voltage, frequency, and current, the length of the conductors, the spacing between the conductors, and the dielectric strength of the conductor insulation. Methods to mitigate breakdown include consideration of one or more of these factors. One method of mitigating the aforementioned issues is to use output conductor cables, constructed of thermoset insulated conductors, that have been evaluated for use with adjustable speed drive systems.

Substantiation for the proposal:

This Public Input is intended to be reviewed in two parts. Rationale for each part of the public input is provided below.

1) During the 2020 code cycle, 430.122(A) informational note no. 2 and section 430.122(B) Output Conductors were added. Informational note no. 2 to 430.122(A) pertains to output conductors of an adjustable-speed drive system and was proposed to be added to 430.122(A) because at the time, 430.122(B) did not exist. Now that 430.122(B) has been added with requirements related to conductors on the output of an adjustable-speed drive system, information note no. 2 of 430.122(A) would be more appropriate as an informational note to 430.122(B). This public input is to delete informational note no. 2 from 430.122(A) and add it to 430.122(B).

2) The addition to the informational note starting at the sentence "one method" serves to further clarify a method of mitigation for cables when used with adjustable speed drives. The inclusion of thermoset insulated conductors is supported by NEMA ICS 7.2-2015 "Application Guide for AC Adjustable Speed Drive Systems" section 5.4.4.2.1, which highlights differences in Partial Discharge Inception voltages between thermoplastic and thermoset insulated wires when used in adjustable speed drive applications.

Public Input No. 1094-NFPA 70-2020 [Section No. 430.122(C)]

(C) Bypass Device.

For an adjustable-speed drive system that utilizes a bypass device, the conductor ampacity shall not be less than required by 430.6. The ampacity of circuit conductors supplying power conversion equipment included as part of an adjustable-speed drive system that utilizes a bypass device shall be the larger of either of the following:

(1) 125 percent of the rated input current to the power conversion equipment

(2) 125 percent of the motor full-load current rating as determined by 430.6

(3)

<u>The ampacity of the minimum conductor size marked on the power conversion equipment as determined in 430.122(B)(2).</u>

<u>Informational Note: The minimum ampacity required of output conductors is often different from that of the conductors supplying the power conversion equipment. See 430.130 and 430.131 for branch circuit protection requirements.</u>

Statement of Problem and Substantiation for Public Input

The minimum ampacity required of output conductors is often different from that of the conductors supplying the power conversion equipment. Depending on the configuration for the system's power wiring, conformance will be assured by all components of the system.

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Submittal Date: Sat May 16 09:58:48 EDT 2020
Committee: NEC-P11

Public Input No. 1588-NFPA 70-2020 [Section No. 430.122(C)]

(C) Bypass Device.

~~For an adjustable-speed drive system that utilizes a bypass device, the conductor ampacity shall not be less than required by 430.6 .~~ The ampacity of circuit conductors supplying power conversion equipment included as part of an adjustable-speed drive system that utilizes a bypass device shall be the larger of either of the following:

(1) 125 percent of the rated input current to the power conversion equipment

(2) 125 percent of the motor full-load current rating as determined by 430.6

Statement of Problem and Substantiation for Public Input

The current wording for 430.122(C) indicates that 430.6 would provide the conductor ampacity. Article 430.6 only provides direction on what FLC should be used to do the cacluation. Removing the first sentence would clarify the requirement.

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Submittal Date: Mon Jun 22 17:30:06 EDT 2020
Committee: NEC-P11

Public Input No. 2060-NFPA 70-2020 [New Section after 430.224]

430.XX Wire-Bending Space in Enclosures

Motor controllers rated over 1000 V shall provide space within the enclosure to comply with 300.34.

Statement of Problem and Substantiation for Public Input

Substantiation:
As currently written, 430.10(B) applies to all motor controllers, regardless of voltage rating. The wire bending space in Table 430.10(B) is only for low voltage cables, and is not appropriate for medium voltage cables. Adding the new section in Part XI as proposed clarifies how bending space is to be determined for other than low voltage motor controllers.

NOTE TO CMP: Although it makes sense to place this before section 430.224 to keep the order similar to other parts of this Article, but this would require the rest of Part XI to be renumbered, so it could be added at the end of Part XI if that is preferable.

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Submittal Date: Mon Jul 27 08:29:54 EDT 2020
Committee: NEC-P11

Public Input No. 2058-NFPA 70-2020 [Section No. 430.224]

430.224 Size of Conductors.

The ampacities of conductors supplying equipment rated over 1000 V, nominal, shall be determined based on 311.60, and 430.224(A) and (B):

(A) Conductors supplying motors shall have an ampacity not less than the current at which the motor overload protective device(s) is selected to trip.

(B) For an adjustable speed drive system, the ampacity of the conductors supplying the power conversion equipment shall have an ampacity not less than 125 percent of the rated input current to the power conversion equipment.

Statement of Problem and Substantiation for Public Input

Substantiation:
Section 430.224 provides guidance for sizing conductors supplying motors, but does not provide further guidance for determining ampacity of medium voltage conductors. Since there is no other guidance in Part XI of Article 430, the user would default to the general requirements in Part I, but 430.6 only provides guidance for low voltage conductors. The references to Article 310 are not appropriate for medium voltage cables. Furthermore, 430.224 only addresses conductors supplying motors. When an adjustable speed drive is used, guidance for sizing of the input conductors to the drive is needed. This public input provides the necessary references to determine the correct ampacity for conductors in medium voltage motor circuits.

NOTE TO CMP - the text that now appears in item (A) is NOT new text, but for some reason, TerraView marks it as new next. This text was the original (and only) text in 430.224, and this PI simply moves it to a new item (A) under the new "lead-in" text that is being proposed, along with new text that appears in item (B)

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Submittal Date: Mon Jul 27 08:11:14 EDT 2020
Committee: NEC-P11

Public Input No. 2118-NFPA 70-2020 [Section No. 430.224]

430.

~~224~~
224 Minimum Size of Motor Circuit Conductors.

(A) Motor Branch Circuit Conductors

~~supplying motors shall have~~

. Motor branch circuit conductors supplying a single motor shall have an ampacity not less than the current at which the motor overload protective device(s)

~~is selected to trip.~~

and fault-current device(s) are selected to trip , and if continuous duty, shall also comply with either (a) or (b):

(1) Continuous Duty.

(a) For an induction-type squirrel cage or wound rotor motor, the branch circuit conductors shall have an ampacity not less than 125% of the motor nameplate full-load current rating.

(b) For synchronous motors, the branch circuit conductors shall have an ampacity not less than 125% of the motor nameplate full-load current rating at unity power factor. Field excitation conductors shall be protected against overcurrent according to the exciter device manufacturer instructions.

(B) Feeder Circuit Conductors. Feeder circuit conductors supplying equipment from which more than one motor or other non-motor loads over 1000 volts, nominal are supplied, shall have an ampacity not less than the current at which the overload protection device(s) and fault-current device(s) are selected to trip and shall comply with the following where applicable:

(1) Continuous Duty Motors and Other Loads.

Feeder conductors supplying equipment from which at least one continuous duty motor is supplied in addition to other motors or non-motor loads, shall have an ampacity not less than 125% of the largest full-load motor nameplate current rating, plus 100% of the current ratings of the other loads. Where the continuous duty motor is a synchronous motor, the unity power factor current nameplate rating shall be used.

(C) Engineering Supervision. Overload and fault-current device(s) settings for each feeder or motor branch circuit shall be determined under the supervision of a qualified licensed professional engineer.

Statement of Problem and Substantiation for Public Input

This proposal is a companion proposal for a new definition for motor branch circuit in Art. 100. In addition, it revises the current language to include the "fault-current device(s)" which are required by 430.225(C).

One of the principles of the NEC is where there is a continuous load, a factor of 125% must be used for calculating the minimum conductor size. It is not clear in Art. 430 in the 2020 edition that this principle applies to motors over 1000 volts as it does for motors less than 1000 volts. Adding this text would clarify that in addition to being protected by the overload and fault-current device (usually a protection relay), there is a minimum requirement of 125% of the continuous motor load which must be considered.

Calculating conductor sizes of circuits over 1000 volts, nominal and performing relay coordination requires special skills, and sometimes software, that an electrician, inspector, or designer alone may not possess. Adding this requirement would clarify the level of engineering supervision required. The proposed terminology for the level of engineering supervision is already used in 490.48 for substations.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 2120-NFPA 70-2020 [Article 100]	motor branch circuit and feeder circuits
Public Input No. 2450-NFPA 70-2020 [New Definition after Definition: Branch Circuit, Individual.]	
Public Input No. 2452-NFPA 70-2020 [Section No. 430.225(B)(1)]	

Submitter Information Verification

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Submittal Date:	Sat Aug 01 21:30:20 EDT 2020
Committee:	NEC-P11

Public Input No. 2057-NFPA 70-2020 [Section No. 430.225(A)]

(A) General.

Each motor circuit shall include coordinated protection to automatically interrupt overload and fault currents in the motor, the motor-circuit conductors, and the motor control apparatus.<u>Adjustable speed drive systems with input or output voltage ratings over 1000 V nominal shall comply with 430.124 and 430.126. All other motor circuits shall comply with 430.225(B) through (C).</u>

Exception: Where a motor is critical to an operation and the motor should operate to failure if necessary to prevent a greater hazard to persons, the sensing device(s) shall be permitted to be connected to a supervised annunciator or alarm instead of interrupting the motor circuit.

Statement of Problem and Substantiation for Public Input

Substantiation:
Section 430.225 provides requirements for motor-circuit overcurrent protection, but does not provide sufficient information for protection of motor circuits in adjustable speed drive systems. Including the reference to the appropriate clauses in Part X make it clear that section 430.225 does not amend the requirements for protection in adjustable speed drive systems, including motor overtemperature requirements.

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Committee: NEC-P11

Public Input No. 2451-NFPA 70-2020 [Section No. 430.225(A)]

(A) General.

Each motor circuit shall include coordinated protection to automatically interrupt overload and fault currents in the motor, the motor-circuit conductors, and the motor control apparatus. Overload and fault-current device(s) settings for each motor feeder or branch circuit shall be determined under the supervision of a qualified licensed professional engineer.

Exception: Where a motor is critical to an operation and the motor should operate to failure if necessary to prevent a greater hazard to persons, the sensing device(s) shall be permitted to be connected to a supervised annunciator or alarm instead of interrupting the motor circuit.

Statement of Problem and Substantiation for Public Input

The overload protective device(s) along with the fault-current devices settings should both be determined under engineering supervision.

The proposed language for the level of engineering supervision required is already used in Section 490.48 for substations.

This is a companion proposal for two others for the revision of 430.224 and 430.225(B)(1).

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 2452-NFPA 70-2020 [Section No. 430.225(B)(1)]	

Submitter Information Verification

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Submittal Date: Sun Aug 23 00:49:25 EDT 2020
Committee: NEC-P11

Public Input No. 2452-NFPA 70-2020 [Section No. 430.225(B)(1)]

(1) Type of Overload Device.

Each motor shall be protected against ~~dangerous heating~~ overheating due to ~~motor overloads and~~ an overload and a subsequent failure to start ~~by~~ . Protection shall be provided by a thermal protector integral with the motor ~~or external~~ , external current-sensing ~~devices~~ device(s) , or both. ~~Protective device settings for each motor circuit shall be determined under engineering supervision.~~

Statement of Problem and Substantiation for Public Input

This is a companion proposal to two others for Sections 430.224 and 430.225(A).

It also removes the adjective "dangerous" from the description of the level of overheating that may occur. Just because a motor may catch fire or has a fault due to overheating which results in a fire doesn't mean that it would necessarily be dangerous. All motors should be protected against overloads regardless if the result is dangerous or not.

This proposal also relocates and modifies the existing language for the required engineering supervision when determining the settings of the overload device.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 2118-NFPA 70-2020 [Section No. 430.224]	Protection of the motor circuit conductors
Public Input No. 2451-NFPA 70-2020 [Section No. 430.225(A)]	Engineering supervision requirements for both overload and fault-current protection.

Submitter Information Verification

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Submittal Date: Sun Aug 23 00:56:42 EDT 2020
Committee: NEC-P11

Public Input No. 2056-NFPA 70-2020 [Section No. 430.227]

430.227 Disconnecting Means.

The controller disconnecting means shall be a switch or circuit breaker having a voltage rating no less than that of the circuit involved, and shall be lockable in accordance with 110.25. The disconnecting means shall have an ampere rating not less than 115 percent of the full-load current rating of the motor. For adjustable speed drive systems, the disconnecting means shall have an ampere rating not less than 115 percent of the rated input current of the power conversion equipment.

Statement of Problem and Substantiation for Public Input

Substantiation:
The single sentence in 430.227 is insufficient to describe the requirements for the disconnect switch in circuits over 1000 V, nominal. Without additional text, the user might assume that 430.109 and 430.110 are applicable to equipment over 1000 V, which is not correct. The disconnect types identified in 430.109 are specifically low voltage type devices, and are not suitable for medium voltage circuits. In addition to specifying the type of device and the required current rating, the text regarding adjustable speed drive systems was added, since it might be assumed that 430.227 contains all the requirements and replaces 430.128 entirely.

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Submittal Date: Mon Jul 27 07:59:06 EDT 2020
Committee: NEC-P11

Public Input No. 1087-NFPA 70-2020 [Section No. 430.241]

430.241 General.

Part XIII specifies the grounding of exposed non–current-carrying metal parts, likely to become energized, of motor and controller frames to prevent a voltage ~~aboveground~~ above ground in the event of accidental contact between energized parts and frames. Insulation, isolation, or guarding are suitable alternatives to grounding of motors under certain conditions.

Statement of Problem and Substantiation for Public Input

Aboveground is an adjective denoting position relative to the surface of the surrounding earth, e.g., aboveground pool. Above ground specifies voltage level relative to ground potential.

Submitter Information Verification

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Submittal Date: Sat May 16 09:09:34 EDT 2020
Committee: NEC-P11

Public Input No. 4582-NFPA 70-2020 [Section No. 430.245(B)]

(B) Separation of Junction Box from Motor.

The junction box required by 430.245(A) shall be permitted to be separated from the motor by not more than 1.8 m (6 ft), provided the leads to the motor are stranded conductors within Type AC cable, interlocked metal tape Type MC cable where listed and identified in accordance with 250.118(10)(a), or armored cord or are stranded leads enclosed in liquidtight flexible metal conduit, flexible metal conduit, intermediate metal conduit, rigid metal conduit, or electrical metallic tubing not smaller than metric designator 12 (trade size ⅜), the armor or raceway being connected both to the motor and to the box.

Liquidtight flexible nonmetallic conduit and rigid ~~nonmetallic conduit~~ polyvinyl chloride conduit shall be permitted to enclose the leads to the motor, provided the leads are stranded and the required equipment grounding conductor is connected to both the motor and to the box.

Where stranded leads are used, protected as specified above, each strand within the conductor shall be not larger than 10 AWG and shall comply with other requirements of this *Code* for conductors to be used in raceways.

Statement of Problem and Substantiation for Public Input

The 2008 NEC first referenced Reinforced Thermosetting Resin Conduit (RTRC) as a wiring method (Article 355). High Density Polyethylene Conduit (HDPE) first appeared in the 2005 NEC as Article 353. When Article 352 first changed (2008 NEC) to be titled “Rigid Polyvinyl Chloride Conduit” there were many changes throughout the Code to pick up this change and accordingly change text from “rigid nonmetallic conduit” to “rigid polyvinyl chloride conduit.”

In the 2002 NEC, this section referenced “rigid nonmetallic conduit” (as it still does in the 2020 NEC) before RTRC and HDPE appeared in the Code. This makes it clear that this section intended to permit only the use of rigid polyvinyl chloride conduit identified as “rigid nonmetallic conduit” as the other raceway types were not recognized by the NEC at the time. This term should be changed to rigid polyvinyl chloride and if the cmp wishes to add other types of nonmetallic raceways they should be listed separately as the metal raceways are.

Submitter Information Verification

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Submittal Date: Thu Sep 10 15:24:31 EDT 2020
Committee: NEC-P11

Public Input No. 3633-NFPA 70-2020 [Section No. 440.2]

(Relocate all definitions in the 440. 2 to Article 100, arrange them in alphabetical order and without any subdivisions.)

440. 2 Definitions.

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

Branch-Circuit Selection Current.

The value in amperes to be used instead of the rated-load current in determining the ratings of motor branch-circuit conductors, disconnecting means, controllers, and branch-circuit short-circuit and ground-fault protective devices wherever the running overload protective device permits a sustained current greater than the specified percentage of the rated-load current. The value of branch-circuit selection current will always be equal to or greater than the marked rated-load current.

Leakage-Current Detector-Interrupter (LCDI).

A device provided in a power supply cord or cord set that senses leakage current flowing between or from the cord conductors and interrupts the circuit at a predetermined level of leakage current.

Rated-Load Current.

The current of a hermetic refrigerant motor-compressor resulting when it is operated at the rated load, rated voltage, and rated frequency of the equipment it serves.

Statement of Problem and Substantiation for Public Input

"The National Electrical Code has definitions in multiple parts in Article 100 and many definitions scattered through out the code many of them in the .2 section of the articles.
Most of the other standards under NFPA have their definitions in one location and this will allow the NEC the same requirement. The revisions to the NEC Style Manual require all the definitions to be relocated to Article 100. "

Submitter Information Verification

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Submittal Date: Wed Sep 09 09:53:41 EDT 2020
Committee: NEC-P11

Public Input No. 4292-NFPA 70-2020 [Section No. 440.3]

440.3 Other Articles.

(A) ~~Article 430~~ Motors .

See Table 440.3. These provisions are in addition to, or amendatory of ~~, the provisions of Article 430~~ ~~and~~ other articles in this *Code*, which apply except as modified in this article.

(B) ~~Articles 422, 424, or 430.~~

~~The rules of Articles 422 , 424 , or 430 , as applicable, shall apply to air-conditioning and refrigerating equipment~~

Air-Conditioning and Refrigerating Equipment that does not incorporate a hermetic refrigerant motor-compressor.

See Table 440.3. This equipment includes devices that employ refrigeration compressors driven by conventional motors, furnaces with air-conditioning evaporator coils installed, fan-coil units, remote forced air-cooled condensers, remote commercial refrigerators, and so forth.

(C) ~~Article 422.~~

~~Equipment such as room air conditioners, household refrigerators and freezers, drinking water coolers, and beverage dispensers shall be considered appliances, and Article 422 shall also apply~~

Room Air Conditioner,s Household Refrigerators and Freezers, Drinking Water Coolers, and Beverage Dispensers.

See Table 440.3. This equipment be considered as appliances and the rules of the applicable article shall apply unless modified in this article .

(D) Other Applicable Articles.

Hermetic refrigerant motor-compressors, circuits, controllers, and equipment shall also comply with the applicable provisions of Table 440.3(D).

Table 440.3(D) Other Articles

Equipment/Occupancy	Article	Section
Motors	–	
Appliances	430	460.9
Fixed Electric Space-Heating Equipment	422	
Capacitors	424	
Commercial garages, aircraft hangars, motor fuel dispensing facilities, bulk storage plants, spray application, dipping, and coating processes, and inhalation anesthetizing locations	511, 513, 514, 515, 516, and 517 Part IV	–
Hazardous (classified) locations	500–503, 505, and 506	–
Motion picture and television studios and similar locations	530	–
Resistors and reactors	470	–

Statement of Problem and Substantiation for Public Input

Section 4.1.4 of the 2020 NEC(R) Style Manual prohibits references to an entire article, with the exception of Article 100. In addition, references to other articles are to be listed in a table in accordance with Sections 2.5 and 2.3 of the NEC(r) Style Manual. As such, it is recommended that the CMP change the language as shown and incorporate a table making reference to other articles. The intent, here, is to comply with the style manual but not to change the requirements formerly stated in this section so careful review by the CMP is encouraged to make sure this has been done.

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Submittal Date:	Thu Sep 10 09:33:43 EDT 2020
Committee:	NEC-P11

Public Input No. 837-NFPA 70-2020 [New Section after 440.3(B)]

AC & Refrigeration Equipment Feeders

Feeders supplying 1 or more overcurrent protection devices for AC or refrigeration equipment shall be sized in accordance with article 430 Part V.

Statement of Problem and Substantiation for Public Input

Article 440 only addresses the sizing for OCPDs and conductors of branch circuits feeding equipment. In the event that an ocpd is installed at the equipment for any purpose, those conductors that are ahead of the equipment disconnect become feeders and are no longer addressed by article 440. This change would give a reference to size these feeders.

Submitter Information Verification

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Committee: NEC-P11

Public Input No. 2624-NFPA 70-2020 [Section No. 440.8]

440.8 Single Machine and location .

An air-conditioning or refrigerating system shall be considered to be a single machine under the provisions of 430.87, Exception No. 1, and 430.112, Exception. The motors shall be permitted to be located remotely from each other. Air Conditioning and refrigeration equipment shall not be installed in the bathtub and shower space.

Statement of Problem and Substantiation for Public Input

This input is being submitted on behalf of the Minnesota Department of Labor and Industry. The Department's 15 office/field staff, and 65 plus contract electrical inspectors complete over 150,000 electrical inspections annually and are involved in the daily enforcement and interpretation of the National Electrical Code.

In older homes with smaller bathrooms this is becoming a problem. With the lack of wall space in these bathrooms, and the fact that the bathtub is generally installed on an outside wall. This wall becomes a prime location for installing the utilization equipment such as a split-mini HVAC evaporator unit. This requirement would be similar to other electrical equipment that is prohibited to be installed in a bathtub or shower space such as switches, receptacles and ceiling suspended luminaires.

Submitter Information Verification

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Submittal Date: Wed Aug 26 08:40:56 EDT 2020

Committee: NEC-P11

Public Input No. 1361-NFPA 70-2020 [Section No. 440.9]

440.9 Equipment Grounding ~~and Bonding~~ Conductor .

Where equipment is installed outdoors on a roof, an equipment grounding conductor of the wire type shall be installed in outdoor portions of metallic raceway systems that use compression or set -screw type fittings.

Statement of Problem and Substantiation for Public Input

According to the NFPA Style Manual, the Section Title needs to reflect the content of the rule. The rule is about the equipment grounding conductor, not about 'Grounding.' Add 'set-screw' to the fitting list, since there are some 'set-screw' fitting listed for wet locations. In addition, set-screw fitting are permitted in wet locations, except where the raceway terminates to enclosures.

Submitter Information Verification

Submitter Full Name: Mike Holt

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City:

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Submittal Date: Mon Jun 01 19:42:52 EDT 2020

Committee: NEC-P11

Public Input No. 4071-NFPA 70-2020 [Section No. 440.11]

440.11 General.

The disconnecting means shall be located at a readily accessible location. If the disconnecting means installed in dwellings exposes any terminals or wiring when physically open the enclosure shall be locked or require a tool to open.

Part II is intended to require disconnecting means capable of disconnecting air-conditioning and refrigerating equipment, including motor-compressors and controllers from the circuit conductors.

Additional Proposed Changes

File Name	Description	Approved
_1_Square_D_WP_switch_with_no_latch_no_interlock_and_no_guards_just_lift_the_cover.jpg	Disconnect switch with no latch and no guard shields just lift up the cover and it conforms to UL98 safety standards	
_2_Toddler_height_and_any_disconnect_switch_60_amps_or_less_have_no_guards.jpg	Toddler height and any disconnect switch 60 amps or less have no guard shields	
SW4.jpg	Toddler height	

Statement of Problem and Substantiation for Public Input

The placement of disconnect switches in dwellings, in locations that are accessible by other than qualified personnel, particularly by children, is a potential hazard. Knife blade disconnect switches are the ONLY widely used piece of electrical equipment that does not require a tool to access the live components inside, thus they have no child safeguards. The disconnect enclosures can often be easily opened exposing potentially life-threatening voltages and current levels if contacted by personnel. The disconnect equipment often is being installed on accessible external and internal surfaces of dwellings, in garages, and in almost any room except bathrooms in dwellings. An opened disconnect enclosure contains wiring and terminals that can be touched with tools, probes or hands. There is a need to require, that they be locked, or require a tool to physically open these enclosures.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 3738-NFPA 70-2020 [Section No. 110.25]	knife blade disconnect switches installed in dwellings
Public Input No. 4057-NFPA 70-2020 [Section No. 404.8(A)]	knife blade disconnect switches installed in dwellings

Public Input No. 4080-NFPA 70-2020 [Section No. 680.13]

Submitter Information Verification

Submitter Full Name:	Tommy Davis
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City:	
State:	
Zip:	
Submittal Date:	Wed Sep 09 19:57:24 EDT 2020
Committee:	NEC-P11

Public Input No. 512-NFPA 70-2020 [Section No. 440.11]

~~**440.11** General.~~

~~Part II is intended to require disconnecting means capable of disconnecting air-conditioning and refrigerating equipment, including motor-compressors and controllers from the circuit conductors.~~

Statement of Problem and Substantiation for Public Input

There is no reason for this section to exist. If the intent of the Article Part is not already clear there should be an informational note. The intent of the disconnecting means required in this article is not any different than any other article's disconnecting means, so there is no reason to need to explain it.

Submitter Information Verification

Submitter Full Name: Ryan Jackson
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Submittal Date: Fri Feb 21 12:09:01 EST 2020
Committee: NEC-P11

Public Input No. 3912-NFPA 70-2020 [New Section after 440.14]

Absence of Voltage Test & Indication

A means shall be provided to verify the absence of voltage in accordance with an acceptable industry practice that does not expose personnel to shock or arc flash hazards or live parts at the test point for the disconnecting means for any voltage supplies or stored energy sources that present a shock or arc flash hazard up to and including 10000 V that are likely to require examination, adjustment, servicing, or maintenance in equipment located other than in dwelling units.

Informational Note: NFPA 70E-2021 Standard for Electrical Safety in the Workplace provides guidance for safely verifying the absence of voltage including the use of devices like a permanently mounted absence of voltage tester.

Statement of Problem and Substantiation for Public Input

Testing for absence of voltage is an important step that helps increase safety by detecting several conditions that could lead to an electrical incident:

- Power remains on if the wrong disconnecting means is utilized or the source is mislabeled (see examples from OSHA Summaries)
- Presence of stored electrical energy from a capacitor, present after the disconnect is opened and locked out (see examples from OSHA Summaries)
- Power remains present when the disconnect handle is in the off position if the disconnect experiences a mechanical failure (see Recall Notices below)

An easily accessible means to test for and visually convey the status of presence and absence of voltage that is part of the equipment installation at the point of work before accessing air conditioning and refrigeration units would prevent this type of incident (several examples are included below) and further the purpose of the code in practical safeguarding of persons and property by leveraging safety by design principles. Absence of Voltage Testers (AVT) listed to UL 1436 are permanently mounted testers that visually indicate when all voltages are less than 3 V (ac and dc) at the test point. This test is initiated before doors and covers are removed preventing accidental contact with energized parts. AVTs listed to UL 1436 have been recognized as an acceptable method to test for the absence of voltage in NFPA 70E since 2018 (120.5 (7) Exception 1).

Permanently mounted AVTs installed on or near the equipment increase the likelihood that the test for absence of voltage test occurs before the equipment is accessed when compared to portable voltage test instruments. Additionally, AVTs often have a feature to visually indicate when ac or dc voltage that would cause a shock hazard is present. In each of the incidents described below, the voltage presence indicators (for AC and DC) would have provided a visual warning that voltage was still present.

OSHA Fatality and Catastrophe Investigation Summaries
Air conditioning and refrigeration equipment often contains capacitors that can store lethal amounts of energy, even after the disconnect has been shut off. For this reason, it is especially important to test for absence of AC and DC voltage after turning off and locking out the electrical supply to the unit before making contact with electrical parts or circuit conductors. A keyword search of the OSHA Fatality and Catastrophe Investigation Summaries (https://www.osha.gov/pls/imis/accidentsearch.html) reveals several incidents resulting in severe injury or death that are attributed to failure to test for absence of voltage after de-energizing the disconnecting means. Some examples:

1. Report ID: 0728900

Employee #1 was on the roof of a customer's building, changing filters for the customer's air conditioning units. The employee had shut off the unit, but he did not lock out the unit or check its power supply for stored energy. As he reached into the unit, he came into contact with a capacitor charged to 280 volts and received an electric shock.

2. Report ID: 0420600

An employee turned off the known energy source to an air conditioning and heat unit at the panel box in a private residence. He pulled the disconnect switch in a box adjacent to the fan or blower assembly in the attic and was attempting to remove the air handler inside the blower housing. The heavy gold chain that the employee was wearing around his neck came in contact with or came in close proximity to a 10 microfarad, mfd, capacitor which can store 370 or more volts of alternating current. The chain burned an arc in his neck and carried sufficient current to his heart via the vascular tract to cause his death.

3. Report ID: 0316300

Employee #1 and his helper were installing a fan on a HVAC chiller unit. Employee asked his helper to open the circuit breaker to deenergize the unit, but Employee #1 never tested the fan circuit to ensure it was deenergized. Employee #1's helper opened the wrong breaker and when Employee #1 touched the conductors for the fan, he was electrocuted.

4. Report ID: 0452110

Employee #1 turned off breaker #22 in a panel box so that he could make a connection in a junction box. He was using a wire stripper to cut into the insulation around a conductor when he was electrocuted. The breakers in the panel box were not labeled, and breaker #22 did not control the current in the circuit on which Employee #1 was preparing to work. He also did not use a voltmeter or another type of instrument to test the circuit and confirm that the power was off.

5. Report ID 0522300

Employee #1 was working on an HVAC air handling unit that had not been cooling adequately. The "lockout" procedure did not include de-energization at the power supply or application of locks. Therefore, although the unit was shut off, it was still energized. Employee #1 was killed.

Disconnect Recall Notices

Several brands of disconnects that are commonly used in HVAC industrial and commercial applications have experienced recalls due to defects that allow power to remain present when the disconnect handle is in the off position, posing a shock hazard. This failure mode is an example of why testing for absence of voltage is critical in all applications, especially HVAC where mechanical technicians and non-electrical workers may be exposed to electrical hazards.

Recalls (https://www.cpsc.gov/Recalls)

1. Example 1

Company A recalled more than a million safety switches manufactured between January 1, 2014 and January 18, 2018 because the power can stay on when the safety switch handle is in the off position, posing an electric shock or electrocution hazard. The switches may be installed in or around commercial buildings, outbuildings, apartments and homes with air conditioning units.

2. Example 2

Company B issued a safety recall of 26 models of safety switches that may not disconnect power when the handle is in the “off” position. The affected devices cover certain models of 30A and 60A heavy-duty safety switches manufactured between Nov. 19, 2015, and Jan. 23, 2018.

3. Example 3

Company C recalled 19,000 toggle and rotary switches. When switched OFF, one electrical pole may remain energized, posing a risk of electrical shock hazard. The switches are typically used with HVAC units, electric distribution and control panels and industrial uses. Primarily the switches are used commercially, however they may also be found in residential applications.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 3835-NFPA 70-2020 [New Section after 110.25]	
Public Input No. 3908-NFPA 70-2020 [New Part after I.]	

Submitter Information Verification

Submitter Full Name: Rachel Bugaris

Organization: Panduit Corp

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Submittal Date:	Wed Sep 09 15:24:04 EDT 2020
Committee:	NEC-P11

Public Input No. 2852-NFPA 70-2020 [Section No. 440.14]

440.14 Location.

Disconnecting means shall be located within sight from, and readily accessible from the air-conditioning or refrigerating equipment. ~~The~~ Disconnecting means shall meet the working space requirements of 110.26 (A)(1) through (A)(3). The disconnecting means shall be permitted to be installed on or within the air-conditioning or refrigerating equipment.

The disconnecting means shall not be located on panels that are designed to allow access to the air-conditioning or refrigeration equipment or to obscure the equipment nameplate(s).

Exception No. 1: Where the disconnecting means provided in accordance with 430.102(A) is lockable in accordance with 110.25 and the refrigerating or air-conditioning equipment is essential to an industrial process in a facility with written safety procedures, and where the conditions of maintenance and supervision ensure that only qualified persons service the equipment, a disconnecting means within sight from the equipment shall not be required.

Exception No. 2: Where an attachment plug and receptacle serve as the disconnecting means in accordance with 440.13, their location shall be accessible but shall not be required to be readily accessible.

Informational Note No. 1: See Parts VII and IX of Article 430 for additional requirements.

Informational Note No. 2: See 110.26.

Additional Proposed Changes

File Name	Description	Approved
AC_Disconnect_clearance.jpg	AC disconnect clearance requirements clarified by IAEI	

Statement of Problem and Substantiation for Public Input

For many years there have been some confusion among Electrical and HVAC contractors, as well as Inspectors. I am proposing to add verbiage to article 440-14 to include "Disconnecting means shall meet the working space requirements of 110.26(A)(1) through (A)(3)" for clarification purposes. Thank you for your consideration.

Submitter Information Verification

Submitter Full Name: Dan Jenkins

Organization: County of York

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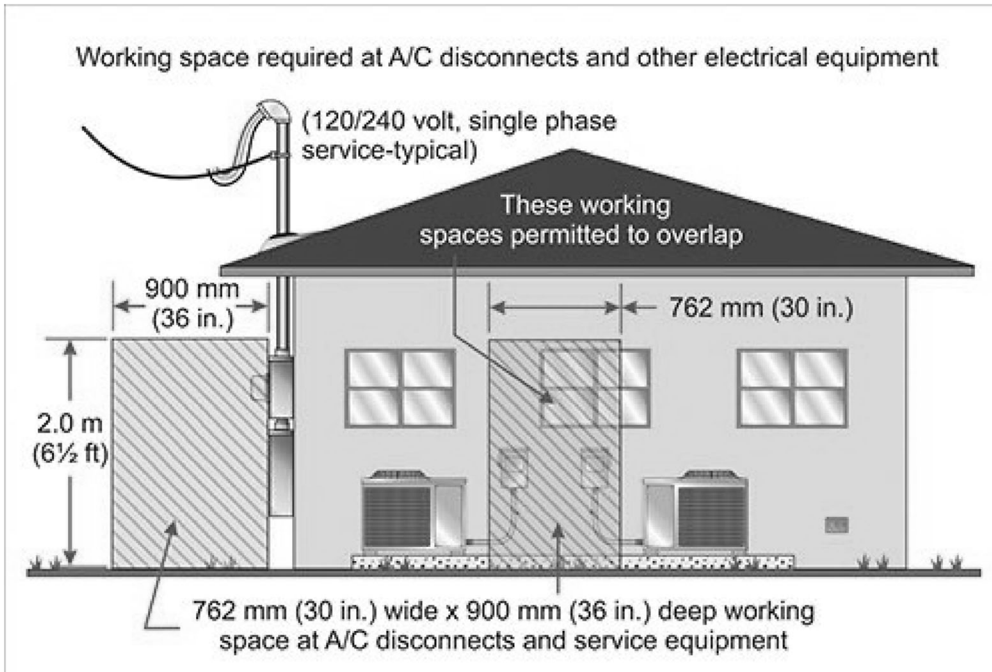
Submittal Date: Wed Sep 02 15:13:57 EDT 2020

Committee: NEC-P11


Working space required at A/C disconnects and other electrical equipment
(120/240 volt, single phase service-typical)
These working spaces permitted to overlap
900 mm (36 in.)
762 mm (30 in.)
2.0 m (6½ ft)
762 mm (30 in.) wide x 900 mm (36 in.) deep working space at A/C disconnects and service equipment

Public Input No. 4298-NFPA 70-2020 [Section No. 440.21]

440.21 General.

Part III specifies devices intended to protect the branch-circuit conductors, control apparatus, and motors in circuits supplying hermetic refrigerant motor-compressors against overcurrent due to short circuits and ground faults. They are in addition to or amendatory of ~~Article 240~~ the overcurrent requirements found elsewhere in the Code .

Statement of Problem and Substantiation for Public Input

Section 4.1.4 of the 2020 NEC(R) Style Manual prohibits references to an entire article, with the exception of Article 100. As such, it is recommended to change to the more generic text "overcurrent requirements found elsewhere in the Code" to comply, without changing the meaning of this section.

Submitter Information Verification

Submitter Full Name: Richard Holub

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Submittal Date: Thu Sep 10 09:44:28 EDT 2020

Committee: NEC-P11

Public Input No. 4432-NFPA 70-2020 [Section No. 440.22(A)]

(A) Rating or Setting for Individual Motor-Compressor.

The motor-compressor branch-circuit short-circuit and ground-fault protective device shall be capable of carrying the starting current of the motor. A protective device having a rating or setting not exceeding 175 percent of the motor-compressor rated-load current or branch-circuit selection current, whichever is greater, shall be permitted~~, provided that, where the protection specified is~~ .

Exception No.1: Where the values for branch-circuit short-circuit and ground-fault protection determined by 440.22(A) do not correspond to the standard sizes or ratings of fuses, nonadjustable circuit breakers, thermal protective devices, or possible settings of adjustable circuit breakers, a higher size, rating, or possible setting that does not exceed the next higher standard ampere rating shall be permitted.

Exception No. 2: Where the values for branch-circuit short-circuit and ground-fault protection determined by 440.22(A) or the rating modified by Exception No. 1 is not sufficient for the starting current of the motor, the rating or setting shall be permitted to be increased but shall not exceed 225 percent of the motor rated-load current or branch-circuit selection current, whichever is greater.

Exception No. 3 : The rating of the branch-circuit short-circuit and ground-fault protective device shall not be required to be less than 15 amperes.

Statement of Problem and Substantiation for Public Input

As written, the current Section 440.22(A) is a long, run-on sentence. This PI is trying to break-up the section while also providing some clarity regarding the calculation required.

New Exception No. 1 is trying to clarify what action may be taken when performing the calculation based on 175%. If a calculation resulted in a device of 53-amperes, the current language does not state if the value may be rounded up to a standard rating or if it must be rounded down instead. This clarifies the value can be rounded up to but not exceed the next higher rating. This is similar to how the committee handles this calculation for motors in 430.52(C).

New Exception #2 is relocated language from the existing Section. If 175% isn't enough to start the motor, we can go up to but not exceed 225% of the RLC or BCSC.

New Exception #3 is the existing exception.

These changes will increase the readability and clarity of the Code for the user.

Submitter Information Verification

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Submittal Date:	Thu Sep 10 12:59:07 EDT 2020
Committee:	NEC-P11

Public Input No. 4299-NFPA 70-2020 [Section No. 440.31]

440.31 General.

Part IV and adjustments made according to Part III of Article 310 specify ampacities of conductors required to carry the motor current without overheating under the conditions specified, except as modified in 440.6(A), Exception No. 1.

These articles shall not apply to integral conductors of motors, to motor controllers and the like, or to conductors that form an integral part of approved equipment.

Statement of Problem and Substantiation for Public Input

Section 4.1.4 of the 2020 NEC(R) Style Manual prohibits references to an entire article, with the exception of Article 100. As such, it is recommended that the CMP change the language as shown to describe clearly here the intent, without referencing the entire article.

Submitter Information Verification

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Submittal Date: Thu Sep 10 09:48:11 EDT 2020

Committee: NEC-P11

Public Input No. 2151-NFPA 70-2020 [Section No. 440.33]

440.33 Motor-Compressor(s) With or Without Additional Motor Loads.

Conductors supplying one or more motor-compressor(s) with or without an additional motor load(s) shall have an ampacity not less than the sum of each of the following:

(1) The sum of the rated-load or branch-circuit selection current, whichever is greater, of all motor-compressor(s)

(2) The sum of the full-load current rating of all other motors

(3) 25 percent of the highest motor-compressor ~~or~~ or motor full load current in the group

Where two or more motors or motor-compressors have the same current rating, only one of the motor or motor-compressor currents shall be considered the highest rated for the above calculations.

Exception No. 1: Where the circuitry is interlocked so as to prevent the starting and running of a second motor-compressor or group of motor-compressors, the conductor size shall be determined from the largest motor-compressor or group of motor-compressors that is to be operated at a given time.

Exception No. 2: The branch-circuit conductors for room air conditioners shall be in accordance with Part VII of Article 440.

Statement of Problem and Substantiation for Public Input

This revision is necessary to clarify the calculation process when 2 or more motors or compressors have the same current rating. For example: A feeder with three 22-amp motor-compressors. Should ALL of them be considered the "highest rated"? (22A X 3 X 125%); Should NONE of them be considered "highest rated"? (22A X 3); I believe the intent is to only consider ONE of them as the the "highest rated". [(22A X 125%) + 22A + 22A).

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 2150-NFPA 70-2020 [Section No. 430.24]	Clarification of "highest rated".

Submitter Information Verification

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Submittal Date: Tue Aug 04 07:02:32 EDT 2020

Committee: NEC-P11

Public Input No. 4305-NFPA 70-2020 [Section No. 440.34]

440.34 Combination Load.

Conductors supplying a motor-compressor load in addition to other load(s) as calculated from ~~Article 220~~ ~~and~~ branch-circuit, feeder, and service load calculations and other applicable articles shall have an ampacity sufficient for the other load(s) plus the required ampacity for the motor-compressor load determined in accordance with 440.33 or, for a single motor-compressor, in accordance with 440.32.

Exception: Where the circuitry is interlocked so as to prevent simultaneous operation of the motor-compressor(s) and all other loads connected, the conductor size shall be determined from the largest size required for the motor-compressor(s) and other loads to be operated at a given time.

Statement of Problem and Substantiation for Public Input

Section 4.1.4 of the 2020 NEC(R) Style Manual prohibits references to an entire article, with the exception of Article 100. As such, it is recommended that the CMP change the language as shown making reference to the more generic title of the article previously referenced without changing the intent of the section..

Submitter Information Verification

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Submittal Date: Thu Sep 10 09:51:54 EDT 2020
Committee: NEC-P11

Public Input No. 4309-NFPA 70-2020 [Section No. 440.54 [Excluding any Sub-Sections]]

Overload protection for motor-compressors and equipment used on 15- or 20-ampere 120-volt, or 15-ampere 208- or 240-volt single-phase branch circuits as permitted elsewhere in ~~Article 210~~ the Code shall be permitted as indicated in 440.54(A) and 440.54(B).

Statement of Problem and Substantiation for Public Input

Section 4.1.4 of the 2020 NEC(R) Style Manual prohibits references to an entire article, with the exception of Article 100. As such, it is recommended that the CMP change the language as shown making reference to the more generic "as permitted elsewhere in the Code" without changing the intent of the section.

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Submittal Date: Thu Sep 10 09:55:51 EDT 2020
Committee: NEC-P11

Public Input No. 4310-NFPA 70-2020 [Section No. 440.55 [Excluding any Sub-Sections]]

Overload protection for motor-compressors and equipment that are cord- and attachment-plug-connected and used on 15- or 20-ampere 120-volt, or 15-ampere 208- or 240-volt, single-phase branch circuits as permitted elsewhere in ~~Article 210~~ the Code shall be permitted as indicated in 440.55(A), (B), and (C).

Statement of Problem and Substantiation for Public Input

Section 4.1.4 of the 2020 NEC(R) Style Manual prohibits references to an entire article, with the exception of Article 100. As such, it is recommended that the CMP change the language as shown making reference to the more generic "as permitted elsewhere in the Code" without changing the intent of the section.

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Submittal Date: Thu Sep 10 09:58:14 EDT 2020
Committee: NEC-P11

Public Input No. 1362-NFPA 70-2020 [Section No. 440.61]

440.61 Equipment Grounding Conductor .

The enclosures of room air conditioners shall be connected to the equipment grounding conductor in accordance with 250.110, 250.112, and 250.114.

Statement of Problem and Substantiation for Public Input

According to the NFPA Style Manual, the Section Title needs to reflect the content of the rule. The rule is about the equipment grounding conductor, not about 'Grounding.'

Submitter Information Verification

Submitter Full Name: Mike Holt

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Submittal Date: Mon Jun 01 19:44:12 EDT 2020

Committee: NEC-P11

Public Input No. 2358-NFPA 70-2020 [Section No. 440.62(B)]

(B) Where No Other Loads Are Supplied.

The total marked amp rating of a cord- and attachment-plug-connected room air conditioner shall not exceed 80 percent of the amp rating of a branch circuit where no other loads are supplied.

Statement of Problem and Substantiation for Public Input

Clarify that though "rating" can mean several things (volts, MOCP, etc), the intent here is that only "amp rating" is meant.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 2359-NFPA 70-2020 [Section No. 440.62(C)]	similar change for similar reason
Public Input No. 2359-NFPA 70-2020 [Section No. 440.62(C)]	

Submitter Information Verification

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Submittal Date: Mon Aug 17 16:54:21 EDT 2020

Committee: NEC-P11

Public Input No. 2359-NFPA 70-2020 [Section No. 440.62(C)]

(C) Where Lighting Units or Other Appliances Are Also Supplied.

The total marked amp rating of a cord- and attachment-plug-connected room air conditioner shall not exceed 50 percent of the amp rating of a branch circuit where lighting outlets, other appliances, or general-use receptacles are also supplied. Where the circuitry is interlocked to prevent simultaneous operation of the room air conditioner and energization of other outlets on the same branch circuit, a cord- and attachment-plug-connected room air conditioner shall not exceed 80 percent of the branch-circuit amp rating.

Statement of Problem and Substantiation for Public Input

Clarify that though "rating" can mean several things (volts, MOCP, etc), the intent here is that only "amp rating" is meant.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 2358-NFPA 70-2020 [Section No. 440.62(B)]	Similar change for similar reason
Public Input No. 2358-NFPA 70-2020 [Section No. 440.62(B)]	

Submitter Information Verification

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Submittal Date: Mon Aug 17 17:00:38 EDT 2020
Committee: NEC-P11

Public Input No. 1919-NFPA 70-2020 [Section No. 440.65]

~~440.~~

~~65~~ ~~Protection Devices.~~

~~65 leakage-Current Detector-Interrupter (LCDI) and Arc-Fault Circuit Interrupter (AFCI) from the NEC Code~~

~~Single-phase cord- and plug-connected room air conditioners shall be provided with~~

~~one of the following~~

~~factory-installed~~

~~devices:~~

~~(1) Leakage-current detector-interrupter (LCDI)~~

~~(2) Arc-fault circuit interrupter (AFCI)~~

~~(3) Heat detecting circuit interrupter (HDCI)~~

~~The protection device~~

~~LCDI or AFCI protection. The LCDI or AFCI protection shall be an integral part of the attachment plug or be located in the power supply cord within~~

~~300 mm~~

~~300 mm (~~

~~12 in~~

~~12 in .) of the attachment plug.~~

Proposal is to Remove the requirements of 440.65 leakage-Current Detector-Interrupter (LCDI) and Arc-Fault Circuit Interrupter (AFCI) from the NEC Code

Additional Proposed Changes

File Name	Description	Approved
NEC_Proposal_LCDI_-_07_2020_00095776_.docx	NEC Proposal - Removal of 440.65	

Statement of Problem and Substantiation for Public Input

Recent changes adopted by the 2017 NEC code have made the requirements within 440.65 redundant & unnecessary. Section 210.12 of the 2017 NEC code requires that for dwelling units, “All 120-volt, single-phase, 15- and 20-ampere branch circuits supplying outlets or devices installed in dwelling unit kitchens, family rooms, dining rooms, living rooms, parlors, libraries, dens, bedrooms, sunrooms, recreation rooms, closets, hallways, laundry areas, or similar rooms or areas shall be protected”… by AFCIs.

The requirements of 210.12 provide additional protection of not only the room air conditioner cord, in the case of the LCDI, but protect the entire air conditioner & branch circuit. Section 440.65 is no longer necessary and unduly burdensome when a superior protection method (or “safety requirement”) is already provided by the code.

The redundant LCDI adds to the complexity of the entire system. It provides additional failure points that may reduce the reliability of the product.

Additionally, the LCDI on the plug adds weight to the plug and strains the connection between the prongs and the receptacle resulting in loosening of the connection which can cause the outlet to fail.

Submitter Information Verification

Submitter Full Name: Matt Williams
Organization: Association Of Home Appliance Manufacturers
Street Address:
City:
State:
Zip:
Submittal Date: Thu Jul 16 11:44:15 EDT 2020
Committee: NEC-P11

Proposal:

Remove the requirements of 440.65 leakage-Current Detector-Interrupter (LCDI) and Arc-Fault Circuit Interrupter (AFCI) from the NEC Code

Current Text:

440.65 leakage-Current Detector-Interrupter (LCDI) and Arc-Fault Circuit Interrupter (AFCI) from the NEC Code

Single-phase cord- and plug-connected room air conditioners shall be provided with factory-installed LCDI or AFCI protection. The LCDI or AFCI protection shall be an integral part of the attachment plug or be located in the power supply cord within 300 mm (12 in.) of the attachment plug.

Rational:

Recent changes adopted by the 2017 NEC code have made the requirements within 440.65 redundant & unnecessary. Section 210.12 of the 2017 NEC code requires that for dwelling units, "All 120-volt, single-phase, 15- and 20-ampere branch circuits supplying outlets or devices installed in dwelling unit kitchens, family rooms, dining rooms, living rooms, parlors, libraries, dens, bedrooms, sunrooms, recreation rooms, closets, hallways, laundry areas, or similar rooms or areas shall be protected"… by AFCIs.

The requirements of 210.12 provide additional protection of not only the room air conditioner cord, in the case of the LCDI, but protect the entire air conditioner & branch circuit. Section 440.65 is no longer necessary and unduly burdensome when a superior protection method (or "safety requirement") is already provided by the code.

The redundant LCDI adds to the complexity of the entire system. It provides additional failure points that may reduce the reliability of the product.

Additionally, the LCDI on the plug adds weight to the plug and strains the connection between the prongs and the receptacle resulting in loosening of the connection which can cause the outlet to fail.

Proposed Revision:

~~440.65 leakage-Current Detector-Interrupter (LCDI) and Arc-Fault Circuit Interrupter (AFCI) from the NEC Code~~

~~Single-phase cord- and plug-connected room air conditioners shall be provided with factory-installed LCDI or AFCI protection. The LCDI or AFCI protection shall be an integral part of the attachment plug or be located in the power supply cord within 300 mm (12 in.) of the attachment plug.~~

Public Input No. 4345-NFPA 70-2020 [Section No. 460.1]

460.1 Scope.

This article covers the installation of capacitors on electrical circuits.

Surge capacitors or capacitors included as a component part of other apparatus and conforming with the requirements of such apparatus are excluded from these requirements.

This article also covers the installation of capacitors in hazardous (classified) locations as modified by ~~Articles 501 through 503~~ the hazardous location requirements .

Statement of Problem and Substantiation for Public Input

Section 4.1.4 of the 2020 NEC(R) Style Manual prohibits references to an entire article, with the exception of Article 100. As such, it is recommended that the CMP change the language as shown making reference to the more generic "as modified by the hazardous location requirements" without changing the intent of the section. It is noted that the previous language was not inclusive of all the hazardous location requirements found generally in Articles 500 though 517, so the more generic language corrects this. It is recommended that this PI also be submitted to CMP14 for information and/or comment.

Submitter Information Verification

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Organization: The DuPont Company, Inc.

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Submittal Date: Thu Sep 10 10:51:50 EDT 2020

Committee: NEC-P11

Public Input No. 3636-NFPA 70-2020 [Section No. 460.2]

(Relocate all definitions in the 460. 2 to Article 100, arrange them in alphabetical order and without any subdivisions.)

460. 2 Definitions.

The definition in this section shall apply only within this article.

Safe Zone.

Low probability of damage other than a slight swelling of the capacitor case, as identified by the case rupture curve of the capacitor.

Statement of Problem and Substantiation for Public Input

"The National Electrical Code has definitions in multiple parts in Article 100 and many definitions scattered through out the code many of them in the .2 section of the articles.
Most of the other standards under NFPA have their definitions in one location and this will allow the NEC the same requirement. The revisions to the NEC Style Manual require all the definitions to be relocated to Article 100. "

Submitter Information Verification

Submitter Full Name: David Williams
Organization: Delta Charter Township
Street Address:
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Submittal Date: Wed Sep 09 09:56:33 EDT 2020
Committee: NEC-P11

Public Input No. 2055-NFPA 70-2020 [Section No. 460.8(C)]

(C) Disconnecting Means.

A disconnecting means shall be provided in each ungrounded conductor for each capacitor bank and shall meet the following requirements:

(1) The disconnecting means shall open all ungrounded conductors simultaneously.

(2) The disconnecting means shall be permitted to disconnect the capacitor from the line as a regular operating procedure.

(3) The rating of the disconnecting means shall not be less than 135 percent of the rated current of the capacitor.

(4) <u>The disconnecting means shall be specifically rated for switching of capacitive loads.</u>

Exception: A separate disconnecting means shall not be required where a capacitor is connected on the load side of a motor controller.

Statement of Problem and Substantiation for Public Input

Many switching devices have current ratings based on switching inductive loads, but have not been investigated for switching capacitive type loads. When used to switch a capacitive load, it is important that the switching device be suitably rated. Switching of capacitor banks can generate recovery voltages of two to three times the rated system voltage and can lead to restrikes and continued flow, which can result in ruptured capacitors, external equipment flashovers, failure of overvoltage device, and damage to the switching device contacts. Additionally, switching of capacitor banks may result in very large inrush currents for which a general purpose type switching device may not have been designed or tested for. Using properly rated switching devices that have specifically been designed and testing for switching of capacitive loads will alleviate these concerns.

Submitter Information Verification

Submitter Full Name: Paul Barnhart
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Submittal Date: Mon Jul 27 07:54:46 EDT 2020
Committee: NEC-P11

Public Input No. 1364-NFPA 70-2020 [Section No. 460.10]

460.10 Equipment Grounding Conductor .

Capacitor cases shall be connected to the equipment grounding conductor.

Exception: Capacitor cases shall not be connected to the equipment grounding conductor where the capacitor units are supported on a structure designed to operate at other than ground potential.

Statement of Problem and Substantiation for Public Input

According to the NFPA Style Manual, the Section Title needs to reflect the content of the rule. The rule is about the equipment grounding conductor, not about 'Grounding.'

Submitter Information Verification

Submitter Full Name: Mike Holt
Organization: Mike Holt Enterprises Inc
Street Address:
City:
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Zip:
Submittal Date: Mon Jun 01 19:48:12 EDT 2020
Committee: NEC-P11

Public Input No. 2063-NFPA 70-2020 [Section No. 460.24(A)]

(A) Load Current.

Group-operated switches shall be used for capacitor switching, shall be specifically rated for switching of capacitive loads, and shall be capable of the following:

(1) Carrying continuously not less than 135 percent of the rated current of the capacitor installation

(2) Interrupting the maximum continuous load current of each capacitor, capacitor bank, or capacitor installation that will be switched as a unit

(3) Withstanding the maximum inrush current, including contributions from adjacent capacitor installations

(4) Carrying currents due to faults on capacitor side of switch

Statement of Problem and Substantiation for Public Input

Substantiation:
Many switching devices have current ratings based on switching inductive loads, but have not been investigated for switching capacitive type loads. When used to switch a capacitive load, it is important that the switching device be suitably rated. Switching of capacitor banks can generate recovery voltages of two to three times the rated system voltage and can lead to restrikes and continued flow, which can result in ruptured capacitors, external equipment flashovers, failure of overvoltage device, and damage to the switching device contacts. Additionally, switching of capacitor banks may result in very large inrush currents for which a general purpose type switching device may not have been designed or tested for. Using properly rated switching devices that have specifically been designed and testing for switching of capacitive loads will alleviate these concerns.

Submitter Information Verification

Submitter Full Name: Paul Barnhart

Organization: UL LLC

Street Address:

City:

State:

Zip:

Submittal Date: Mon Jul 27 09:35:44 EDT 2020

Committee: NEC-P11

Public Input No. 1365-NFPA 70-2020 [Section No. 460.27]

460.27 Equipment Grounding Conductor .

Capacitor cases shall be connected to the equipment grounding conductor. If the capacitor neutral point is connected to a grounding electrode conductor, the connection shall be made in accordance with Part III of Article 250.

Exception: Capacitor cases shall not be connected to the equipment grounding conductor where the capacitor units are supported on a structure designed to operate at other than ground potential.

Statement of Problem and Substantiation for Public Input

According to the NFPA Style Manual, the Section Title needs to reflect the content of the rule. The rule is about the equipment grounding conductor, not about 'Grounding.'

Submitter Information Verification

Submitter Full Name: Mike Holt

Organization: Mike Holt Enterprises Inc

Street Address:

City:

State:

Zip:

Submittal Date: Mon Jun 01 19:49:25 EDT 2020

Committee: NEC-P11

Public Input No. 4350-NFPA 70-2020 [Section No. 470.1]

470.1 Scope.

This article covers the installation of separate resistors and reactors on electrical circuits.

~~*Exception: Resistors and reactors that are component parts of other apparatus.*~~

This article also covers the installation of resistors and reactors in hazardous (classified) locations as modified by ~~Articles 501 through 504~~ . the hazardous location requirements. This article does not cover resistors and reactors that are component parts of other apparatus.

Statement of Problem and Substantiation for Public Input

Section 4.1.4 of the 2020 NEC(R) Style Manual prohibits references to an entire article, with the exception of Article 100. As such, it is recommended that the CMP change the language as shown making reference to the more generic "as modified by the hazardous location requirements" without changing the intent of the section. It is noted that the previous language was not inclusive of all the hazardous location requirements found generally in Articles 500 though 517, so the more generic language corrects this. It is recommended that this PI also be submitted to CMP14 for information and/or comment. Finally, this PI also rewrites the former "exception" as a specific sentence covering what this article does not cover as the previous exception was not written in a complete sentence as required by Section 3.1.4.1 of the Style Manual.

Submitter Information Verification

Submitter Full Name: Richard Holub

Organization: The DuPont Company, Inc.

Street Address:

City:

State:

Zip:

Submittal Date: Thu Sep 10 10:55:31 EDT 2020

Committee: NEC-P11

Public Input No. 3624-NFPA 70-2020 [New Section after 470.4]

470.5 Reconditioning of Equipment

Reconditioning of resistors shall not be permitted. Reconditioning of reactors shall be determined by the manufacturer.

Statement of Problem and Substantiation for Public Input

Power resistors are typically manufactured using steel plates, wire strips wrapped around ceramic cores and resistance wire helically wrapped around ceramic cores. The construction of grid resistor banks includes welds, ceramic spacers and other components. To repair a grid resistor, all the welds would need to be broken to replace any quantity of plates. Additionally, the ceramic spacers and other components would need to be inspected by a qualified individual. For resistors using ceramic cores, the strip or wire needs to be inspected to verify that it still provides the nominal resistance as delivered by the manufacturer. Additionally, the ceramic cores require inspection. The expertise to perform these tests and inspections resides with the manufacturer. In many cases, the materials, designs and other engineered products may no longer be available from the manufacturer and a new bank meeting the same requirements but with different technology may be provided as a replacement.

Submitter Information Verification

Submitter Full Name: Paul Rylatt

Organization: Post Glover Resistor

Street Address:

City:

State:

Zip:

Submittal Date: Wed Sep 09 09:43:46 EDT 2020

Committee: NEC-P11

Public Input No. 1366-NFPA 70-2020 [Section No. 470.19]

470.19 Equipment Grounding Conductor .

Resistor and reactor cases or enclosures shall be connected to the equipment grounding conductor.

Exception: Resistor or reactor cases or enclosures supported on a structure designed to operate at other than ground potential shall not be connected to the equipment grounding conductor.

Statement of Problem and Substantiation for Public Input

According to the NFPA Style Manual, the Section Title needs to reflect the content of the rule. The rule is about the equipment grounding conductor, not about 'Grounding.'

Submitter Information Verification

Submitter Full Name: Mike Holt

Organization: Mike Holt Enterprises Inc

Street Address:

City:

State:

Zip:

Submittal Date: Mon Jun 01 19:50:47 EDT 2020

Committee: NEC-P11

Public Input No. 3683-NFPA 70-2020 [New Section after 470.20]

470.21 Reconditioning of Equipment

Reconditioning of resistors shall not be permitted. Reconditioning of reactors shall be determined by the manufacturer.

Statement of Problem and Substantiation for Public Input

Power resistors are typically manufactured using steel plates, wire strips wrapped around ceramic cores and resistance wire helically wrapped around ceramic cores. The construction of grid resistor banks includes welds, ceramic spacers and other components. To repair a grid resistor, all the welds would need to be broken to replace any quantity of plates. Additionally, the ceramic spacers and other components would need to be inspected by a qualified individual. For resistors using ceramic cores, the strip or wire needs to be inspected to verify that it still provides the nominal resistance as delivered by the manufacturer. Additionally, the ceramic cores require inspection. The expertise to perform these tests and inspections resides with the manufacturer. In many cases, the materials, designs and other engineered products may no longer be available from the manufacturer and a new bank meeting the same requirements but with different technology may be provided as a replacement.

Submitter Information Verification

Submitter Full Name: Paul Rylatt
Organization: Post Glover Resistor
Street Address:
City:
State:
Zip:
Submittal Date: Wed Sep 09 10:45:43 EDT 2020
Committee: NEC-P11

Public Input No. 4355-NFPA 70-2020 [Section No. 470.20]

470.20 Oil-Filled Reactors.

Installation of oil-filled reactors, in addition to the above requirements, shall comply with ~~applicable requirements~~ Part II of Article 450.

Statement of Problem and Substantiation for Public Input

Section 4.1.4 of the 2020 NEC(R) Style Manual prohibits references to an entire article, with the exception of Article 100. The current oil-filled installation requirements for transformers and reactors is found in Part II of Article 450 and it is proposed to instead point to that part to comply with the style manual requirements.

Submitter Information Verification

Submitter Full Name:	Richard Holub
Organization:	The DuPont Company, Inc.
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Thu Sep 10 11:08:18 EDT 2020
Committee:	NEC-P11

Public Input No. 4376-NFPA 70-2020 [Part I.]

(Relocate Part I. ~~– 1000 Volts, Nominal, and Under General to directly uncer the title and prior to the scope in 460.1)~~

Part I. General

Statement of Problem and Substantiation for Public Input

Relocate Part I. General to directly after the title of Article 460 and prior to Section 460.1 Scope.
Article 460 is subdivided into multiple parts and needs to comply with the revised NEC Style Manual on Parts 2.1.4 Part titles shall be descriptive and as concise as possible.
2.4.2.1 ...Where an article has multiple parts, Part I. shall be titled "General".

Submitter Information Verification

Submitter Full Name:	David Williams
Organization:	Delta Charter Township
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Thu Sep 10 11:28:43 EDT 2020
Committee:	NEC-P11

Public Input No. 4381-NFPA 70-2020 [Part I.]

Part I. ~~– 1000 Volts, Nominal, and Under~~ General

Statement of Problem and Substantiation for Public Input

"Article 470 is subdivided into multiple parts and needs to comply with the revised NEC Style Manual on Parts 2.1.4 Part titles shall be descriptive and as concise as possible.
2.4.2.1 ...Where an article has multiple parts, Part I. shall be titled "General". "

Submitter Information Verification

Submitter Full Name:	David Williams
Organization:	Delta Charter Township
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Thu Sep 10 11:33:51 EDT 2020
Committee:	NEC-P11

Public Input No. 1420-NFPA 70-2020 [Part IV.]

Part IV. ~~Branch-~~ Circuit Conductors

Statement of Problem and Substantiation for Public Input

Change the title to the scope so that the rules in this part also apply to feeder and servcie conductors, particularly when there are multiple a/c units on a feeder or service. Currently there are not rules addressing feeder conductor sizing because of the Title name.

Submitter Information Verification

Submitter Full Name: Mike Holt
Organization: Mike Holt Enterprises Inc
Street Address:
City:
State:
Zip:
Submittal Date: Tue Jun 02 13:55:22 EDT 2020
Committee: NEC-P11

Public Input No. 976-NFPA 70-2020 [Part VII.]

Part VII. ~~– Provisions for Room~~ _ Room Air Conditioners

Statement of Problem and Substantiation for Public Input

The words “Provisions for” are unnecessary and redundant.

Submitter Information Verification

Submitter Full Name:	Agnieszka Golriz
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Zip:	
Submittal Date:	Wed May 06 11:43:31 EDT 2020
Committee:	NEC-P11

Public Input No. 4550-NFPA 70-2020 [Part VIII.]

Part VIII. Motor Control Centers

430.XXX Reconditioning of Motor Control Centers

(A) Motor Control Centers

Motor control centers shall not be permitted to be reconditioned.

(B) Motor Control Center Unit

Motor control center units shall meet the requirements of 430.XXX(B)(1) through (B)(2)

(1) Motor control enter units shall not be permitted to be reconditioned.

(2) Replacement of a motor control center unit within an enclosure shall be permitted provided it has been listed and labeled for the use.

Additional Proposed Changes

File Name	Description	Approved
MCC_Article_430_-_Part_VIII_Reconditioned_Final.docx		

Statement of Problem and Substantiation for Public Input

Motor control centers are comprised of a series of component items that evaluated as part of type tested 3rd party agency approval to industry standard. Many of these components, when evaluated individually by various CMPs in the NEC do not support reconditioning. When these devices are arranged within a motor control center they are part of a combination of specifically designed bus, connectors, cabling and panel volumes which are evaluated to support short-circuit current ratings and not exceed temperature limits so as not to incur thermal runaway which may lead to nuisance operation or electrical fire. This results in specific listing for motor control center sections and each motor control center cubicle. Reconditioning activities for this equipment does not consider these factors and create heightened safety risk.

This should not prevent activities such as replacement of OEM hardware, doors, covers maintenance, cleaning of components or equipment, or other items which would otherwise be considered under normal servicing of equipment.

Submitter Information Verification

Submitter Full Name: Matt Hussey
Organization: Eaton Corporation
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City:
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Submittal Date: Thu Sep 10 14:59:57 EDT 2020
Committee: NEC-P11

Article 430 Motors, Motor Circuits, and Controllers
Part VIII. Motor Control Centers

430.XXX Reconditioning of Motor Control Centers

(A) Motor Control Centers
Motor control centers shall not be permitted to be reconditioned.

(B) Motor Control Center Unit
Motor control center units shall meet the requirements of 430.XXX(B)(1) through (B)(2)

(1) Motor control enter units shall not be permitted to be reconditioned.
(2) Replacement of a motor control center unit within an enclosure shall be permitted provided it has been listed and labeled for the use.

Statement of problem

Motor control centers are comprised of a series of component items that evaluated as part of type tested 3rd party agency approval to industry standard. Many of these components, when evaluated individually by various CMPs in the NEC do not support reconditioning. When these devices are arranged within a motor control center they are part of a combination of specifically designed bus, connectors, cabling and panel volumes which are evaluated to support short-circuit current ratings and not exceed temperature limits so as not to incur thermal runaway which may lead to nuisance operation or electrical fire. This results in specific listing for motor control center sections and each motor control center cubicle. Reconditioning activities for this equipment does not consider these factors and create heightened safety risk.

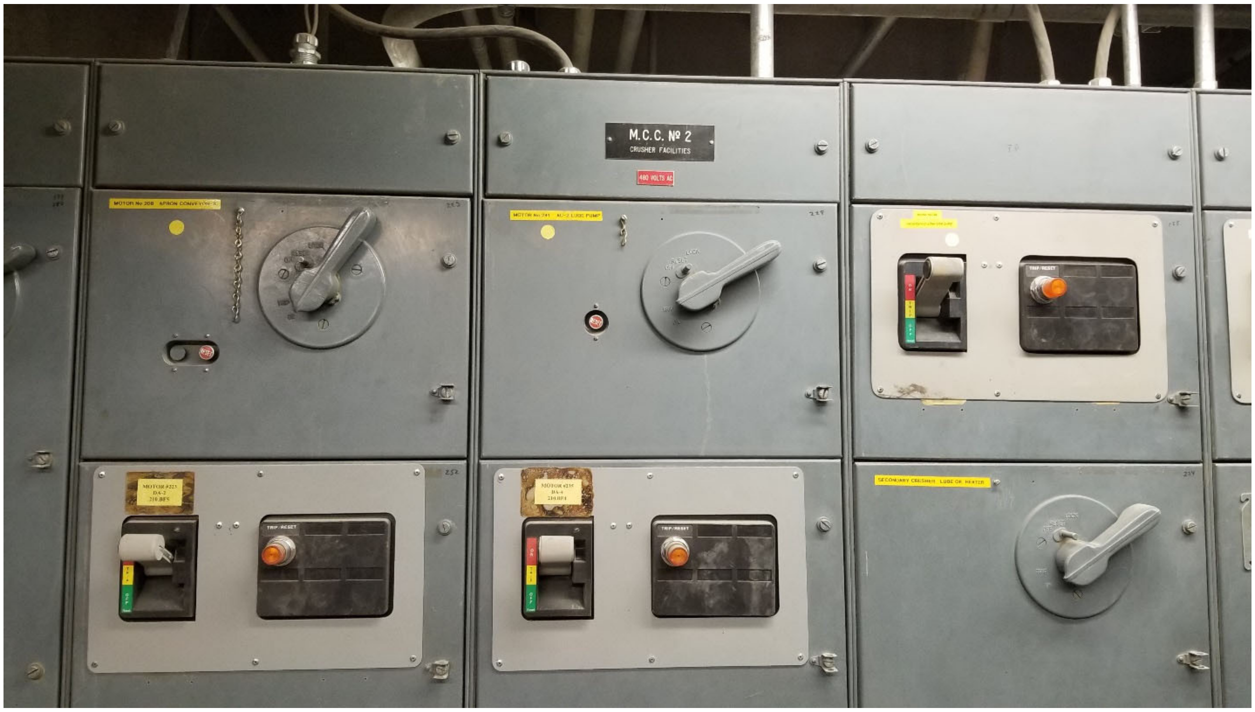
This should not prevent activities such as replacement of OEM hardware, doors, covers maintenance, cleaning of components or equipment, or other items which would otherwise be considered under normal servicing of equipment.

Examples

- MCC lineup has been installed for __ # of years. Facility decides to perform maintenance on MCC. This process could result in a few different routes:
    - Cleaning, normal servicing done. Not considered reconditioning
    - MCC doors, handles, latches, etc… are damaged in a facility and need to be replaced. OEM parts can be sourced and installed without modifying design (i.e. handles are not obsolete). This is not reconditioning as it is normal servicing of the equipment since no modification is required.
    - MCC unit has breaker/starter/drive/etc to be replaced in a “like-for-like” scenario. Not considered reconditioning as replacement parts are matched with same components.
    - MCC unit has breaker/starter/drive/etc to be replaced in an upgrade or change of style scenario (mentioned in the Word document). This should not be allowed as it could invalidate listing (combination SCCR, temperature rise, etc..) and the original listing mark is no longer applicable
- MCC lineup has been installed for __ # of years. Facility decides to procure a motor control center bucket to either replace existing or introduce new load to the MCC. This process could result in a few different routes:
    - MCC unit is procured from reseller (re-purposed from another facility/company) and installed into equipment. This should not be allowed as it is a transfer of ownership and does not involve any steps to validate the equipment has not been changed from its original listing.
    - MCC unit is procured from authorized channel for the OEM. This should be allowed (not sure it’s considered reconditioning) provided:
        - OEM manufactures new, UL listed (or UL Classified if vintage is no longer being actively produced) unit with new components. OEM maintains follow up testing to ensure new equipment meets short-circuit and other essential testing records are up to date, even with new component technologies if they weren’t present at time.
        - Insertion of new/replacement unit does not require structural modification to the extent that would invalidate the listing of the vertical section. Examples:
            - Unit support shelves can be relocated to accommodate new units via simple locating features hardware
            - Doors can be removed/installed to meet installation needs and any remaining openings can be covered with additional doors if necessary
- MCC lineup has been installed for __ # of years. Facility decides to expand lineup by adding another vertical section’s worth of loads. This process could result in a few different routes:
    - MCC structure is procured from reseller (re-purposed from another site) and installed into equipment. This should not be allowed as it is a transfer of ownership and does not involve any steps to validate the equipment has not been changed from its original listing.
    - MCC structure is procured from authorized channel for the OEM. This should be allowed (not sure it’s considered reconditioning) provided:
        - OEM manufactures new, UL listed (or UL Classified if vintage is no longer being actively produced) structure which is designed to be connected to

existing bus. OEM maintains follow up testing to ensure new equipment meets short-circuit and other essential testing records are up to date, even with new component technologies if they weren't present at time.

- Insertion of new/replacement unit does not require structural modification to the extent that would invalidate the listing of the vertical section. Examples:
    - Bus splices are designed to be connected between existing and new sections and are procedurally identified
    - Doors can be removed/installed to meet installation needs and any remaining openings can be covered with additional doors if necessary


M.C.C. № 2
CRUSHER FACILITIES
480 VOLTS AC

Public Input No. 10-NFPA 70-2019 [New Part after XIV.]

Large Motors.

when a motor is larger then the tables indicate, the nameplate rating shall be alowed to be used for the conductor sizing.

Statement of Problem and Substantiation for Public Input

the code users need to know how to size conductors for larger motors then what is indicated in the tables, and although it is true that those types of jobs are typically under the control of a design professional, they should still be able to rely on the NEC to size the conductors, and this will also require the design professionals and also electricians to size the conductors properly for large motors.

Submitter Information Verification

Submitter Full Name: Joel Sandel
Organization: JRS Consulting Inc.
Street Address:
City:
State:
Zip:
Submittal Date: Fri Nov 01 15:52:47 EDT 2019
Committee: NEC-P11

Public Input No. 100-NFPA 70-2019 [Part XIV.]

Part XIV. Tables

Table 430.247 Full-Load Current in Amperes, Direct-Current Motors

The following values of full-load currents* are for motors running at base speed.

Horsepower	Armature Voltage Rating*					
	90 Volts	120 Volts	180 Volts	240 Volts	500 Volts	550 Volts
1/4	4.0	3.1	2.0	1.6	—	—
1/3	5.2	4.1	2.6	2.0	—	—
1/2	6.8	5.4	3.4	2.7	—	—
3/4	9.6	7.6	4.8	3.8	—	—
1	12.2	9.5	6.1	4.7	—	—
1 1/2	—	13.2	8.3	6.6	—	—
2	—	17	10.8	8.5	—	—
3	—	25	16	12.2	—	—
5	—	40	27	20	—	—
7 1/2	—	58	—	29	13.6	12.2
10	—	76	—	38	18	16
15	—	—	—	55	27	24
20	—	—	—	72	34	31
25	—	—	—	89	43	38
30	—	—	—	106	51	46
40	—	—	—	140	67	61
50	—	—	—	173	83	75
60	—	—	—	206	99	90
75	—	—	—	255	123	111
100	—	—	—	341	164	148
125	—	—	—	425	205	185
150	—	—	—	506	246	222
200	—	—	—	675	330	294

*These are average dc quantities.

Table 430.248 Full-Load Currents in Amperes, Single-Phase Alternating-Current Motors

The following values of full-load currents are for motors running at usual speeds and motors with normal torque characteristics. The voltages listed are rated motor voltages. The currents listed shall be permitted for system voltage ranges of 110 to 120 and 220 to 240 volts.

Horsepower	115 Volts	200 Volts	208 Volts	230 Volts
1/6	4.4	2.5	2.4	2.2
1/4	5.8	3.3	3.2	2.9
1/3	7.2	4.1	4.0	3.6
1/2	9.8	5.6	5.4	4.9
3/4	13.8	7.9	7.6	6.9
1	16	9.2	8.8	8.0

Horsepower	115 Volts	200 Volts	208 Volts	230 Volts
1 1/2	20	11.5	11.0	10
2	24	13.8	13.2	12
3	34	19.6	18.7	17
5	56	32.2	30.8	28
7 1/2	80	46.0	44.0	40
10	100	57.5	55.0	50

Table 430.249 Full-Load Current, Two-Phase Alternating-Current Motors (4-Wire)

The following values of full-load current are for motors running at speeds usual for belted motors and motors with normal torque characteristics. Current in the common conductor of a 2-phase, 3-wire system will be 1.41 times the value given. The voltages listed are rated motor voltages. The currents listed shall be permitted for system voltage ranges of 110 to 120, 220 to 240, 440 to 480, and 550 to 600 volts.

Horsepower	Induction-Type Squirrel Cage and Wound Rotor (Amperes)			
	115 Volts	230 Volts	460 Volts	575 Volts
~~Volts2300~~				
1/2	4.0	2.0	1.0	0.8
—				
3/4	4.8	2.4	1.2	1.0
—				
1	6.4	3.2	1.6	1.3
—				
1 1/2	9.0	4.5	2.3	1.8
—				
2	11.8	5.9	3.0	2.4
—				
3	—	8.3	4.2	3.3
—				
5	—	13.2	6.6	5.3
—				
7 1/2	—	19	9.0	8.0
—				

10	—	24	12	10	—
15	—	36	18	14	—
20	—	47	23	19	—
25	—	59	29	24	—
30	—	69	35	28	—
40	—	90	45	36	—
50	—	113	56	45	—
60	—	133	67	53	~~14~~
75	—	166	83	66	~~18~~
100	—	218	109	87	~~23~~
125	—	270	135	108	~~28~~
150	—	312	156	125	~~32~~
200	—	416	208	167	~~43~~

Table 430.250 Full-Load Current, Three-Phase Alternating-Current Motors

The following values of full-load currents are typical for motors running at speeds usual for belted motors and motors with normal torque characteristics. The voltages listed are rated motor voltages. The currents listed shall be permitted for system voltage ranges of 110 to 120, 220 to 240, 440 to 480, and 550 to 600 volts.

Horsepower	**Induction-Type Squirrel Cage and Wound Rotor (Amperes)**								
	Synchronous-Type Unity Power Factor* (Amperes)								
115 Volts	**200 Volts**	**208 Volts**	**230 Volts**	**460 Volts**	**575 Volts**	~~2300 Volts~~			
	230 Volts		**460 Volts**		**575 Volts**	~~2300 Volts~~			

1/2	4.4	2.5	2.4	2.2	1.1	0.9	—
-							
		—				—	
— —							
3/4	6.4	3.7	3.5	3.2	1.6	1.3	—
-							
		—				—	
— —							
1	8.4	4.8	4.6	4.2	2.1	1.7	—
-							
		—				—	
— —							
1 1/2	12.0	6.9	6.6	6.0	3.0	2.4	—
-							
		—				—	
— —							
2	13.6	7.8	7.5	6.8	3.4	2.7	—
-							
		—				—	
— —							
3	—	11.0	10.6	9.6	4.8	3.9	—
-							
		—				—	
— —							
5	—	17.5	16.7	15.2	7.6	6.1	—
-							
		—				—	
— —							
7 1/2	—	25.3	24.2	22	11	9	—
-							
		—				—	
— —							
10	—	32.2	30.8	28	14	11	—
-							
		—				—	
— —							
15	—	48.3	46.2	42	21	17	—
-							
		—				—	
— —							
20	—	62.1	59.4	54	27	22	—
-							

		—			—	
— —						
25	—	78.2	74.8	68	34	27
— -						
	53		26		21	
—						
30	—	92	88	80	40	32
— -						
	63		32		26	
—						
40	—	120	114	104	52	41
— -						
	83		41		33	
—						
50	—	150	143	130	65	52
— -						
	104		52		42	
—						
60	—	177	169	154	77	62
~~16~~ -						
	123		61		49	
~~12~~						
75	—	221	211	192	96	77
~~20~~ -						
	155		78		62	
~~15~~						
100	—	285	273	248	124	99
~~26~~ -						
	202		101		81	
~~20~~						
125	—	359	343	312	156	125
~~31~~ -						
	253		126		101	
~~25~~						
150	—	414	396	360	180	144
~~37~~ -						
	302		151		121	
~~30~~						
200						
-						
552		528	480	240	192	
~~49~~ -						
	400		201		161	

40						
250	—	—	—	—	302	242
~~60~~						
	—		—			—
—						
300	—	—	—	—	361	289
~~72~~						
	—		—			—
—						
350	—	—	—	—	414	336
~~83~~						
	—		—			—
—						
400	—	—	—	—	477	382
~~95~~						
	—		—			—
—						
450	—	—	—	—	515	412
~~103~~						
	—		—			—
—						
500	—	—	—	—	590	472
~~118~~						
	—		—			—
—						

*For 90 and 80 percent power factor, the figures shall be multiplied by 1.1 and 1.25, respectively.

Table 430.251(A) Conversion Table of Single-Phase Locked-Rotor Currents for Selection of Disconnecting Means and Controllers as Determined from Horsepower and Voltage Rating

For use only with 430.110, 440.12, 440.41, and 455.8(C).

Rated Horsepower	**Maximum Locked-Rotor Current in Amperes, Single Phase**		
	115 Volts	**208 Volts**	**230 Volts**
½	58.8	32.5	29.4
¾	82.8	45.8	41.4
1	96	53	48
1½	120	66	60
2	144	80	72
3	204	113	102
5	336	186	168
7½	480	265	240
10	1000	332	300

Table 430.251(B) Conversion Table of Polyphase Design B, C, and D Maximum Locked-Rotor Currents for Selection of Disconnecting Means and Controllers as Determined from Horsepower and Voltage Rating and Design Letter

For use only with 430.110, 440.12, 440.41, and 455.8(C).

Rated Horsepower	Maximum Motor Locked-Rotor Current in Amperes, Two- and Three-Phase, Design B, C, and D*
	115 Volts
	200 Volts
	208 Volts
	230 Volts
	460 Volts
	575 Volts
	B, C, D
	B, C, D
	B, C, D
	B, C, D
	B, C, D
	B, C, D
1/2	40
	23
	22.1
	20
	10
	8
3/4	50
	28.8

		27.6		
–				
		25		
–				
		12.5		
–				
1	60		10	
–				
		34.5		
–				
		33		
–				
		30		
–				
		15		
–				
1 1/2			80	12
–				
		46		
–				
		44		
–				
		40		
–				
		20		
–				
2	100		16	
–				
		57.5		
–				
		55		
–				
		50		
–				
		25		
–				
3			20 —	
–				
		73.6		
–				
		71		

64

32

25.6

5 —

105.8

102

92

46

36.8

7 1⁄2 —

146

140

127

63.5

50.8

10 —

186.3

179

162

81

64.8

15 —

267

257

	232	
–		
	116	
–		
20		93 —
–		
	334	
–		
	321	
–		
	290	
–		
	145	
–		
25		116 —
–		
	420	
–		
	404	
–		
	365	
–		
	183	
–		
30		146 —
–		
	500	
–		
	481	
–		
	435	
–		
	218	
–		
40		174 —
–		
	667	
–		
	641	
–		
	580	
–		

	290	
-		
		232
50		—
-		
	834	
-		
	802	
-		
	725	
-		
	363	
-		
		290
60		—
-		
	1001	
-		
	962	
-		
	870	
-		
	435	
-		
		348
75		—
-		
	1248	
-		
	1200	
-		
	1085	
-		
	543	
-		
		434
100		—
-		
	1668	
-		
	1603	
-		
	1450	
-		
	725	
-		

125		580 —
-	2087	
-	2007	
-	1815	
-	908	
150		726 —
-	2496	
-	2400	
-	2170	
-	1085	
200		868 —
-	3335	
-	3207	
-	2900	
-	1450	
250		1160 —
-	—	
-	—	
-	—	
-	1825	
		1460

300		—
-		
	—	
-		
	—	
-		
	—	
-		
	2200	
-		
		1760
350		—
-		
	—	
-		
	—	
-		
	—	
-		
	2550	
-		
		2040
400		—
-		
	—	
-		
	—	
-		
	—	
-		
	2900	
-		
		2320
450		—
-		
	—	
-		
	—	
-		
	—	
-		
	3250	
-		
		2600
500		—
-		

—
_
—
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—
_
3625
_
2900

*Design A motors are not limited to a maximum starting current or locked rotor current.

Statement of Problem and Substantiation for Public Input

Article 430 Part XI, Section 430.225(B)(1) addresses the need for protection schemes to be performed under engineering supervision. There is no need to indicate FLC amperage for 2300V motors in Table 430.250. 430.6(A) currently refers the user to the tables to size all cables, fuses, breakers, disconnecting means, etc. Table 430.250 should not contain motors rated larger than 1000V as these motors and their protection schemes and equipment should not be designed without engineering supervision. Eliminating these values would align 430 Part XI with 430.6 and the Tables.

Submitter Information Verification

Submitter Full Name: Paul Guidry

Organization: Fluor Enterprises, Inc.

Affiliation: Associated Builders and Contractors

Street Address:

City:

State:

Zip:

Submittal Date: Tue Nov 12 16:52:55 EST 2019

Committee: NEC-P11

Public Input No. 1250-NFPA 70-2020 [Part XIV.]

Part XIV. Tables

Table 430.247 Full-Load Current in Amperes, Direct-Current Motors

The following values of full-load currents* are for motors running at base speed.

Horsepower	Armature Voltage Rating*					
	90 Volts	120 Volts	180 Volts	240 Volts	500 Volts	550 Volts
¼	4.0	3.1	2.0	1.6	—	—
⅓	5.2	4.1	2.6	2.0	—	—
½	6.8	5.4	3.4	2.7	—	—
¾	9.6	7.6	4.8	3.8	—	—
1	12.2	9.5	6.1	4.7	—	—
1½	—	13.2	8.3	6.6	—	—
2	—	17	10.8	8.5	—	—
3	—	25	16	12.2	—	—
5	—	40	27	20	—	—
7½	—	58	—	29	13.6	12.2
10	—	76	—	38	18	16
15	—	—	—	55	27	24
20	—	—	—	72	34	31
25	—	—	—	89	43	38
30	—	—	—	106	51	46
40	—	—	—	140	67	61
50	—	—	—	173	83	75
60	—	—	—	206	99	90
75	—	—	—	255	123	111
100	—	—	—	341	164	148
125	—	—	—	425	205	185
150	—	—	—	506	246	222
200	—	—	—	675	330	294

*These are average dc quantities.

Table 430.248 Full-Load Currents in Amperes, Single-Phase Alternating-Current Motors

The following values of full-load currents are for motors running at usual speeds and motors with normal torque characteristics. The voltages listed are rated motor voltages. The currents listed shall be permitted for system voltage ranges of 110 to 120 and 220 to 240 volts.

Horsepower	115 Volts	200 Volts	208 Volts	230 Volts
⅙	4.4	2.5	2.4	2.2
¼	5.8	3.3	3.2	2.9
⅓	7.2	4.1	4.0	3.6
½	9.8	5.6	5.4	4.9
¾	13.8	7.9	7.6	6.9
1	16	9.2	8.8	8.0
1½	20	11.5	11.0	10
2	24	13.8	13.2	12
3	34	19.6	18.7	17
5	56	32.2	30.8	28

Horsepower	115 Volts	200 Volts	208 Volts	230 Volts
7½	80	46.0	44.0	40
10	100	57.5	55.0	50

Table 430.249 Full-Load Current, Two-Phase Alternating-Current Motors (4-Wire)

The following values of full-load current are for motors running at speeds usual for belted motors and motors with normal torque characteristics. Current in the common conductor of a 2-phase, 3-wire system will be 1.41 times the value given. The voltages listed are rated motor voltages. The currents listed shall be permitted for system voltage ranges of 110 to 120, 220 to 240, 440 to 480, and 550 to 600 volts.

Horsepower	Induction-Type Squirrel Cage and Wound Rotor (Amperes)				
	115 Volts	230 Volts	460 Volts	575 Volts	2300 Volts
½	4.0	2.0	1.0	0.8	—
¾	4.8	2.4	1.2	1.0	—
1	6.4	3.2	1.6	1.3	—
1½	9.0	4.5	2.3	1.8	—
2	11.8	5.9	3.0	2.4	—
3	—	8.3	4.2	3.3	—
5	—	13.2	6.6	5.3	—
7½	—	19	9.0	8.0	—
10	—	24	12	10	—
15	—	36	18	14	—
20	—	47	23	19	—
25	—	59	29	24	—
30	—	69	35	28	—
40	—	90	45	36	—
50	—	113	56	45	—
60	—	133	67	53	14
75	—	166	83	66	18
100	—	218	109	87	23
125	—	270	135	108	28
150	—	312	156	125	32
200	—	416	208	167	43

Table 430.250 Full-Load Current, Three-Phase Alternating-Current Motors

The following values of full-load currents are typical for motors running at speeds usual for belted motors and motors with normal torque characteristics. The voltages listed are rated motor voltages. The currents listed shall be permitted for system voltage ranges of 110 to 120, 220 to 240, 440 to 480, and 550 to 600 volts.

Horsepower	Induction-Type Squirrel Cage and Wound Rotor (Amperes)								Syr
	115 Volts	200 Volts	208 Volts	230 Volts	460 Volts	575 Volts	2300 Volts		230 Volt
½	4.4	2.5	2.4	2.2	1.1	0.9	—		—
¾	6.4	3.7	3.5	3.2	1.6	1.3	—		—
1	8.4	4.8	4.6	4.2	2.1	1.7	—		—

Horsepower	Induction-Type Squirrel Cage and Wound Rotor (Amperes)							Syr
	115 Volts	200 Volts	208 Volts	230 Volts	460 Volts	575 Volts	2300 Volts	230 Volts
1½	12.0	6.9	6.6	6.0	3.0	2.4	—	—
2	13.6	7.8	7.5	6.8	3.4	2.7	—	—
3	—	11.0	10.6	9.6	4.8	3.9	—	—
5	—	17.5	16.7	15.2	7.6	6.1	—	—
7½	—	25.3	24.2	22	11	9	—	—
10	—	32.2	30.8	28	14	11	—	—
15	—	48.3	46.2	42	21	17	—	—
20	—	62.1	59.4	54	27	22	—	—
25	—	78.2	74.8	68	34	27	—	53
30	—	92	88	80	40	32	—	63
40	—	120	114	104	52	41	—	83
50	—	150	143	130	65	52	—	104
60	—	177	169	154	77	62	16	123
75	—	221	211	192	96	77	20	155
100	—	285	273	248	124	99	26	202
125	—	359	343	312	156	125	31	253
150	—	414	396	360	180	144	37	302
200		552	528	480	240	192	49	400
250	—	—	—	—	302	242	60	—
300	—	—	—	—	361	289	72	—
350	—	—	—	—	414	336	83	—
400	—	—	—	—	477	382	95	—
450	—	—	—	—	515	412	103	—
500	—	—	—	—	590	472	118	—

*For 90 and 80 percent power factor, the figures shall be multiplied by 1.1 and 1.25, respectively.

Table 430.251(A) Conversion Table of Single-Phase Locked-Rotor Currents for Selection of Disconnecting Means and Controllers as Determined from Horsepower and Voltage Rating

For use only with 430.110, 440.12, 440.41, and 455.8(C).

Rated Horsepower	Maximum Locked-Rotor Current in Amperes, Single Phase		
	115 Volts	208 Volts	230 Volts
½	58.8	32.5	29.4
¾	82.8	45.8	41.4
1	96	53	48
1½	120	66	60
2	144	80	72
3	204	113	102
5	336	186	168
7½	480	265	240
10	1000	332	300

Table 430.251(B) Conversion Table of Polyphase Design B, C, and D Maximum Locked-Rotor Currents for Selection of Disconnecting Means and Controllers as Determined from Horsepower and Voltage Rating and Design Letter

For use only with 430.110, 440.12, 440.41, and 455.8(C).

Rated Horsepower	Maximum Motor Locked-Rotor Current in Amperes, Two- and Three-Phase, Design B, C, and D*					
	115 Volts	200 Volts	208 Volts	230 Volts	460 Volts	575 Volts
	B, C, D	B, C, D	B, C, D	B, C, D	B, C, D	B, C, D
½	40	23	22.1	20	10	8
¾	50	28.8	27.6	25	12.5	10
1	60	34.5	33	30	15	12
1½	80	46	44	40	20	16
2	100	57.5	55	50	25	20
3	—	73.6	71	64	32	25.6
5	—	105.8	102	92	46	36.8
7½	—	146	140	127	63.5	50.8
10	—	186.3	179	162	81	64.8
15	—	267	257	232	116	93
20	—	334	321	290	145	116
25	—	420	404	365	183	146
30	—	500	481	435	218	174
40	—	667	641	580	290	232
50	—	834	802	725	363	290
60	—	1001	962	870	435	348
75	—	1248	1200	1085	543	434
100	—	1668	1603	1450	725	580
125	—	2087	2007	1815	908	726
150	—	2496	2400	2170	1085	868
200	—	3335	3207	2900	1450	1160
250	—	—	—	—	1825	1460
300	—	—	—	—	2200	1760
350	—	—	—	—	2550	2040
400	—	—	—	—	2900	2320
450	—	—	—	—	3250	2600
500	—	—	—	—	3625	2900

*Design A motors are not limited to a maximum starting current or locked rotor current.

Additional Proposed Changes

File Name	Description	Approved
2023_NEC_PI_Table_430.248_Guidry.docx	Revised Table 430.248	

Statement of Problem and Substantiation for Public Input

460V single phase ac motors are common. Since 430.6 requires the use of the full-load currents from the tables for sizing wire, fuses and breakers for motors less than 600V, the full-load current values for 460V single phase motors should be included. The values are based on the currently shown 230V motors full-load current divided by 2, and rounded up to the nearest single decimal.

Submitter Information Verification

Submitter Full Name:	Paul Guidry
Organization:	Fluor Enterprises, Inc.
Affiliation:	Associated Builders and Contractors
Street Address:	
City:	
State:	
Zip:	
Submittal Date:	Sun May 24 16:50:32 EDT 2020
Committee:	NEC-P11

Table 430.248 Full-Load Currents in Amperes, Single-Phase Alternating-Current Motors

The following values of full-load currents are for motors running at usual speeds and motors with normal torque characteristics. The voltages listed are rated motor voltages. †The currents listed shall be permitted for system voltage ranges of 110 to 120 and 220 to 240 and 440 to 480 volts.

Horsepower	†115 Volts	200 Volts	208 Volts	†230 Volts	†460 Volts
1⁄6	4.4	2.5	2.4	2.2	1.1
1⁄4	5.8	3.3	3.2	2.9	1.5
1⁄3	7.2	4.1	4	3.6	1.8
1⁄2	9.8	5.6	5.4	4.9	2.5
3⁄4	13.8	7.9	7.6	6.9	3.5
1	16	9.2	8.8	8	4
1 1⁄2	20	11.5	11	10	5
2	24	13.8	13.2	12	6
3	34	19.6	18.7	17	8.5
5	56	32.2	30.8	28	14
7 1⁄2	80	46	44	40	20
10	100	57.5	55	50	25

Public Input No. 2350-NFPA 70-2020 [Part XIV.]

Part XIV. Tables

Table 430.247 Full-Load Current in Amperes, Direct-Current Motors

The following values of full-load currents* are for motors running at base speed.

Horsepower	Armature Voltage Rating*					
	90 Volts	120 Volts	180 Volts	240 Volts	500 Volts	550 Volts
¼	4.0	3.1	2.0	1.6	—	—
⅓	5.2	4.1	2.6	2.0	—	—
½	6.8	5.4	3.4	2.7	—	—
¾	9.6	7.6	4.8	3.8	—	—
1	12.2	9.5	6.1	4.7	—	—
1½	—	13.2	8.3	6.6	—	—
2	—	17	10.8	8.5	—	—
3	—	25	16	12.2	—	—
5	—	40	27	20	—	—
7½	—	58	—	29	13.6	12.2
10	—	76	—	38	18	16
15	—	—	—	55	27	24
20	—	—	—	72	34	31
25	—	—	—	89	43	38
30	—	—	—	106	51	46
40	—	—	—	140	67	61
50	—	—	—	173	83	75
60	—	—	—	206	99	90
75	—	—	—	255	123	111
100	—	—	—	341	164	148
125	—	—	—	425	205	185
150	—	—	—	506	246	222
200	—	—	—	675	330	294

*These are average dc quantities.

Table 430.248 Full-Load Currents in Amperes, Single-Phase Alternating-Current Motors

The following values of full-load currents are for motors running at usual speeds and motors with normal torque characteristics. The voltages listed are rated motor voltages. The currents listed shall be permitted for system voltage ranges of 110 to 120 and 220 to 240 volts.

Horsepower	115 Volts	200 Volts	208 Volts	230 Volts	277 Volts
⅙	4.4	2.5	2.4	2.2	
¼	5.8	3.3	3.2	2.9	
⅓	7.2	4.1	4.0	3.6	
½	9.8	5.6	5.4	4.9	
¾	13.8	7.9	7.6	6.9	
1	16	9.2	8.8	8.0	
1½	20	11.5	11.0	10	
2	24	13.8	13.2	12	
3	34	19.6	18.7	17	

Horsepower	115 Volts	200 Volts	208 Volts	230 Volts	277 Volts
5	56	32.2	30.8	28	
7½	80	46.0	44.0	40	
10	100	57.5	55.0	50	

Table 430.249 Full-Load Current, Two-Phase Alternating-Current Motors (4-Wire)

The following values of full-load current are for motors running at speeds usual for belted motors and motors with normal torque characteristics. Current in the common conductor of a 2-phase, 3-wire system will be 1.41 times the value given. The voltages listed are rated motor voltages. The currents listed shall be permitted for system voltage ranges of 110 to 120, 220 to 240, 440 to 480, and 550 to 600 volts.

Horsepower	Induction-Type Squirrel Cage and Wound Rotor (Amperes)				
	115 Volts	230 Volts	460 Volts	575 Volts	2300 Volts
½	4.0	2.0	1.0	0.8	—
¾	4.8	2.4	1.2	1.0	—
1	6.4	3.2	1.6	1.3	—
1½	9.0	4.5	2.3	1.8	—
2	11.8	5.9	3.0	2.4	—
3	—	8.3	4.2	3.3	—
5	—	13.2	6.6	5.3	—
7½	—	19	9.0	8.0	—
10	—	24	12	10	—
15	—	36	18	14	—
20	—	47	23	19	—
25	—	59	29	24	—
30	—	69	35	28	—
40	—	90	45	36	—
50	—	113	56	45	—
60	—	133	67	53	14
75	—	166	83	66	18
100	—	218	109	87	23
125	—	270	135	108	28
150	—	312	156	125	32
200	—	416	208	167	43

Table 430.250 Full-Load Current, Three-Phase Alternating-Current Motors

The following values of full-load currents are typical for motors running at speeds usual for belted motors and motors with normal torque characteristics. The voltages listed are rated motor voltages. The currents listed shall be permitted for system voltage ranges of 110 to 120, 220 to 240, 440 to 480, and 550 to 600 volts.

Horsepower	Induction-Type Squirrel Cage and Wound Rotor (Amperes)	-	S

	115 Volts	200 Volts	208 Volts	230 Volts	460 Volts	575 Volts	2300 Volts	-	230 Vo
½	4.4	2.5	2.4	2.2	1.1	0.9	—	-	—
¾	6.4	3.7	3.5	3.2	1.6	1.3	—	-	—
1	8.4	4.8	4.6	4.2	2.1	1.7	—	-	—
1½	12.0	6.9	6.6	6.0	3.0	2.4	—	-	—
2	13.6	7.8	7.5	6.8	3.4	2.7	—	-	—
3	—	11.0	10.6	9.6	4.8	3.9	—	-	—
5	—	17.5	16.7	15.2	7.6	6.1	—	-	—
7½	—	25.3	24.2	22	11	9	—	-	—
10	—	32.2	30.8	28	14	11	—	-	—
15	—	48.3	46.2	42	21	17	—	-	—
20	—	62.1	59.4	54	27	22	—	-	—
25	—	78.2	74.8	68	34	27	—	-	53
30	—	92	88	80	40	32	—	-	63
40	—	120	114	104	52	41	—	-	83
50	—	150	143	130	65	52	—	-	104
60	—	177	169	154	77	62	16	-	123
75	—	221	211	192	96	77	20	-	155
100	—	285	273	248	124	99	26	-	202
125	—	359	343	312	156	125	31	-	253
150	—	414	396	360	180	144	37	-	302
200	-		552	528	480	240	192	49 -	
250	—	—	—	—	302	242	60	-	—
300	—	—	—	—	361	289	72	-	—
350	—	—	—	—	414	336	83	-	—
400	—	—	—	—	477	382	95	-	—
450	—	—	—	—	515	412	103	-	—
500	—	—	—	—	590	472	118	-	—

*For 90 and 80 percent power factor, the figures shall be multiplied by 1.1 and 1.25, respectively.

Table 430.251(A) Conversion Table of Single-Phase Locked-Rotor Currents for Selection of Disconnecting Means and Controllers as Determined from Horsepower and Voltage Rating

For use only with 430.110, 440.12, 440.41, and 455.8(C).

Rated Horsepower	Maximum Locked-Rotor Current in Amperes, Single Phase		
	115 Volts	208 Volts	230 Volts
½	58.8	32.5	29.4
¾	82.8	45.8	41.4
1	96	53	48
1½	120	66	60
2	144	80	72
3	204	113	102
5	336	186	168
7½	480	265	240
10	1000	332	300

Table 430.251(B) Conversion Table of Polyphase Design B, C, and D Maximum Locked-Rotor Currents for Selection of Disconnecting Means and Controllers as Determined from Horsepower and Voltage Rating and Design Letter

For use only with 430.110, 440.12, 440.41, and 455.8(C).

Rated Horsepower	Maximum Motor Locked-Rotor Current in Amperes, Two- and Three-Phase, Design B, C, and D*										
	115 Volts	-	200 Volts	-	208 Volts	-	230 Volts	-	460 Volts	-	575 Volts
	B, C, D	-	B, C, D	-	B, C, D	-	B, C, D	-	B, C, D	-	B, C, D
½	40	-	23	-	22.1	-	20	-	10	-	8
¾	50	-	28.8	-	27.6	-	25	-	12.5	-	10
1	60	-	34.5	-	33	-	30	-	15	-	12
1½	80	-	46	-	44	-	40	-	20	-	16
2	100	-	57.5	-	55	-	50	-	25	-	20
3	—	-	73.6	-	71	-	64	-	32	-	25.6
5	—	-	105.8	-	102	-	92	-	46	-	36.8
7½	—	-	146	-	140	-	127	-	63.5	-	50.8
10	—	-	186.3	-	179	-	162	-	81	-	64.8
15	—	-	267	-	257	-	232	-	116	-	93
20	—	-	334	-	321	-	290	-	145	-	116
25	—	-	420	-	404	-	365	-	183	-	146
30	—	-	500	-	481	-	435	-	218	-	174
40	—	-	667	-	641	-	580	-	290	-	232
50	—	-	834	-	802	-	725	-	363	-	290
60	—	-	1001	-	962	-	870	-	435	-	348
75	—	-	1248	-	1200	-	1085	-	543	-	434
100	—	-	1668	-	1603	-	1450	-	725	-	580
125	—	-	2087	-	2007	-	1815	-	908	-	726
150	—	-	2496	-	2400	-	2170	-	1085	-	868
200	—	-	3335	-	3207	-	2900	-	1450	-	1160
250	—	-	—	-	—	-	—	-	1825	-	1460
300	—	-	—	-	—	-	—	-	2200	-	1760
350	—	-	—	-	—	-	—	-	2550	-	2040
400	—	-	—	-	—	-	—	-	2900	-	2320
450	—	-	—	-	—	-	—	-	3250	-	2600
500	—	-	—	-	—	-	—	-	3625	-	2900

*Design A motors are not limited to a maximum starting current or locked rotor current.

Statement of Problem and Substantiation for Public Input

Table 430.248 only list voltages up to 230V. Recommend adding 277V/1-phase motor column. 277V/1-phase motors are common in commercial buildings for use with HVAC and plumbing systems.

Submitter Information Verification

Submitter Full Name: John Romine

Organization: Burns & McDonnell

Street Address:

City:	
State:	
Zip:	
Submittal Date:	Mon Aug 17 15:30:07 EDT 2020
Committee:	NEC-P11

Public Input No. 557-NFPA 70-2020 [Part XIV.]

Part XIV. Tables

Table 430.247 Full-Load Current in Amperes, Direct-Current Motors

The following values of full-load currents* are for motors running at base speed.

Horsepower	Armature Voltage Rating*					
	90 Volts	120 Volts	180 Volts	240 Volts	500 Volts	550 Volts
¼	4.0	3.1	2.0	1.6	—	—
⅓	5.2	4.1	2.6	2.0	—	—
½	6.8	5.4	3.4	2.7	—	—
¾	9.6	7.6	4.8	3.8	—	—
1	12.2	9.5	6.1	4.7	—	—
1½	—	13.2	8.3	6.6	—	—
2	—	17	10.8	8.5	—	—
3	—	25	16	12.2	—	—
5	—	40	27	20	—	—
7½	—	58	—	29	13.6	12.2
10	—	76	—	38	18	16
15	—	—	—	55	27	24
20	—	—	—	72	34	31
25	—	—	—	89	43	38
30	—	—	—	106	51	46
40	—	—	—	140	67	61
50	—	—	—	173	83	75
60	—	—	—	206	99	90
75	—	—	—	255	123	111
100	—	—	—	341	164	148
125	—	—	—	425	205	185
150	—	—	—	506	246	222
200	—	—	—	675	330	294

*These are average dc quantities.

Table 430.248 Full-Load Currents in Amperes, Single-Phase Alternating-Current Motors

The following values of full-load currents are for motors running at usual speeds and motors with normal torque characteristics. The voltages listed are rated motor voltages. The currents listed shall be permitted for system voltage ranges of 110 to 120 and 220 to 240 volts.

Horsepower	115 Volts	200 Volts	208 Volts	230 Volts
⅙	4.4	2.5	2.4	2.2
¼	5.8	3.3	3.2	2.9
⅓	7.2	4.1	4.0	3.6
½	9.8	5.6	5.4	4.9
¾	13.8	7.9	7.6	6.9
1	16	9.2	8.8	8.0
1½	20	11.5	11.0	10
2	24	13.8	13.2	12
3	34	19.6	18.7	17
5	56	32.2	30.8	28

Horsepower	115 Volts	200 Volts	208 Volts	230 Volts
7½	80	46.0	44.0	40
10	100	57.5	55.0	50

Table 430.249 Full-Load Current, Two-Phase Alternating-Current Motors (4-Wire)

The following values of full-load current are for motors running at speeds usual for belted motors and motors with normal torque characteristics. Current in the common conductor of a 2-phase, 3-wire system will be 1.41 times the value given. The voltages listed are rated motor voltages. The currents listed shall be permitted for system voltage ranges of 110 to 120, 220 to 240, 440 to 480, and 550 to 600 volts.

Horsepower	Induction-Type Squirrel Cage and Wound Rotor (Amperes)				
	115 Volts	230 Volts	460 Volts	575 Volts	2300 Volts
½	4.0	2.0	1.0	0.8	—
¾	4.8	2.4	1.2	1.0	—
1	6.4	3.2	1.6	1.3	—
1½	9.0	4.5	2.3	1.8	—
2	11.8	5.9	3.0	2.4	—
3	—	8.3	4.2	3.3	—
5	—	13.2	6.6	5.3	—
7½	—	19	9.0	8.0	—
10	—	24	12	10	—
15	—	36	18	14	—
20	—	47	23	19	—
25	—	59	29	24	—
30	—	69	35	28	—
40	—	90	45	36	—
50	—	113	56	45	—
60	—	133	67	53	14
75	—	166	83	66	18
100	—	218	109	87	23
125	—	270	135	108	28
150	—	312	156	125	32
200	—	416	208	167	43

Table 430.250 Full-Load Current, Three-Phase Alternating-Current Motors

The following values of full-load currents are typical for motors running at speeds usual for belted motors and motors with normal torque characteristics. The voltages listed are rated motor voltages. The currents listed shall be permitted for system voltage ranges of 110 to 120, 220 to 240, 440 to 480, and 550 to 600 volts.

Horsepower	Induction-Type Squirrel Cage and Wound Rotor (Amperes)							Syr
	115 Volts	200 Volts	208 Volts	230 Volts	460 Volts	575 Volts	2300 Volts	230 Volt
½	4.4	2.5	2.4	2.2	1.1	0.9	—	—
¾	6.4	3.7	3.5	3.2	1.6	1.3	—	—
1	8.4	4.8	4.6	4.2	2.1	1.7	—	—

Horsepower	Induction-Type Squirrel Cage and Wound Rotor (Amperes)							Syr
	115 Volts	200 Volts	208 Volts	230 Volts	460 Volts	575 Volts	2300 Volts	230 Volt
1½	12.0	6.9	6.6	6.0	3.0	2.4	—	—
2	13.6	7.8	7.5	6.8	3.4	2.7	—	—
3	—	11.0	10.6	9.6	4.8	3.9	—	—
5	—	17.5	16.7	15.2	7.6	6.1	—	—
7½	—	25.3	24.2	22	11	9	—	—
10	—	32.2	30.8	28	14	11	—	—
15	—	48.3	46.2	42	21	17	—	—
20	—	62.1	59.4	54	27	22	—	—
25	—	78.2	74.8	68	34	27	—	53
30	—	92	88	80	40	32	—	63
40	—	120	114	104	52	41	—	83
50	—	150	143	130	65	52	—	104
60	—	177	169	154	77	62	16	123
75	—	221	211	192	96	77	20	155
100	—	285	273	248	124	99	26	202
125	—	359	343	312	156	125	31	253
150	—	414	396	360	180	144	37	302
200		552	528	480	240	192	49	400
250	—	—	—	—	302	242	60	—
300	—	—	—	—	361	289	72	—
350	—	—	—	—	414	336	83	—
400	—	—	—	—	477	382	95	—
450	—	—	—	—	515	412	103	—
500	—	—	—	—	590	472	118	—

*For 90 and 80 percent power factor, the figures shall be multiplied by 1.1 and 1.25, respectively.

Table 430.251(A) Conversion Table of Single-Phase Locked-Rotor Currents for Selection of Disconnecting Means and Controllers as Determined from Horsepower and Voltage Rating

For use only with 430.110, 440.12, 440.41, and 455.8(C).

Rated Horsepower	Maximum Locked-Rotor Current in Amperes, Single Phase		
	115 Volts	208 Volts	230 Volts
½	58.8	32.5	29.4
¾	82.8	45.8	41.4
1	96	53	48
1½	120	66	60
2	144	80	72
3	204	113	102
5	336	186	168
7½	480	265	240
10	1000	332	300

Table 430.251(B) Conversion Table of Polyphase Design B, C, and D Maximum Locked-Rotor Currents for Selection of Disconnecting Means and Controllers as Determined from Horsepower and Voltage Rating and Design Letter

For use only with 430.110, 440.12, 440.41, and 455.8(C).

Rated Horsepower	Maximum Motor Locked-Rotor Current in Amperes, Two- and Three-Phase, Design B, C, and D*					
	115 Volts	200 Volts	208 Volts	230 Volts	460 Volts	575 Volts
	B, C, D	B, C, D	B, C, D	B, C, D	B, C, D	B, C, D
½	40	23	22.1	20	10	8
¾	50	28.8	27.6	25	12.5	10
1	60	34.5	33	30	15	12
1½	80	46	44	40	20	16
2	100	57.5	55	50	25	20
3	—	73.6	71	64	32	25.6
5	—	105.8	102	92	46	36.8
7½	—	146	140	127	63.5	50.8
10	—	186.3	179	162	81	64.8
15	—	267	257	232	116	93
20	—	334	321	290	145	116
25	—	420	404	365	183	146
30	—	500	481	435	218	174
40	—	667	641	580	290	232
50	—	834	802	725	363	290
60	—	1001	962	870	435	348
75	—	1248	1200	1085	543	434
100	—	1668	1603	1450	725	580
125	—	2087	2007	1815	908	726
150	—	2496	2400	2170	1085	868
200	—	3335	3207	2900	1450	1160
250	—	—	—	—	1825	1460
300	—	—	—	—	2200	1760
350	—	—	—	—	2550	2040
400	—	—	—	—	2900	2320
450	—	—	—	—	3250	2600
500	—	—	—	—	3625	2900

*Design A motors are not limited to a maximum starting current or locked rotor current.

Additional Proposed Changes

File Name	Description	Approved
CMP_11_TIA_1462_issued_TIA_70_20_7.pdf	NEC TIA 20-7 Log No. 1462	

Statement of Problem and Substantiation for Public Input

NOTE: This public input originates from Tentative Interim Amendment No. 20-7 (Log 1462) issued by the Standards Council on August 6, 2019 and per the NFPA Regs., needs to be reconsidered by the Code Making Panel for the next edition of the Document.

Substantiation: During the 2020 NEC First Draft Meeting CMP-5 created a First Revision that revised how equipment grounding conductors were sized. This revision impacted Table 250.122. As a result CMP-11 viewed this change as negatively impacting the proper sizing of conductors for motor circuits and created a new 430.246 section during the Second Draft Meeting. This action fundamentally adopted the original equipment grounding conductor sizing method and in essence relocated the original Table 250.122 to Article 430. During the Second Revision meeting CMP-5 reconsidered the change and rejected the new equipment grounding conductor sizing method returning to the original method. During the Correlating Committee Second Meeting, the Correlating Committee created a Correlating Committee Second Revision to correlate sections 250.122 and 430.246. As a result, Section 430.246 was deleted but the corresponding Table 430.252 was inadvertently not removed. This TIA seeks to correct this error by deleting Table 430.252 which has no language referencing the table and will only create confusion for the user if it remains in the 2020 NEC

Emergency Nature: The standard contains an error or an omission that was overlooked during the regular revision process.

This TIA seeks to correct an error by deleting Table 430.252 which has no language referencing the table and will only create confusion for the user if it remains in the 2020 NEC. The Correlating Committee inadvertently overlooked the removal of Table 430.252 when it acted to correlate the actions taken between CMP-5 and CMP-11 during the regular revision process of the Second Revision.

Submitter Information Verification

Submitter Full Name:	CMP ON NEC-P11
Organization:	Code Making Panel 11
Street Address:	
City:	
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Submittal Date:	Fri Feb 28 11:33:14 EST 2020
Committee:	NEC-P11

Tentative Interim Amendment

NFPA® 70®

National Electrical Code®

2020 Edition

Reference: Table 430.252
TIA 20-7
(SC 19-8-26 / TIA Log #1462)

Note: Text of the TIA was issued and approved for incorporation into the document prior to printing.

1. Delete Table 430.252 in its entirety:

Table 430.252 Minimum Size Equipment Grounding Conductors for Grounding Motor Circuits and Equipment

Rating or Setting of Branch Circuit Short-Circuit and Ground-Fault Protective Device in Circuit Ahead of Equipment, Conduit, etc., Not Exceeding (Amperes)	Size (AWG or kcmil)	
	Copper	Aluminum or Copper-Clad Aluminum*
15	14	12
20	12	10
60	10	8
100	8	6
200	6	4
300	4	2
400	3	1
500	2	1/0
600	1	2/0
800	1/0	3/0
1000	2/0	4/0
1200	3/0	250
1600	4/0	350
2000	250	400
2500	350	600
3000	400	600
4000	500	750
5000	700	1200
6000	800	1200

Note: Where necessary to comply with 250.4(A)(5) or (B)(4), the equipment grounding conductor shall be sized larger than given in this table.
*See installation restrictions in 250.120.

Issue Date: August 6, 2019
Effective Date: August 26, 2019

(Note: For further information on NFPA Codes and Standards, please see www.nfpa.org/docinfo)

Public Input No. 3728-NFPA 70-2020 [Global Input]

See Attached Word Document for Changes

Additional Proposed Changes

File Name	Description	Approved
240_and_490_Public_Input_-_Final0.docx	Global PI to Revise Articles 240, 242 and Chapter 4, Adding New Articles 245 and 495.	✓

Statement of Problem and Substantiation for Public Input

This Public Input is submitted on behalf of a Correlating Committee Long-Range Planning Task Group consisting of Robert Osborne (Chair), Paul Barnhart, Lou Grahor, David Temple, Donny Cook, Dean Hunter, Mike Querry, Roger McDaniel, Dave Burns, Rod Belisle, and Kevin Rogers. This Public Input, along with other companion Public Inputs, was developed with the goal of improving usability and providing a platform to increase the focus on requirements associated with Medium or High Voltage.

Installations, including campus-wide distribution systems, microgrids, alternative energy installations, etc., are covered by the Scope of the NEC®; however, requirements for conductors, equipment, and raceways used in applications operating in systems rated over 1000 volts are treated as an “after-thought” in how they are arranged in the document and covered by Technical Committees. In many cases, the “over 1000 volts” requirements exist in a dedicated “Part” within the Article – such is the case with existing Article 300. In other cases, similar products are handled in two separate Articles, such as with “switchgear”, with equipment rated 1000 volts and below addressed in Article 408, and equipment rated over 1000 volts addressed in Article 490. In addition to these two approaches, there are Articles where the “over 1000 volts” is intermingled with the “under 1000 volt” requirements, such as the case with Article 225. In many of these cases, the information for over 1000 volts is very limited (for example, Article 240 has only 3 Sections in the Part dedicated to requirements for over 1000 volts).

This Task Group’s initial task was to establish a demarcation for what can be referred to as Medium or High Voltage. The recommendation has been to establish this threshold as being equipment rated over 1000 Vac, 1500 Vdc. It is believed that levels below these voltages can be addressed with existing requirements for systems rated 1000 V ac max, and 1500 V dc, as this has been established as a upper limit for photovoltaic applications within Article 690, with requirements noting that those systems are not required to comply with Parts II and III of Article 490.

Using these limits, the Task Group then set out to identify a structure to better align requirements, improve consistency in approach, improve usability, and create the opportunity for Code Making Panels to have an increased focus on higher voltage applications.
All changes to Articles 240 and 242, along with Chapter 4, are being submitted as a Global Input, and below is a summary of those changes:

• Overcurrent Protection requirements in Part IX of Article 240 (Overcurrent Protection over 1000 Volts, Nominal), and Overvoltage Protection requirements in Part III of Article 242 (Surge Arresters, Over 1000 Volts) are relocated to a new Article 245, “Overcurrent and Overvoltage Protection for Systems Rated Over 1000 VAC, 1500 VDC. In addition, requirements from Article 490 that are specific to overcurrent protection are relocated to the new Article 245. A summary of the relocated Sections is noted below:
o Reconditioning requirements in Section 240.88 and 240.102 that are specific to overcurrent devices rated over 1000 volts are relocated to Section 245.15
o Section 490.21 is relocated to Section 245.21.
o Sections 240.100 and 240.101 are relocated to Sections 245.26 and 245.27, respectively.
o Sections 242.40 – 242-56 are relocated to Sections 245.42 – 245.56.

o Scope of 242 is revised to address only Overvoltage Protection rated not more than 1000 volts.
o Over 1000 Volt Equipment Articles (490 and 399) are relocated from Table 242.3 to new Table 245.40
o Article 242 is restructured to only have one Part to cover all Overvoltage Protection not more than 1000 volts.
• Article 490 has been renumbered to become Article 495 and remains "Equipment over 1000 Volts, Nominal"
• Article 495 now consists of 10 parts:
o Parts I –V are existing 490 text relocated and renumbered to "New" Article 495
o Part VI consists of relocated materials from Article 430 Part XI "Over 1000 Volts, Nominal," with Sections 430.221 - 430.227 relocated to Sections 495.80 - 495.86
 The over 1000 Volts portions of tables 430.249 and 430.250, including notes, have also been relocated o Part VI.
o Part VII contains the requirements from Article 450 regarding Transformers, Over 1000 Volts, including requirements for liquid-filled transformers. While liquid-filled transformers (including "less-flammable," "non-flammable," "askarel-insulated") may be used in any installation, they are more common in installations over 1000 volts. While these requirements are relocated to Article 495, a new section 450.23 notes that the requirements in Part VII of 495 apply.
o Part VIII contains requirements from Article 450 Part III, Transformer Vaults. While transformer vaults may be used in any installation, they are more common in installations over 1000 volts. While these requirements are relocated to Article 495, a new section 450.40 notes that the requirements in Part VIII of 495 apply.
o Part IX contains the Requirements from Article 460 Part II, Capacitors, Over 1000 volts, nominal, (previously numbered 460.24 - 460.28).
o Part X contains the requirements from Article 470 (Resistors and Reactors), Part II Over 1000 volts, Nominal (previously numbered 470.18 - 470.20).

Note: There are other Public Inputs being submitted that address restructuring, and these are identified as "Companion Public Inputs". Other Article or Section references may be impacted due restructuring activities by those companion Public Inputs; however, changes to references outside of Articles 240, 242, and Chapter 4 are not shown in this Public Input.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 3765-NFPA 70-2020 [New Section after 250.194(B)]	Companion Public Input (Article 255)
Public Input No. 3772-NFPA 70-2020 [New Section after 110.79]	Companion Public Input (Article 115)
Public Input No. 3815-NFPA 70-2020 [New Section after 200.11]	Companion Public Input (Article 205)
Public Input No. 3819-NFPA 70-2020 [Global Input]	Companion Public Input (Article 235)
Public Input No. 3827-NFPA 70-2020 [Global Input]	Companion Public Input (Article 305)
Public Input No. 3838-NFPA 70-2020 [Section No. 690.31(A)]	Companion Public Input (Section 690.31(A))
Public Input No. 3846-NFPA 70-2020 [Section No. 694.30(A)]	Companion Public Input (Section 694.30(A))
Public Input No. 3849-NFPA 70-2020 [New Part after IV.]	Companion Public Input (Section 706.30)

Submitter Information Verification

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Submittal Date: Wed Sep 09 11:28:25 EDT 2020

Committee: NEC-P09

Copyright Assignment

Substantiation:

This Public Input is submitted on behalf of a Correlating Committee Long-Range Planning Task Group consisting of Robert Osborne (Chair), Paul Barnhart, Lou Grahor, David Temple, Donny Cook, Dean Hunter, Mike Querry, Roger McDaniel, Dave Burns, Rod Belisle, and Kevin Rogers. This Public Input, along with other companion Public Inputs, was developed with the goal of improving usability and providing a platform to increase the focus on requirements associated with Medium or High Voltage.

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This Task Group's initial task was to establish a demarcation for what can be referred to as Medium or High Voltage. The recommendation has been to establish this threshold as being equipment rated over 1000 Vac, 1500 Vdc. It is believed that levels below these voltages can be addressed with existing requirements for systems rated 1000 V ac max, and 1500 V dc, as this has been established as a upper limit for photovoltaic applications within Article 690, with requirements noting that those systems are not required to comply with Parts II and III of Article 490.

Using these limits, the Task Group then set out to identify a structure to better align requirements, improve consistency in approach, improve usability, and create the opportunity for Code Making Panels to have an increased focus on higher voltage applications.

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  - Reconditioning requirements in Section 240.88 and 240.102 that are specific to overcurrent devices rated over 1000 volts are relocated to Section 245.15
  - Section 490.21 is relocated to Section 245.21.
  - Sections 240.100 and 240.101 are relocated to Sections 245.26 and 245.27, respectively.
  - Sections 242.40 – 242-56 are relocated to Sections 245.42 – 245.56.
  - Scope of 242 is revised to address only Overvoltage Protection rated not more than 1000 volts.
  - Over 1000 Volt Equipment Articles (490 and 399) are relocated from Table 242.3 to new Table 245.40
  - Article 242 is restructured to only have one Part to cover all Overvoltage Protection not more than 1000 volts.

- Article 490 has been renumbered to become Article 495 and remains "Equipment over 1000 Volts, Nominal"

- Article 495 now consists of 10 parts:

  - Parts I –V are existing 490 text relocated and renumbered to "New" Article 495

  - Part VI consists of relocated materials from Article 430 Part XI "Over 1000 Volts, Nominal," with Sections 430.221 - 430.227 relocated to Sections 495.80 - 495.86

    - The over 1000 Volts portions of tables 430.249 and 430.250, including notes, have also been relocated o Part VI.

  - Part VII contains the requirements from Article 450 regarding Transformers, Over 1000 Volts, including requirements for liquid-filled transformers. While liquid-filled transformers (including "less-flammable," "non-flammable," "askarel-insulated") may be used in any installation, they are more common in installations over 1000 volts. While these requirements are relocated to Article 495, a new section 450.23 notes that the requirements in Part VII of 495 apply.

- Part VIII contains requirements from Article 450 Part III, Transformer Vaults. While transformer vaults may be used in any installation, they are more common in installations over 1000 volts. While these requirements are relocated to Article 495, a new section 450.40 notes that the requirements in Part VIII of 495 apply.

- Part IX contains the Requirements from Article 460 Part II, Capacitors, Over 1000 volts, nominal,(previously numbered 460.24 - 460.28).

- Part X contains the requirements from Article 470 (Resistors and Reactors), Part II Over 1000 volts, Nominal (previously numbered 470.18 - 470.20).

Note: There are other Public Inputs being submitted that address restructuring, and these are identified as "Companion Public Inputs". Other Article or Section references may be impacted due restructuring activities by those companion Public Inputs; however, changes to references outside of Articles 240, 242, and Chapter 4 are not shown in this Public Input.

Revisions to Article 240:

240.88 Reconditioned Equipment.
Reconditioned equipment shall be listed as “reconditioned” and the original listing mark removed.

(A) Circuit Breakers.
The use of reconditioned circuit breakers shall comply with (1) ~~through~~ and (2~~3~~):

(1) Molded-case circuit breakers shall not be permitted to be reconditioned.

(2) Low-~~and medium~~ voltage power circuit breakers shall be permitted to be reconditioned.

~~(3) High-voltage circuit breakers shall be permitted to be reconditioned.~~

(B) Components.
The use of reconditioned trip units, protective relays, and current transformers shall comply with (1) and (2):

(1) Low-voltage power circuit breaker electronic trip units shall not be permitted to be reconditioned.

(2) Electromechanical protective relays and current transformers shall be permitted to be reconditioned.

~~**Part IX. Overcurrent Protection over 1000 Volts, Nominal**~~

~~**240.100 Feeders and Branch Circuits.**~~

~~**(A) Location and Type of Protection.**~~
~~Feeder and branch-circuit conductors shall have overcurrent protection in each ungrounded conductor located at the point where the conductor receives its supply or at an alternative location in the circuit when designed under engineering supervision that includes but is not limited to considering the appropriate fault studies and time-current coordination analysis of the protective devices and the conductor damage curves. The overcurrent protection shall be permitted to be provided by either 240.100(A)(1) or (A)(2).~~

~~**(1) Overcurrent Relays and Current Transformers.**~~
~~Circuit breakers used for overcurrent protection of 3-phase circuits shall have a minimum of three overcurrent relay elements operated from three current transformers. The separate overcurrent relay elements (or protective functions) shall be permitted to be part of a single electronic protective relay unit.~~
~~On 3-phase, 3-wire circuits, an overcurrent relay element in the residual circuit of the current transformers shall be permitted to replace one of the phase relay elements.~~
~~An overcurrent relay element, operated from a current transformer that links all phases of a 3-phase, 3-wire circuit, shall be permitted to replace the residual relay element and one of the phase conductor current transformers. Where the neutral conductor is not regrounded on the load side of the circuit as permitted in 250.184(B), the current transformer shall be permitted to link all 3-phase conductors and the grounded circuit conductor (neutral).~~

~~**(2) Fuses.**~~
~~A fuse shall be connected in series with each ungrounded conductor.~~

~~**(B) Protective Devices.**~~
~~The protective device(s) shall be capable of detecting and interrupting all values of current that can occur at their location in excess of their trip-setting or melting point.~~

~~**(C) Conductor Protection.**~~
~~The operating time of the protective device, the available short-circuit current, and the conductor used shall be coordinated to prevent damaging or dangerous temperatures in conductors or conductor insulation under short-circuit conditions.~~

~~**240.101 Additional Requirements for Feeders.**~~

~~**(A) Rating or Setting of Overcurrent Protective Devices.**~~

~~The continuous ampere rating of a fuse shall not exceed three times the ampacity of the conductors. The long-time trip element setting of a breaker or the minimum trip setting of an electronically actuated fuse shall not exceed six times the ampacity of the conductor. For fire pumps, conductors shall be permitted to be protected for overcurrent in accordance with 695.4(B)(2).~~

~~(B) Feeder Taps.~~
~~Conductors tapped to a feeder shall be permitted to be protected by the feeder overcurrent device where that overcurrent device also protects the tap conductor.~~

~~240.102 Reconditioned Equipment.~~
~~Medium-voltage fuseholders and medium-voltage nonrenewable fuses shall not be permitted to be reconditioned.~~

Revisions to Article 242:

ARTICLE 242 Overvoltage Protection

Part I. General

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

Informational Note No. 1: Article 24~~5~~2 covers surge arresters permanently installed on premises wiring systems over 1000 volts, nominal~~combines and replaces Articles 280 and 285 in *NFPA 70* 2017~~.

Informational Note No. 2: Surge arresters 1000 volts or less are also known as Type 1 surge protective devices (SPDs).

242.3 Other Articles. Equipment shall be protected against overvoltage in accordance with the article in this *Code* that covers the type of equipment or location specified in Table 242.3.

Table 242.3 Other Articles

Equipment	Article
Class I locations	501
Class II locations	502
Community antenna television and radio distribution systems	820
Critical operations power systems	708
Elevators, dumbwaiters, escalators, moving walks, platform lifts, and stairway chairlifts	620
Emergency systems	700
~~Equipment over 1000 volts, nominal~~	~~490~~
Fire pumps	695
Industrial machinery	670
Information technology equipment	645
Modular data centers	646
~~Outdoor overhead conductors over 1000 volts~~	~~399~~
Radio and television equipment	810
Receptacles, cord connectors, and attachment plugs (caps)	406
Wind electric systems	694

~~**Part II. Surge Protective Devices (SPDs), 1000 Volts or Less**~~

~~Informational Note: Surge arresters 1000 volts or less are also known as Type 1 SPDs.~~

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

(1) Circuits over 1000 volts

(2) On ungrounded systems, impedance grounded systems, or corner grounded delta systems unless listed specifically for use on these systems

(3) Where the rating of the SPD is less than the maximum continuous phase-to-ground voltage at the power frequency available at the point of application

242.8 Listing. An SPD shall be a listed device.

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

242.12 Type 1 SPDs. Type 1 SPDs shall be installed in accordance with 242.12(A) and (B).

(A) Installation. Type 1 SPDs shall be permitted to be connected in accordance with one of the following:

(1) To the supply side of the service disconnect as permitted in 230.82(4)

(2) As specified in 242.14

(B) At the Service. When installed at services, Type 1 SPDs shall be connected to one of the following:

(1) Grounded service conductor

(2) Grounding electrode conductor

(3) Grounding electrode for the service

(4) Equipment grounding terminal in the service equipment

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

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

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

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

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

242.18 Type 4 and Other Component Type SPDs. Type 4 component assemblies and other component type SPDs shall only be installed by the equipment manufacturer.

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

242.22 Location. SPDs shall be permitted to be located indoors or outdoors and shall be made inaccessible to unqualified persons unless listed for installation in accessible locations.

242.24 Routing of Connections. The conductors used to connect the SPD to the line or bus and to ground shall not be any longer than necessary and shall avoid unnecessary bends.

242.26 Connection. Where an SPD device is installed, it shall comply with 242.12, 242.14, 242.16, 242.28. and 242.30.

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

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

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

~~Part III. Surge Arresters, Over 1000 Volts~~

~~242.40 Uses Not Permitted.~~
~~A surge arrester shall not be installed where the rating of the surge arrester is less than the maximum continuous phase-to-ground voltage at the power frequency available at the point of application.~~

~~242.42 Surge Arrester Selection.~~
~~The surge arresters shall comply with 242.42(A) and (B).~~
~~(A) Rating.~~
~~The rating of a surge arrester shall be equal to or greater than the maximum continuous operating voltage available at the point of application.~~
~~(1) Solidly Grounded Systems.~~
~~The maximum continuous operating voltage shall be the phase-to-ground voltage of the system.~~
~~(2) Impedance or Ungrounded System.~~
~~The maximum continuous operating voltage shall be the phase-to-phase voltage of the system.~~
~~(B) Silicon Carbide Types.~~
~~The rating of a silicon carbide-type surge arrester shall be not less than 125 percent of the rating specified in 242.42(A).~~

~~Informational Note No. 1: For further information on surge arresters, see IEEE C62.11-2012,~~ *~~Standard for Metal-Oxide Surge Arresters for Alternating-Current Power Circuits (>1 kV)~~*~~, and IEEE C62.22-2009,~~ *~~Guide for the Application of Metal-Oxide Surge Arresters for Alternating-Current Systems.~~*
~~Informational Note No. 2: The selection of a properly rated metal oxide arrester is based on considerations of maximum continuous operating voltage and the magnitude and duration of overvoltages at the arrester location as affected by phase-to-ground faults, system grounding techniques, switching surges, and other causes. See the manufacturer's application rules for selection of the specific arrester to be used at a particular location.~~
~~242.44 Number Required.~~
~~Where used at a point on a circuit, a surge arrester shall be connected to each ungrounded conductor. A single installation of such surge arresters shall be permitted to protect a number of interconnected circuits if no circuit is exposed to surges while disconnected from the surge arresters.~~

~~242.46 Location.~~
~~Surge arresters shall be permitted to be located indoors or outdoors. Surge arresters shall be made inaccessible to unqualified persons unless listed for installation in accessible locations.~~

~~242.48 Routing of Surge Arrester Equipment Grounding Conductors.~~
~~The conductor used to connect the surge arrester to line, bus, or equipment and to an equipment grounding conductor or grounding electrode connection point as provided in 242.50 shall not be any longer than necessary and shall avoid unnecessary bends.~~

~~242.50 Connection.~~
~~The arrester shall be connected to one of the following:~~

~~(1) Grounded service conductor~~

~~(2) Grounding electrode conductor~~

~~(3) Grounding electrode for the service~~

~~(4) Equipment grounding terminal in the service equipment~~

~~242.52 Surge-Arrester Conductors.~~

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

~~242.54 Interconnections.~~

~~The surge arrester protecting a transformer that supplies a secondary distribution system shall be interconnected as specified in 242.54(A), (B), or (C).~~

~~(A) Metal Interconnections.~~

~~A metal interconnection shall be made to the secondary grounded circuit conductor or the secondary circuit grounding electrode conductor, if, in addition to the direct grounding connection at the surge arrester, the connection complies with 242.54(A)(1) or (A)(2).~~

~~(1) Additional Grounding Connection.~~

~~The grounded conductor of the secondary has a grounding connection elsewhere to a continuous metal underground water piping system. In urban water-pipe areas where there are at least four water-pipe connections on the neutral conductor and not fewer than four such connections in each mile of neutral conductor, the metal interconnection shall be permitted to be made to the secondary neutral conductor with omission of the direct grounding connection at the surge arrester.~~

~~(2) Multigrounded Neutral System Connection.~~

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

~~(B) Through Spark Gap or Device.~~

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

~~(1) Ungrounded or Unigrounded Primary System.~~

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

~~(2) Multigrounded Neutral Primary System.~~

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

~~(C) By Special Permission.~~

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

~~242.56 Grounding Electrode Conductor Connections and Enclosures.~~

~~Except as indicated in this article, surge-arrester grounding electrode conductor connections shall be made as specified in Article 250, Parts III and X. Grounding electrode conductors installed in metal enclosures shall comply with 250.64(E).~~

Proposed new Article 245:

Article 245 Overcurrent and Overvoltage Protection for Systems Rated Over 1000 VAC, 1500 VDC

Part I. General and Scope

245.1 Scope.

This article covers requirements for the installation of overcurrent protection of circuits and related electrical equipment and over and overvoltage protection (surge arresters) permanently installed on premises wiring systems over 1000 VAC, 1500 VDC, nominal.

245.15 Reconditioned Equipment.

Reconditioned equipment shall be listed as "reconditioned" and the original listing mark removed.

(A) Medium and high-voltage circuit breakers shall be permitted to be reconditioned

(B) Electromechanical protective relays and current transformers shall be permitted to be reconditioned

(C) Medium-voltage fuseholders and medium-voltage nonrenewable fuses shall not be permitted to be reconditioned.

Part II. Overcurrent Protection

245.21 Circuit Interrupting Devices

(A) Circuit Breakers

(1) Location.

(a) Circuit breakers installed indoors shall be mounted either in metal-enclosed units or fire-resistant cell-mounted units, or they shall be permitted to be open-mounted in locations accessible to qualified persons only.

(b) Circuit breakers used to control oil-filled transformers in a vault shall either be located outside the transformer vault or be capable of operation from outside the vault.

(c) Oil circuit breakers shall be arranged or located so that adjacent readily combustible structures or materials are safeguarded in an approved manner

(2) Operating Characteristics. Circuit breakers shall have the following equipment or operating characteristics:

1. An accessible mechanical or other identified means for manual tripping, independent of control power
2. Be release free (trip free)
3. If capable of being opened or closed manually while energized, main contacts that operate independently of the speed of the manual operation
4. A mechanical position indicator at the circuit breaker to show the open or closed position of the main contacts

5. A means of indicating the open and closed position of the breaker at the point(s) from which they may be operated

(3) Nameplate. A circuit breaker shall have a permanent and legible nameplate showing manufacturer's name or trademark, manufacturer's type or identification number, continuous current rating, interrupting rating in megavolt-amperes (MVA) or amperes, and maximum voltage rating. Modification of a circuit breaker affecting its rating(s) shall be accompanied by an appropriate change of nameplate information.

(4) Rating. Circuit breakers shall have the following ratings:

1. The continuous current rating of a circuit breaker shall not be less than the maximum continuous current through the circuit breaker.

2. The interrupting rating of a circuit breaker shall not be less than the available fault current the circuit breaker will be required to interrupt, including contributions from all connected sources of energy.

3. The closing rating of a circuit breaker shall not be less than the maximum asymmetrical fault current into which the circuit breaker can be closed.

4. The momentary rating of a circuit breaker shall not be less than the maximum asymmetrical fault current at the point of installation.

5. The rated maximum voltage of a circuit breaker shall not be less than the maximum circuit voltage.

(5) Retrofit Trip Units. Retrofit trip units shall be listed for use with the specific circuit breaker with which it is installed

(B) Power Fuses and Fuseholders.

(1) Use. Where fuses are used to protect conductors and equipment, a fuse shall be placed in each ungrounded conductor. Two power fuses shall be permitted to be used in parallel to protect the same load if both fuses have identical ratings and both fuses are installed in an identified common mounting with electrical connections that divide the current equally. Power fuses of the vented type shall not be used indoors, underground, or in metal enclosures unless identified for the use.

(2) Interrupting Rating. The interrupting rating of power fuses shall not be less than the available fault current the fuse is required to interrupt, including contributions from all connected sources of energy.

(3) Voltage Rating. The maximum voltage rating of power fuses shall not be less than the maximum circuit voltage. Fuses having a minimum recommended operating voltage shall not be applied below this voltage.

(4) Identification of Fuse Mountings and Fuse Units. Fuse mountings and fuse units shall have permanent and legible nameplates showing the manufacturer's type or designation, continuous current rating, interrupting current rating, and maximum voltage rating.

(5) Fuses. Fuses that expel flame in opening the circuit shall be designed or arranged so that they function properly without hazard to persons or property.

(6) Fuseholders. Fuseholders shall be designed or installed so that they are de-energized while a fuse is being replaced. A field-applied permanent and legible sign, in accordance with 110.21(B), shall be installed immediately adjacent to the fuseholders and shall be worded as follows:

DANGER — DISCONNECT CIRCUIT BEFORE REPLACING FUSES.

Exception: Fuses and fuseholders designed to permit fuse replacement by qualified persons using identified equipment without de-energizing the fuseholder shall be permitted.

(7) High-Voltage Fuses. Switchgear and substations that utilize high-voltage fuses shall be provided with a gang-operated disconnecting switch. Isolation of the fuses from the circuit shall be provided by either connecting a switch between the source and the fuses or providing roll-out switch and fuse-type construction. The switch shall be of the load-interrupter type, unless mechanically or electrically interlocked with a load-interrupting device arranged to reduce the load to the interrupting capability of the switch.

Exception: More than one switch shall be permitted as the disconnecting means for one set of fuses where the switches are installed to provide connection to more than one set of supply conductors. The switches shall be mechanically or electrically interlocked to permit access to the fuses only when all switches are open. A conspicuous sign shall be placed at the fuses identifying the presence of more than one source.

(C) Distribution Cutouts and Fuse Links — Expulsion Type.

(1) Installation. Cutouts shall be located so that they may be readily and safely operated and re-fused, and so that the exhaust of the fuses does not endanger persons. Distribution cutouts shall not be used indoors, underground, or in metal enclosures.

(2) Operation. Where fused cutouts are not suitable to interrupt the circuit manually while carrying full load, an approved means shall be installed to interrupt the entire load. Unless the fused cutouts are interlocked with the switch to prevent opening of the cutouts under load, a conspicuous sign shall be placed at such cutouts identifying that they shall not be operated under load.

(3) Interrupting Rating. The interrupting rating of distribution cutouts shall not be less than the available fault current the cutout is required to interrupt, including contributions from all connected sources of energy.

(4) Voltage Rating. The maximum voltage rating of cutouts shall not be less than the maximum circuit voltage.

(5) Identification. Distribution cutouts shall have on their body, door, or fuse tube a permanent and legible nameplate or identification showing the manufacturer's type or designation, continuous current rating, maximum voltage rating, and interrupting rating.

(6) Fuse Links. Fuse links shall have a permanent and legible identification showing continuous current rating and type.

(7) Structure Mounted Outdoors. The height of cutouts mounted outdoors on structures shall provide safe clearance between lowest energized parts (open or closed position) and standing surfaces, in accordance with 110.34(E).

(D) Oil-Filled Cutouts.

(1) Continuous Current Rating. The continuous current rating of oil-filled cutouts shall not be less than the maximum continuous current through the cutout.

(2) Interrupting Rating. The interrupting rating of oil-filled cutouts shall not be less than the available fault current the oil-filled cutout is required to interrupt, including contributions from all connected sources of energy.

(3) Voltage Rating. The maximum voltage rating of oil-filled cutouts shall not be less than the maximum circuit voltage.

(4) Fault Closing Rating. Oil-filled cutouts shall have a fault closing rating not less than the maximum asymmetrical fault current that can occur at the cutout location, unless suitable interlocks or operating procedures preclude the possibility of closing into a fault.

(5) Identification. Oil-filled cutouts shall have a permanent and legible nameplate showing the rated continuous current, rated maximum voltage, and rated interrupting current.

(6) Fuse Links. Fuse links shall have a permanent and legible identification showing the rated continuous current.

(7) Location. Cutouts shall be located so that they are readily and safely accessible for re-fusing, with the top of the cutout not over 1.5 m (5 ft) above the floor or platform.

(8) Enclosure. Suitable barriers or enclosures shall be provided to prevent contact with nonshielded cables or energized parts of oil-filled cutouts.

(E) Load Interrupters. Load-interrupter switches shall be permitted if suitable fuses or circuit breakers are used in conjunction with these devices to interrupt available fault currents. Where these devices are used in combination, they shall be coordinated electrically so that they will safely withstand the effects of closing, carrying, or interrupting all possible currents up to the assigned maximum short-circuit rating.

Where more than one switch is installed with interconnected load terminals to provide for alternate connection to different supply conductors, each switch shall be provided with a warning sign identifying the presence of more than one source. Each warning sign or label shall comply with 110.21.

(1) Continuous Current Rating. The continuous current rating of interrupter switches shall equal or exceed the maximum continuous current at the point of installation.

(2) Voltage Rating. The maximum voltage rating of interrupter switches shall equal or exceed the maximum circuit voltage.

(3) Identification. Interrupter switches shall have a permanent and legible nameplate including the following information: manufacturer's type or designation, continuous current rating, interrupting current rating, fault closing rating, maximum voltage rating.

(4) Switching of Conductors. The switching mechanism shall be arranged to be operated from a location where the operator is not exposed to energized parts and shall be arranged to open all ungrounded conductors of the circuit simultaneously with one operation. Switches shall be arranged to be locked in the open position. Metal-enclosed switches shall be operable from outside the enclosure.

245.26 Feeders and Branch Circuits

(A) Location and Type of Protection. Feeder and branch-circuit conductors shall have overcurrent protection in each ungrounded conductor located at the point where the conductor receives its supply or at an alternative location in the circuit when designed under engineering supervision that includes but is not limited to considering the appropriate fault studies and time–current coordination analysis of the protective devices and the conductor damage curves. The overcurrent protection shall be permitted to be provided by either 245.26(A)(1) or (A)(2).

(1) Overcurrent Relays and Current Transformers. Circuit breakers used for overcurrent protection of 3-phase circuits shall have a minimum of three overcurrent relay elements operated from three current transformers. The separate overcurrent relay elements (or protective functions) shall be permitted to be part of a single electronic protective relay unit.

On 3-phase, 3-wire circuits, an overcurrent relay element in the residual circuit of the current transformers shall be permitted to replace one of the phase relay elements.

An overcurrent relay element, operated from a current transformer that links all phases of a 3-phase, 3-wire circuit, shall be permitted to replace the residual relay element and one of the phase-conductor current transformers. Where the neutral conductor is not regrounded on the load side of the circuit as permitted in 250.184(B), the current transformer shall be permitted to link all 3-phase conductors and the grounded circuit conductor (neutral).

(2) Fuses. A fuse shall be connected in series with each ungrounded conductor.

(B) Protective Devices. The protective device(s) shall be capable of detecting and interrupting all values of current that can occur at their location in excess of their trip-setting or melting point.

(C) Conductor Protection. The operating time of the protective device, the available short-circuit current, and the conductor used shall be coordinated to prevent damaging or dangerous temperatures in conductors or conductor insulation under short-circuit conditions.

245.27 Additional Requirements for Feeders.

(A) Rating or Setting of Overcurrent Protective Devices. The continuous ampere rating of a fuse shall not exceed three times the ampacity of the conductors. The long-time trip element setting of a breaker or the minimum trip setting of an electronically actuated fuse shall not exceed six times the ampacity of the conductor. For fire pumps, conductors shall be permitted to be protected for overcurrent in accordance with 695.4(B)(2).

(B) Feeder Taps. Conductors tapped to a feeder shall be permitted to be protected by the feeder overcurrent device where that overcurrent device also protects the tap conductor.

Part III. Overvoltage Protection

245.40 Other Articles. Equipment shall be protected against overvoltage in accordance with the article in this Code that covers the type of equipment or location specified in Table 245.40.

Table 245.40 Other Articles

Equipment	**Article**
Equipment over 1000 volts, nominal	495
Outdoor overhead conductors over 1000 volts	399

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

245.42 Surge Arrester Selection. The surge arresters shall comply with 245.42(A) and (B).

(A) Rating. The rating of a surge arrester shall be equal to or greater than the maximum continuous operating voltage available at the point of application.

(1) Solidly Grounded Systems. The maximum continuous operating voltage shall be the phase-to-ground voltage of the system.

(2) Impedance or Ungrounded System. The maximum continuous operating voltage shall be the phase-to-phase voltage of the system.

(B) Silicon Carbide Types. The rating of a silicon carbide-type surge arrester shall be not less than 125 percent of the rating specified in 245.42(A).

Informational Note No. 1: For further information on surge arresters, see IEEE C62.11-2012, *Standard for Metal-Oxide Surge Arresters for Alternating-Current Power Circuits (>1 kV)*, and IEEE C62.22-2009, *Guide for the Application of Metal-Oxide Surge Arresters for Alternating-Current Systems*.

Informational Note No. 2: The selection of a properly rated metal oxide arrester is based on considerations of maximum continuous operating voltage and the magnitude and duration of overvoltages at the arrester location as affected by phase-to-ground faults, system grounding techniques, switching surges, and other causes. See the manufacturer's application rules for selection of the specific arrester to be used at a particular location.

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

245.46 Location. Surge arresters shall be permitted to be located indoors or outdoors. Surge arresters shall be made inaccessible to unqualified persons unless listed for installation in accessible locations.

245.48 Routing of Surge Arrester Equipment Grounding Conductors. The conductor used to connect the surge arrester to line, bus, or equipment and to an equipment grounding conductor or grounding electrode connection point as provided in 245.50 shall not be any longer than necessary and shall avoid unnecessary bends.

245.50 Connection. The arrester shall be connected to one of the following:

1. Grounded service conductor

2. Grounding electrode conductor

3. Grounding electrode for the service

4. Equipment grounding terminal in the service equipment

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

245.54 Interconnections. The surge arrester protecting a transformer that supplies a secondary distribution system shall be interconnected as specified in 245.54(A), (B), or (C).

(A) Metal Interconnections. A metal interconnection shall be made to the secondary grounded circuit conductor or the secondary circuit grounding electrode conductor, if, in addition to the direct grounding connection at the surge arrester, the connection complies with 245.54(A)(1) or (A)(2).

(1) Additional Grounding Connection. The grounded conductor of the secondary has a grounding connection elsewhere to a continuous metal underground water piping system. In urban water-pipe areas where there are at least four water-pipe connections on the neutral conductor and not fewer than four such connections in each mile of neutral conductor, the metal interconnection shall be permitted to be made to the secondary neutral conductor with omission of the direct grounding connection at the surge arrester.

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

(B) Through Spark Gap or Device. Where the surge arrester grounding electrode conductor is not connected as in 245.54(A), or where the secondary is not grounded as in 245.54(A) but is otherwise grounded as in 250.52, an interconnection shall be made through a spark gap or listed device as required by 245.54(B)(1) or (B)(2).

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

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

(C) By Special Permission. An interconnection of the surge-arrester ground and the secondary neutral conductor, other than as provided in 245.54(A) or (B), shall be permitted to be made only by special permission.

245.56 Grounding Electrode Conductor Connections and Enclosures. Except as indicated in this article, surge-arrester grounding electrode conductor connections shall be made as specified in Article 250, Parts III and X. Grounding electrode conductors installed in metal enclosures shall comply with 250.64(E).

Revisions to Chapter 4

ARTICLE 430 Motors, Motor Circuits, and Controllers

(Only deleted / relocated text of Article 430 shown) (-relocated to Article 495 Part VI)

~~Part XI. Over 1000 Volts, Nominal~~

~~**430.221 General.** Part XI recognizes the additional hazard due to the use of higher voltages. It adds to or amends the other provisions of this article.~~

~~**430.222 Marking on Controllers.** In addition to the marking required by 430.8, a controller shall be marked with the control voltage.~~

~~**430.223 Raceway Connection to Motors.** Flexible metal conduit or liquidtight flexible metal conduit not exceeding 1.8 m (6 ft) in length shall be permitted to be employed for raceway connection to a motor terminal enclosure.~~

~~**430.224 Size of Conductors.** Conductors supplying motors shall have an ampacity not less than the current at which the motor overload protective device(s) is selected to trip.~~

~~430.225 Motor-Circuit Overcurrent Protection.~~

~~**(A) General.** Each motor circuit shall include coordinated protection to automatically interrupt overload and fault currents in the motor, the motor-circuit conductors, and the motor control apparatus.~~
~~*Exception: Where a motor is critical to an operation and the motor should operate to failure if necessary to prevent a greater hazard to persons, the sensing device(s) shall be permitted to be connected to a supervised annunciator or alarm instead of interrupting the motor circuit.*~~

~~(B) Overload Protection.~~

~~**(1) Type of Overload Device.** Each motor shall be protected against dangerous heating due to motor overloads and failure to start by a thermal protector integral with the motor or external current-sensing devices, or both. Protective device settings for each motor circuit shall be determined under engineering supervision.~~

~~**(2) Wound-Rotor Alternating-Current Motors.** The secondary circuits of wound-rotor ac motors, including conductors, controllers, and resistors rated for the application, shall be considered as protected against overcurrent by the motor overload protection means.~~

~~**(3) Operation.** Operation of the overload interrupting device shall simultaneously disconnect all ungrounded conductors.~~

~~**(4) Automatic Reset.** Overload sensing devices shall not automatically reset after trip unless resetting of the overload sensing device does not cause automatic restarting of the motor or there is no hazard to persons created by automatic restarting of the motor and its connected machinery.~~

~~(C) Fault-Current Protection.~~

~~**(1) Type of Protection.** Fault-current protection shall be provided in each motor circuit as specified by either 430.225(C)(1)(a) or (C)(1)(b).~~

> ~~(a) A circuit breaker of suitable type and rating arranged so that it can be serviced without hazard. The circuit breaker shall simultaneously disconnect all ungrounded conductors. The circuit breaker shall be permitted to sense the fault current by means of integral or external sensing elements.~~

~~(b) Fuses of a suitable type and rating placed in each ungrounded conductor. Fuses shall be used with suitable disconnecting means, or they shall be of a type that can also serve as the disconnecting means. They shall be arranged so that they cannot be serviced while they are energized.~~

~~**(2) Reclosing.** Fault-current interrupting devices shall not automatically reclose the circuit.~~
~~*Exception: Automatic reclosing of a circuit shall be permitted where the circuit is exposed to transient faults and where such automatic reclosing does not create a hazard to persons.*~~

~~**(3) Combination Protection.** Overload protection and fault-current protection shall be permitted to be provided by the same device.~~

~~**430.226 Rating of Motor Control Apparatus.** The ultimate trip current of overcurrent (overload) relays or other motor-protective devices used shall not exceed 115 percent of the controller's continuous current rating. Where the motor branch-circuit disconnecting means is separate from the controller, the disconnecting means current rating shall not be less than the ultimate trip setting of the overcurrent relays in the circuit.~~

~~**430.227 Disconnecting Means.** The controller disconnecting means shall be lockable in accordance with 110.25.~~

Table 430.249 Full-Load Current, Two-Phase Alternating-Current Motors (4-Wire)
The following values of full-load current are for motors running at speeds usual for belted motors and motors with normal torque characteristics. Current in the common conductor of a 2-phase, 3-wire system will be 1.41 times the value given. The voltages listed are rated motor voltages. The currents listed shall be permitted for system voltage ranges of 110 to 120, 220 to 240, 440 to 480, and 550 to 600 volts.

Horsepower	Induction-Type Squirrel Cage and Wound Rotor (Amperes)				
	115 Volts	230 Volts	460 Volts	575 Volts	~~2300 Volts~~
1/2	4.0	2.0	1.0	0.8	—
3/4	4.8	2.4	1.2	1.0	—
1	6.4	3.2	1.6	1.3	—
1 1/2	9.0	4.5	2.3	1.8	—
2	11.8	5.9	3.0	2.4	—
3	—	8.3	4.2	3.3	—
5	—	13.2	6.6	5.3	—
7 1/2	—	19	9.0	8.0	—

Table 430.249 Full-Load Current, Two-Phase Alternating-Current Motors (4-Wire)
The following values of full-load current are for motors running at speeds usual for belted motors and motors with normal torque characteristics. Current in the common conductor of a 2-phase, 3-wire system will be 1.41 times the value given. The voltages listed are rated motor voltages. The currents listed shall be permitted for system voltage ranges of 110 to 120, 220 to 240, 440 to 480, and 550 to 600 volts.

	Induction-Type Squirrel Cage and Wound Rotor (Amperes)				
Horsepower	**115 Volts**	**230 Volts**	**460 Volts**	**575 Volts**	~~**2300 Volts**~~
10	—	24	12	10	—
15	—	36	18	14	—
20	—	47	23	19	—
25	—	59	29	24	—
30	—	69	35	28	—
40	—	90	45	36	—
50	—	113	56	45	—
60	—	133	67	53	~~14~~
75	—	166	83	66	~~18~~
100	—	218	109	87	~~23~~
125	—	270	135	108	~~28~~
150	—	312	156	125	~~32~~
200	—	416	208	167	~~43~~

Table 430.250 Full-Load Current, Three-Phase Alternating-Current Motors
The following values of full-load currents are typical for motors running at speeds usual for belted motors and motors with normal torque characteristics. The voltages listed are rated motor voltages. The currents listed shall be permitted for system voltage ranges of 110 to 120, 220 to 240, 440 to 480, and 550 to 600 volts.

	Induction-Type Squirrel Cage and Wound Rotor (Amperes)							Synchronous-Type Unity Power Factor* (Amperes)			
Horsepower	115 Volts	200 Volts	208 Volts	230 Volts	460 Volts	575 Volts	~~2300 Volts~~	230 Volts	460 Volts	575 Volts	~~2300 Volts~~
1⁄2	4.4	2.5	2.4	2.2	1.1	0.9	—	—	—	—	—
3⁄4	6.4	3.7	3.5	3.2	1.6	1.3	—	—	—	—	—
1	8.4	4.8	4.6	4.2	2.1	1.7	—	—	—	—	—
1 1⁄2	12.0	6.9	6.6	6.0	3.0	2.4	—	—	—	—	—
2	13.6	7.8	7.5	6.8	3.4	2.7	—	—	—	—	—
3	—	11.0	10.6	9.6	4.8	3.9	—	—	—	—	—
5	—	17.5	16.7	15.2	7.6	6.1	—	—	—	—	—
7 1⁄2	—	25.3	24.2	22	11	9	—	—	—	—	—
10	—	32.2	30.8	28	14	11	—	—	—	—	—
15	—	48.3	46.2	42	21	17	—	—	—	—	—
20	—	62.1	59.4	54	27	22	—	—	—	—	—
25	—	78.2	74.8	68	34	27	—	53	26	21	—
30	—	92	88	80	40	32	—	63	32	26	—
40	—	120	114	104	52	41	—	83	41	33	—
50	—	150	143	130	65	52	—	104	52	42	—

Table 430.250 Full-Load Current, Three-Phase Alternating-Current Motors
The following values of full-load currents are typical for motors running at speeds usual for belted motors and motors with normal torque characteristics. The voltages listed are rated motor voltages. The currents listed shall be permitted for system voltage ranges of 110 to 120, 220 to 240, 440 to 480, and 550 to 600 volts.

	Induction-Type Squirrel Cage and Wound Rotor (Amperes)							Synchronous-Type Unity Power Factor* (Amperes)			
Horsepower	**115 Volts**	**200 Volts**	**208 Volts**	**230 Volts**	**460 Volts**	**575 Volts**	**~~2300 Volts~~**	**230 Volts**	**460 Volts**	**575 Volts**	**~~2300 Volts~~**
60	—	177	169	154	77	62	16	123	61	49	~~12~~
75	—	221	211	192	96	77	20	155	78	62	~~15~~
100	—	285	273	248	124	99	26	202	101	81	~~20~~
125	—	359	343	312	156	125	31	253	126	101	~~25~~
150	—	414	396	360	180	144	37	302	151	121	~~30~~
200		552	528	480	240	192	49	400	201	161	~~40~~
250	—	—	—	—	302	242	60	—	—	—	—
300	—	—	—	—	361	289	72	—	—	—	—
350	—	—	—	—	414	336	83	—	—	—	—
400	—	—	—	—	477	382	95	—	—	—	—
450	—	—	—	—	515	412	103	—	—	—	—
500	—	—	—	—	590	472	118	—	—	—	—

*For 90 and 80 percent power factor, the figures shall be multiplied by 1.1 and 1.25, respectively.

ARTICLE 450 Transformers ~~and Transformer Vaults~~ (Including Secondary Ties)

(450 part III Vaults -deleted / relocated)(relocated to Article 495 Parts VII and VIII)(450.21(c) edit also)

Part I. General Provisions

450.1 Scope. This article covers the installation of all transformers.

Informational Note: Article 495 includes additional requirements for transformers rated over 1000 volts ac, 1500 volts dc, nominal on either or both the primary or the secondary.

Exception No. 1: Current transformers.

Exception No. 2: Dry-type transformers that constitute a component part of other apparatus and comply with the requirements for such apparatus.

Exception No. 3: Transformers that are an integral part of an X-ray, high-frequency, or electrostatic-coating apparatus.

Exception No. 4: Transformers used with Class 2 and Class 3 circuits that comply with Article 725.

Exception No. 5: Transformers for sign and outline lighting that comply with Article 600.

Exception No. 6: Transformers for electric-discharge lighting that comply with Article 410.

Exception No. 7: Transformers used for power-limited fire alarm circuits that comply with Part III of Article 760.

Exception No. 8: Transformers used for research, development, or testing, where effective arrangements are provided to safeguard persons from contacting energized parts.

This article covers the installation of transformers dedicated to supplying power to a fire pump installation as modified by Article 695.

This article also covers the installation of transformers in hazardous (classified) locations as modified by Articles 501 through 504.

450.2 Definition.
The definitions in this section shall apply only within this article.

Transformer.
An individual transformer, single- or polyphase, identified by a single nameplate, unless otherwise indicated in this article.

450.3 Overcurrent Protection. Overcurrent protection of transformers shall comply with 450.3(A) (B), or (C). As used in this section, the word *transformer* shall mean a transformer or polyphase bank of two or more single-phase transformers operating as a unit.

Informational Note No. 1: See 240.4, 240.21, 240.100, and 240.101 for overcurrent protection of conductors.

Informational Note No. 2: Nonlinear loads can increase heat in a transformer without operating its overcurrent protective device.

(A) Transformers Over 1000 Volts, Nominal. Overcurrent protection shall be provided in accordance with Table 495.103.

(B) Transformers 1000 Volts, Nominal, or Less. Overcurrent protection shall be provided in accordance with Table 450.3~~(B)~~.

Exception: Where the transformer is installed as a motor control circuit transformer in accordance with 430.72(C)(1) through (C)(5).

~~Table 450.3(A) Maximum Rating or Setting of Overcurrent Protection for Transformers Over 1000 Volts (as a Percentage of Transformer-Rated Current)~~

				~~Secondary Protection (See Note 2.)~~		
		~~Primary Protection over 1000 Volts~~		~~Over 1000 Volts~~		~~1000 Volts or Less~~
~~Location Limitations~~	~~Transformer Rated Impedance~~	~~Circuit Breaker (See Note 4.)~~	~~Fuse Rating~~	~~Circuit Breaker (See Note 4.)~~	~~Fuse Rating~~	~~Circuit Breaker or Fuse Rating~~
~~Any location~~	~~Not more than 6%~~	~~600% (See Note 1.)~~	~~300% (See Note 1.)~~	~~300% (See Note 1.)~~	~~250% (See Note 1.)~~	~~125% (See Note 1.)~~
	~~More than 6% and not more than 10%~~	~~400% (See Note 1.)~~	~~300% (See Note 1.)~~	~~250% (See Note 1.)~~	~~225% (See Note 1.)~~	~~125% (See Note 1.)~~
~~Supervised locations only (See Note 3.)~~	~~Any~~	~~300% (See Note 1.)~~	~~250% (See Note 1.)~~	~~Not required~~	~~Not required~~	~~Not required~~
	~~Not more than 6%~~	~~600%~~	~~300%~~	~~300% (See Note 5.)~~	~~250% (See Note 5.)~~	~~250% (See Note 5.)~~
	~~More than 6% and not more than 10%~~	~~400%~~	~~300%~~	~~250% (See Note 5.)~~	~~225% (See Note 5.)~~	~~250% (See Note 5.)~~

~~Notes:~~

~~1. Where the required fuse rating or circuit breaker setting does not correspond to a standard rating or setting, a higher rating or setting that does not exceed the following shall be permitted:~~

~~a. The next higher standard rating or setting for fuses and circuit breakers 1000 volts and below, or~~

~~b. The next higher commercially available rating or setting for fuses and circuit breakers above 1000 volts.~~

~~2. Where secondary overcurrent protection is required, the secondary overcurrent device shall be permitted to consist of not more than six circuit breakers or six sets of fuses grouped in one location. Where multiple overcurrent devices are utilized, the total of all the device ratings shall not exceed the allowed value of a single overcurrent device. If both circuit breakers and fuses are used as the overcurrent device, the total of the device ratings shall not exceed that allowed for fuses.~~

~~3. A supervised location is a location where conditions of maintenance and supervision ensure that only qualified persons monitor and service the transformer installation.~~

~~4. Electronically actuated fuses that may be set to open at a specific current shall be set in accordance with settings for circuit breakers.~~

~~5. A transformer equipped with a coordinated thermal overload protection by the manufacturer shall be permitted to have separate secondary protection omitted.~~

Table 450.3~~(B)~~ Maximum Rating or Setting of Overcurrent Protection for Transformers 1000 Volts and Less (as a Percentage of Transformer-Rated Current)

	Primary Protection			Secondary Protection (See Note 2.)	
Protection Method	**Currents of 9 Amperes or More**	**Currents Less Than 9 Amperes**	**Currents Less Than 2 Amperes**	**Currents of 9 Amperes or More**	**Currents Less Than 9 Amperes**
Primary only protection	125% (See Note 1.)	167%	300%	Not required	Not required
Primary and secondary protection	250% (See Note 3.)	250% (See Note 3.)	250% (See Note 3.)	125% (See Note 1.)	167%

Notes:

1. Where 125 percent of this current does not correspond to a standard rating of a fuse or nonadjustable circuit breaker, a higher rating that does not exceed the next higher standard rating shall be permitted.

2. Where secondary overcurrent protection is required, the secondary overcurrent device shall be permitted to consist of not more than six circuit breakers or six sets of fuses grouped in one location. Where multiple overcurrent devices are utilized, the total of all the device ratings shall not exceed the allowed value of a single overcurrent device.

3. A transformer equipped with coordinated thermal overload protection by the manufacturer and arranged to interrupt the primary current shall be permitted to have primary overcurrent protection rated or set at a current value that is not more than six times the rated current of the transformer for transformers having not more than 6 percent impedance and not more than four times the rated current of the transformer for transformers having more than 6 percent but not more than 10 percent impedance.

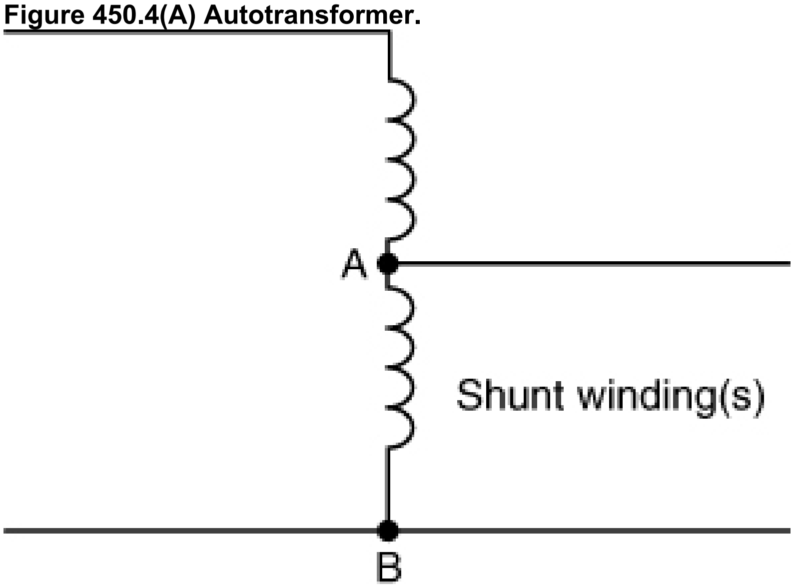
(C) Voltage (Potential) Transformers. Voltage (potential) transformers installed indoors or enclosed shall be protected with primary fuses.

Informational Note: For protection of instrument circuits including voltage transformers, see 408.52.

450.4 Autotransformers 1000 Volts, Nominal, or Less.

(A) Overcurrent Protection. Each autotransformer 1000 volts, nominal, or less shall be protected by an individual overcurrent device installed in series with each ungrounded input conductor. Such overcurrent device shall be rated or set at not more than 125 percent of the rated full-load input current of the autotransformer. Where this calculation does not correspond to a standard rating of a fuse or nonadjustable circuit breaker and the rated input current is 9 amperes or more, the next higher standard rating described in 240.6 shall be permitted. An overcurrent device shall not be installed in series with the shunt winding (the winding common to both the input and the output circuits) of the autotransformer between Points A and B as shown in Figure 450.4(A).

Figure 450.4(A) Autotransformer.



Exception: Where the rated input current of the autotransformer is less than 9 amperes, an overcurrent device rated or set at not more than 167 percent of the input current shall be permitted.

(B) Transformer Field-Connected as an Autotransformer. A transformer field-connected as an autotransformer shall be identified for use at elevated voltage.

Informational Note: For information on permitted uses of autotransformers, see 210.9 and 215.11.

450.5 Grounding Autotransformers. Grounding autotransformers covered in this section are zigzag or T-connected transformers connected to 3-phase, 3-wire ungrounded systems for the purpose of creating a 3-phase, 4-wire distribution system or providing a neutral point for grounding purposes. Such transformers shall have a continuous per-phase current rating and a continuous neutral current rating. Zigzag-connected transformers shall not

be installed on the load side of any system grounding connection, including those made in accordance with 250.24(B), 250.30(A)(1), or 250.32(B), Exception No. 1.
Informational Note: The phase current in a grounding autotransformer is one-third the neutral current.

(A) Three-Phase, 4-Wire System. A grounding autotransformer used to create a 3-phase, 4-wire distribution system from a 3-phase, 3-wire ungrounded system shall conform to 450.5(A)(1)through (A)(4).

(1) Connections. The transformer shall be directly connected to the ungrounded phase conductors and shall not be switched or provided with overcurrent protection that is independent of the main switch and common-trip overcurrent protection for the 3-phase, 4-wire system.

(2) Overcurrent Protection. An overcurrent sensing device shall be provided that will cause the main switch or common-trip overcurrent protection referred to in 450.5(A)(1) to open if the load on the autotransformer reaches or exceeds 125 percent of its continuous current per-phase or neutral rating. Delayed tripping for temporary overcurrents sensed at the autotransformer overcurrent device shall be permitted for the purpose of allowing proper operation of branch or feeder protective devices on the 4-wire system.

(3) Transformer Fault Sensing. A fault-sensing system that causes the opening of a main switch or common-trip overcurrent device for the 3-phase, 4-wire system shall be provided to guard against single-phasing or internal faults.

Informational Note: This can be accomplished by the use of two subtractive-connected donut-type current transformers installed to sense and signal when an unbalance occurs in the line current to the autotransformer of 50 percent or more of rated current.

(4) Rating. The autotransformer shall have a continuous neutral-current rating that is not less than the maximum possible neutral unbalanced load current of the 4-wire system.

(B) Ground Reference for Fault Protection Devices. A grounding autotransformer used to make available a specified magnitude of ground-fault current for operation of a ground-responsive protective device on a 3-phase, 3-wire ungrounded system shall conform to 450.5(B)(1) and (B)(2).

(1) Rating. The autotransformer shall have a continuous neutral-current rating not less than the specified ground-fault current.

(2) Overcurrent Protection. Overcurrent protection shall comply with 450.5(B)(2)(a) and (B)(2)(b).

(a) *Operation and Interrupting Rating.* An overcurrent protective device having an interrupting rating in compliance with 110.9 and that will open simultaneously all ungrounded conductors when it operates shall be applied in the grounding autotransformer branch circuit.

(b) *Ampere Rating.* The overcurrent protection shall be rated or set at a current not exceeding 125 percent of the autotransformer continuous per-phase current rating or 42 percent of the continuous-current rating of any series-connected devices in the autotransformer neutral connection. Delayed tripping for temporary overcurrents to permit the proper operation of ground-responsive tripping devices on the main system shall be permitted but shall not exceed values that would be more than the short-time current rating of the grounding autotransformer or any series connected devices in the neutral connection thereto.

Exception: For high-impedance grounded systems covered in 250.36, where the maximum ground-fault current is designed to be not more than 10 amperes, and where the grounding autotransformer and the grounding impedance are rated for continuous duty, an overcurrent device rated not more than 20 amperes that will simultaneously open all ungrounded conductors shall be permitted to be installed on the line side of the grounding autotransformer.

(C) Ground Reference for Damping Transitory Overvoltages. A grounding autotransformer used to limit transitory overvoltages shall be of suitable rating and connected in accordance with 450.5(A)(1).

450.6 Secondary Ties. As used in this article, a secondary tie is a circuit operating at 1000 volts, nominal, or less between phases that connects two power sources or power supply points, such as the secondaries of two transformers. The tie shall be permitted to consist of one or more conductors per phase or neutral. Conductors connecting the secondaries of transformers in accordance with 450.7 shall not be considered secondary ties. As used in this section, the word *transformer* means a transformer or a bank of transformers operating as a unit.

(A) Tie Circuits. Tie circuits shall be provided with overcurrent protection at each end as required in Parts I, II, and VIII of Article 240.

Under the conditions described in 450.6(A)(1) and 450.6(A)(2), the overcurrent protection shall be permitted to be in accordance with 450.6(A)(3).

(1) Loads at Transformer Supply Points Only. Where all loads are connected at the transformer supply points at each end of the tie and overcurrent protection is not provided in accordance with Parts I, II, and VIII of Article 240, the ampacity of the tie shall not be less than 67 percent of the rated secondary current of the highest rated transformer supplying the secondary tie system.

(2) Loads Connected Between Transformer Supply Points. Where load is connected to the tie at any point between transformer supply points and overcurrent protection is not provided in accordance with Parts I, II, and VIII of Article 240, the ampacity of the tie shall not be less than 100 percent of the rated secondary current of the highest rated transformer supplying the secondary tie system.

Exception: Tie circuits comprised of multiple conductors per phase shall be permitted to be sized and protected in accordance with 450.6(A)(4).

(3) Tie Circuit Protection. Under the conditions described in 450.6(A)(1) and (A)(2), both supply ends of each ungrounded tie conductor shall be equipped with a protective device that opens at a predetermined temperature of the tie conductor under short-circuit conditions. This protection shall consist of one of the following: (1) a fusible link cable connector, terminal, or lug, commonly known as a limiter, each being of a size corresponding with that of the conductor and of construction and characteristics according to the operating voltage and the type of insulation on the tie conductors or (2) automatic circuit breakers actuated by devices having comparable time–current characteristics.

(4) Interconnection of Phase Conductors Between Transformer Supply Points. Where the tie consists of more than one conductor per phase or neutral, the conductors of each phase or neutral shall comply with 450.6(A)(4)(a) or (A)(4)(b).

(a) *Interconnected.* The conductors shall be interconnected in order to establish a load supply point, and the protective device specified in 450.6(A)(3) shall be provided in each ungrounded tie conductor at this point on both sides of the interconnection. The means of interconnection shall have an ampacity not less than the load to be served.

(b) *Not Interconnected.* The loads shall be connected to one or more individual conductors of a paralleled conductor tie without interconnecting the conductors of each phase or neutral and without the protection specified in 450.6(A)(3) at load connection points. Where this is done, the tie conductors of each phase or neutral shall have a combined capacity ampacity of not less than 133 percent of the rated secondary current of the highest rated transformer supplying the secondary tie system, the total load of such taps shall not exceed the rated secondary current of the highest rated transformer, and the loads shall be equally divided on each phase and on the individual conductors of each phase as far as practicable.

(5) Tie Circuit Control. Where the operating voltage exceeds 150 volts to ground, secondary ties provided with limiters shall have a switch at each end that, when open, de-energizes the associated tie conductors and limiters. The current rating of the switch shall not be less than the rated current ampacity of the conductors connected to the switch. It shall be capable of interrupting its rated current, and it shall be constructed so that it will not open under the magnetic forces resulting from short-circuit current.

(B) Overcurrent Protection for Secondary Connections. Where secondary ties are used, an overcurrent device rated or set at not more than 250 percent of the rated secondary current of the transformers shall be provided in the secondary connections of each transformer supplying the tie system. In addition, an automatic circuit breaker actuated by a reverse-current relay set to open the circuit at not more than the rated secondary current of the transformer shall be provided in the secondary connection of each transformer.

(C) Grounding. Where the secondary tie system is grounded, each transformer secondary supplying the tie system shall be grounded in accordance with the requirements of 250.30 for separately derived systems.

450.7 Parallel Operation. Transformers shall be permitted to be operated in parallel and switched as a unit, provided the overcurrent protection for each transformer meets the requirements of 495.103~~450.3(A)~~ for primary and secondary protective devices over 1000 volts, or 450.3(B) for primary and secondary protective devices 1000 volts or less.

450.8 Guarding. Transformers shall be guarded as specified in 450.8(A) through (D).

(A) Mechanical Protection. Appropriate provisions shall be made to minimize the possibility of damage to transformers from external causes where the transformers are exposed to physical damage.

(B) Case or Enclosure. Dry-type transformers shall be provided with a noncombustible moisture-resistant case or enclosure that provides protection against the accidental insertion of foreign objects.

(C) Exposed Energized Parts. Switches or other equipment operating at 1000 volts, nominal, or less and serving only equipment within a transformer enclosure shall be permitted to be installed in the transformer enclosure if accessible to qualified persons only. All energized parts shall be guarded in accordance with 110.27.~~ and 110.34.~~

(D) Voltage Warning. The operating voltage of exposed live parts of transformer installations shall be indicated by signs or visible markings on the equipment or structures.

450.9 Ventilation. The ventilation shall dispose of the transformer full-load heat losses without creating a temperature rise that is in excess of the transformer rating.

Informational Note No. 1: See IEEE C57.12.00-2015, *General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers*, and IEEE C57.12.01-2015, *General Requirements for Dry-Type Distribution and Power Transformers*.

Informational Note No. 2: Additional losses occur in some transformers where nonsinusoidal currents are present, resulting in increased heat in the transformer above its rating. See IEEE C57.110-2008, *Recommended Practice for Establishing Liquid-Filled and Dry-Type Power and Distribution Transformer Capability When Supplying Nonsinusoidal Load Currents*, where transformers are utilized with nonlinear loads.

Transformers with ventilating openings shall be installed so that the ventilating openings are not blocked by walls or other obstructions. The required clearances shall be clearly marked on the transformer. Transformer top surfaces that are horizontal and readily accessible shall be marked to prohibit storage.

450.10 Grounding.
(A) Dry-Type Transformer Enclosures. Where separate equipment grounding conductors and supply-side bonding jumpers are installed, a terminal bar for all grounding and bonding conductor connections shall be secured inside the transformer enclosure. The terminal bar shall be bonded to the enclosure in accordance with 250.12 and shall not be installed on or over any vented portion of the enclosure.

Exception: Where a dry-type transformer is equipped with wire-type connections (leads), the grounding and bonding connections shall be permitted to be connected together using any of the methods in 250.8 and shall be bonded to the enclosure if of metal.

(B) Other Metal Parts. Exposed non–current-carrying metal parts of transformer installations, including fences, guards, and so forth, shall be grounded and bonded under the conditions and in the manner specified for electrical equipment and other exposed metal parts in Parts V, VI, and VII of Article 250.

450.11 Marking.

(A) General. Each transformer shall be provided with a nameplate giving the following information:

(1) Name of manufacturer

(2) Rated kilovolt-amperes

(3) Frequency

(4) Primary and secondary voltage

(5) Impedance of transformers 25 kVA and larger

(6) Required clearances for transformers with ventilating openings

(7) Amount and kind of insulating liquid where used

(8) For dry-type transformers, temperature class for the insulation system

(B) Source Marking. A transformer shall be permitted to be supplied at the marked secondary voltage, provided that the installation is in accordance with the manufacturer's instructions.

450.12 Terminal Wiring Space. The minimum wire-bending space at fixed, 1000-volt and below terminals of transformer line and load connections shall be as required in 312.6. Wiring space for pigtail connections shall conform to Table 314.16(B).

450.13 Accessibility. All transformers ~~and transformer vaults~~ shall be readily accessible to qualified personnel for inspection and maintenance or shall meet the requirements of 450.13(A) or 450.13(B).

(A) Open Installations. Dry-type transformers 1000 volts, nominal, or less, located in the open on walls, columns, or structures, shall not be required to be readily accessible.

(B) Hollow Space Installations. Dry-type transformers 1000 volts, nominal, or less and not exceeding 50 kVA shall be permitted in hollow spaces of buildings not permanently closed in by structure, provided they meet the ventilation requirements of 450.9 and separation from combustible materials requirements of 450.21(A). Transformers so installed shall not be required to be readily accessible.

450.14 Disconnecting Means. Transformers, other than Class 2 or Class 3 transformers, shall have a disconnecting means located either in sight of the transformer or in a remote location. Where located in a remote location, the disconnecting means shall be lockable open in accordance with 110.25, and its location shall be field marked on the transformer.

Part II. Specific Provisions Applicable to Different Types of Transformers

450.21 Dry-Type Transformers Installed Indoors.

(A) Not Over 112½ kVA. Dry-type transformers installed indoors and rated 112½ kVA or less shall have a separation of at least 300 mm (12 in.) from combustible material unless separated from the combustible material by a fire-resistant, heat-insulated barrier.

Exception: This rule shall not apply to transformers rated for 1000 volts, nominal, or less that are completely enclosed, except for ventilating openings.

(B) Over 112½ kVA. Individual dry-type transformers of more than 112½ kVA rating shall be installed in a transformer room of fire-resistant construction having a minimum fire rating of 1 hour.

Exception No. 1: Transformers with Class 155 or higher insulation systems and separated from combustible material by a fire-resistant, heat-insulating barrier or by not less than 1.83 m (6 ft) horizontally and 3.7 m (12 ft) vertically.

Exception No. 2: Transformers with Class 155 or higher insulation systems and completely enclosed except for ventilating openings.

Informational Note: See ASTM E119-18a, *Standard Test Methods for Fire Tests of Building Construction and Materials*.

(C) Over 35,000 Volts. Dry-type transformers rated over 35,000 volts shall be installed in a vault complying with Part VIII of ~~this~~ article 495.

450.22 Dry-Type Transformers Installed Outdoors. Dry-type transformers installed outdoors shall have a weatherproof enclosure.

Transformers exceeding 112½ kVA shall not be located within 300 mm (12 in.) of combustible materials of buildings unless the transformer has Class 155 insulation systems or higher and is completely enclosed except for ventilating openings.

450.23 ~~Less-Flammable~~ Liquid-Insulated Transformers. Liquid-insulated transformers shall comply with Part VII of article 495. ~~Transformers insulated with listed less-flammable liquids that have a fire point of not less than 300°C shall be permitted to be installed in accordance with 450.23(A) or 450.23(B).~~

450.40 Transformer Vaults. Transformer vaults shall comply with Part VIII of article 495.

~~**(A) Indoor Installations.** Indoor installations shall be permitted in accordance with one of the following:~~
~~(1) In Type I or Type II buildings, in areas where all of the following requirements are met:~~
~~a. The transformer is rated 35,000 volts or less.~~
~~b. No combustible materials are stored.~~
~~c. A liquid confinement area is provided.~~
~~d. The installation complies with all the restrictions provided for in the listing of the liquid.~~
~~Informational Note: Such restrictions can include, but are not limited to, maximum pressure of the tank, use of a pressure relief valve, appropriate fuse types, and proper sizing of overcurrent protection.~~
~~(2) If an automatic fire extinguishing system and a liquid confinement area is present, provided the transformer is rated 35,000 volts or less~~
~~(3) If the installation complies with 450.26~~
~~**(B) Outdoor Installations.** Less-flammable liquid-filled transformers shall be permitted to be installed outdoors, attached to, adjacent to, or on the roof of buildings, if installed in accordance with (1) or (2).~~
~~(1) For Type I and Type II buildings, the installation shall comply with all the restrictions provided for in the listing of the liquid.~~
~~Informational Note No. 1: Installations adjacent to combustible material, fire escapes, or door and window openings can require additional safeguards such as those listed in 450.27.~~
~~Informational Note No. 2: Such restrictions can include, but are not limited to: maximum pressure of the tank, use of a pressure relief valve, appropriate fuse types, and proper sizing of overcurrent protection.~~
~~(2) In accordance with 450.27.~~
~~Informational Note No. 1: As used in this section, *Type I and Type II buildings* refers to Type I and Type II building construction as defined in NFPA 220-2018, *Standard on Types of Building Construction. Combustible materials* refers to those materials not classified as noncombustible or limited-combustible as defined in NFPA 220-2018, *Standard on Types of Building Construction.*~~

~~Informational Note No. 2: See definition of *Listed* in Article 100.~~

~~**450.24 Nonflammable Fluid-Insulated Transformers.** Transformers insulated with a dielectric fluid identified as nonflammable shall be permitted to be installed indoors or outdoors. Such transformers installed indoors and rated over 35,000 volts shall be installed in a vault. Such transformers installed indoors shall be furnished with a liquid confinement area and a pressure-relief vent. The transformers shall be furnished with a means for absorbing any gases generated by arcing inside the tank, or the pressure-relief vent shall be connected to a chimney or flue that will carry such gases to an environmentally safe area.~~

~~Informational Note: Safety may be increased if fire hazard analyses are performed for such transformer installations.~~

~~For the purposes of this section, a nonflammable dielectric fluid is one that does not have a flash point or fire point and is not flammable in air.~~

~~**450.25 Askarel-Insulated Transformers Installed Indoors.** Askarel-insulated transformers installed indoors and rated over 25 kVA shall be furnished with a pressure-relief vent. Where installed in a poorly ventilated place, they shall be furnished with a means for absorbing any gases generated by arcing inside the case, or the pressure-relief vent shall be connected to a chimney or flue that carries such gases outside the building. Askarel-insulated transformers rated over 35,000 volts shall be installed in a vault.~~

~~**450.26 Oil-Insulated Transformers Installed Indoors.** Oil-insulated transformers installed indoors shall be installed in a vault constructed as specified in Part VIIIIII of this article 495.~~

~~*Exception No. 1: Where the total capacity does not exceed 112½ kVA, the vault specified in Part VIIIIII of this articl 495e shall be permitted to be constructed of reinforced concrete that is not less than 100 mm (4 in.) thick.*~~

~~*Exception No. 2: Where the nominal voltage does not exceed 1000, a vault shall not be required if suitable arrangements are made to prevent a transformer oil fire from igniting other materials and the total capacity in one location does not exceed 10 kVA in a section of the building classified as combustible or 75 kVA where the surrounding structure is classified as fire-resistant construction.*~~

~~*Exception No. 3: Electric furnace transformers that have a total rating not exceeding 75 kVA shall be permitted to be installed without a vault in a building or room of fire-resistant construction, provided suitable arrangements are made to prevent a transformer oil fire from spreading to other combustible material.*~~

~~*Exception No. 4: A transformer that has a total rating not exceeding 75 kVA and a supply voltage of 1000 volts or less that is an integral part of charged-particle-accelerating equipment shall be permitted to be installed without a vault in a building or room of noncombustible or fire-resistant construction, provided suitable arrangements are made to prevent a transformer oil fire from spreading to other combustible material.*~~

~~*Exception No. 5: Transformers shall be permitted to be installed in a detached building that does not comply with Part III of this article if neither the building nor its contents present a fire hazard to any other building or property, and if the building is used only in supplying electric service and the interior is accessible only to qualified persons.*~~

~~*Exception No. 6: Oil-insulated transformers shall be permitted to be used without a vault in portable and mobile surface mining equipment (such as electric excavators) if each of the following conditions is met:*~~

~~*(1) Provision is made for draining leaking fluid to the ground.*~~

~~*(2) Safe egress is provided for personnel.*~~

~~*(3) A minimum 6-mm (¼-in.) steel barrier is provided for personnel protection.*~~

~~**450.27 Oil-Insulated Transformers Installed Outdoors.** Combustible material, combustible buildings, and parts of buildings, fire escapes, and door and window openings shall be safeguarded from fires originating in oil-insulated transformers installed on roofs, attached to or adjacent to a building or combustible material.~~
~~In cases where the transformer installation presents a fire hazard, one or more of the following safeguards shall be applied according to the degree of hazard involved:~~

~~(1) Space separations~~

~~(2) Fire-resistant barriers~~

~~(3) Automatic fire suppression systems~~

~~(4) Enclosures that confine the oil of a ruptured transformer tank~~

~~Oil enclosures shall be permitted to consist of fire-resistant dikes, curbed areas or basins, or trenches filled with coarse, crushed stone. Oil enclosures shall be provided with trapped drains where the exposure and the quantity of oil involved are such that removal of oil is important.~~

~~Informational Note: For additional information on transformers installed on poles or structures or under ground, see ANSI/IEEE C2-2017, *National Electrical Safety Code*.~~

~~**450.28 Modification of Transformers.** When modifications are made to a transformer in an existing installation that change the type of the transformer with respect to Part II of this article, such transformer shall be marked to show the type of insulating liquid installed, and the modified transformer installation shall comply with the applicable requirements for that type of transformer.~~

~~**Part III. Transformer Vaults**~~

~~**450.41 Location.** Vaults shall be located where they can be ventilated to the outside air without using flues or ducts wherever such an arrangement is practicable.~~

~~**450.42 Walls, Roofs, and Floors.** The walls and roofs of vaults shall be constructed of materials that have approved structural strength for the conditions with a minimum fire resistance of 3 hours. The floors of vaults in contact with the earth shall be of concrete that is not less than 100 mm (4 in.) thick, but, where the vault is constructed with a vacant space or other stories below it, the floor shall have approved structural strength for the load imposed thereon and a minimum fire resistance of 3 hours. For the purposes of this section, studs and wallboard construction shall not be permitted.~~

~~*Exception: Where transformers are protected with automatic sprinkler, water spray, carbon dioxide, or halon, construction of 1-hour rating shall be permitted.*~~

~~Informational Note No. 1: For additional information, see ASTM E119-18a, *Methods for Fire Tests of Building Construction and Materials*.~~

~~Informational Note No. 2: A typical 3-hour construction is 150 mm (6 in.) thick reinforced concrete.~~

~~**450.43 Doorways.** Vault doorways shall be protected in accordance with 450.43(A), (B), and (C).~~

~~**(A) Type of Door.** Each doorway leading into a vault from the building interior shall be provided with a tight-fitting door that has a minimum fire rating of 3 hours. The authority having jurisdiction shall be permitted to require such a door for an exterior wall opening where conditions warrant.~~

~~*Exception: Where transformers are protected with automatic sprinkler, water spray, carbon dioxide, or halon, construction of 1-hour rating shall be permitted.*~~

~~Informational Note: For additional information, see NFPA 80-2016, *Standard for Fire Doors and Other Opening Protectives*.~~

~~**(B) Sills.** A door sill or curb that is of an approved height that will confine the oil from the largest transformer within the vault shall be provided, and in no case shall the height be less than 100 mm (4 in.).~~

~~**(C) Locks.** Doors shall be equipped with locks, and doors shall be kept locked, with access being allowed only to qualified persons. Personnel doors shall open in the direction of egress and be equipped with listed fire exit hardware.~~

~~**450.45 Ventilation Openings.** Where required by 450.9, openings for ventilation shall be provided in accordance with 450.45(A) through (F).~~

~~**(A) Location.** Ventilation openings shall be located as far as possible from doors, windows, fire escapes, and combustible material.~~

~~**(B) Arrangement.** A vault ventilated by natural circulation of air shall be permitted to have roughly half of the total area of openings required for ventilation in one or more openings near the floor and the remainder in one or more openings in the roof or in the sidewalls near the roof, or all of the area required for ventilation shall be permitted in one or more openings in or near the roof.~~

~~**(C) Size.** For a vault ventilated by natural circulation of air to an outdoor area, the combined net area of all ventilating openings, after deducting the area occupied by screens, gratings, or louvers, shall not be less than 1900 mm² (3 in.²) per kVA of transformer capacity in service, and in no case shall the net area be less than 0.1 m² (1 ft²) for any capacity under 50 kVA.~~

~~**(D) Covering.** Ventilation openings shall be covered with durable gratings, screens, or louvers, according to the treatment required in order to avoid unsafe conditions.~~

~~**(E) Dampers.** All ventilation openings to the indoors shall be provided with automatic closing fire dampers that operate in response to a vault fire. Such dampers shall possess a standard fire rating of not less than 1½ hours.~~
~~Informational Note: See ANSI/UL 555-2016, *Standard for Fire Dampers*.~~

~~**(F) Ducts.** Ventilating ducts shall be constructed of fire-resistant material.~~

~~**450.46 Drainage.** Where practicable, vaults containing more than 100 kVA transformer capacity shall be provided with a drain or other means that will carry off any accumulation of oil or water in the vault unless local conditions make this impracticable. The floor shall be pitched to the drain where provided.~~

~~**450.47 Water Pipes and Accessories.** Any pipe or duct system foreign to the electrical installation shall not enter or pass through a transformer vault. Piping or other facilities provided for vault fire protection, or for transformer cooling, shall not be considered foreign to the electrical installation.~~

~~**450.48 Storage in Vaults.** Materials shall not be stored in transformer vaults.~~

ARTICLE 460 Capacitors

(Part II, Over 1000 Volts deleted / relocated to Article 495 Part IV. "Part I" is deleted as a Part in 460)

460.1 Scope. This article covers the installation of capacitors on electrical circuits operating at 1000 Volts ac, 1500 Volts dc, nominal or less.

Surge capacitors or capacitors included as a component part of other apparatus and conforming with the requirements of such apparatus are excluded from these requirements.

This article also covers the installation of capacitors in hazardous (classified) locations as modified by Articles 501 through 503.

> Informational Note: Article 495 includes requirements for capacitors rated over 1000 volts ac, 1500 volts dc, nominal.

~~**460.2 Definitions.** The definition in this section shall apply only within this article.~~

~~**Safe Zone.** Low probability of damage other than a slight swelling of the capacitor case, as identified by the case rupture curve of the capacitor.~~

460.3 Enclosing and Guarding.

(A) Containing More Than 11 L (3 gal) of Flammable Liquid. Capacitors containing more than 11 L (3 gal) of flammable liquid shall be enclosed in vaults or outdoor fenced enclosures complying with Article 110, Part III. This limit shall apply to any single unit in an installation of capacitors.

(B) Accidental Contact. Where capacitors are accessible to unauthorized and unqualified persons, they shall be enclosed, located, or guarded so that persons cannot come into accidental contact or bring conducting materials into accidental contact with exposed energized parts, terminals, or buses associated with them. However, no additional guarding is required for enclosures accessible only to authorized and qualified persons.

~~**Part I. 1000 Volts, Nominal, and Under**~~

460.6 Discharge of Stored Energy. Capacitors shall be provided with a means of discharging stored energy.

(A) Time of Discharge. The residual voltage of a capacitor shall be reduced to 50 volts, nominal, or less within 1 minute after the capacitor is disconnected from the source of supply.

(B) Means of Discharge. The discharge circuit shall be either permanently connected to the terminals of the capacitor or capacitor bank or provided with automatic means of connecting it to the terminals of the capacitor bank on removal of voltage from the line. Manual means of switching or connecting the discharge circuit shall not be used.

460.8 Conductors.

(A) Ampacity. The ampacity of capacitor circuit conductors shall not be less than 135 percent of the rated current of the capacitor. The ampacity of conductors that connect a capacitor to the terminals of a motor or to motor circuit conductors shall not be less than one-third the ampacity of the motor circuit conductors and in no case less than 135 percent of the rated current of the capacitor.

(B) Overcurrent Protection. An overcurrent device shall be provided in each ungrounded conductor for each capacitor bank. The rating or setting of the overcurrent device shall be as low as practicable.
Exception: A separate overcurrent device shall not be required for a capacitor connected on the load side of a motor overload protective device.

(C) Disconnecting Means. A disconnecting means shall be provided in each ungrounded conductor for each capacitor bank and shall meet the following requirements:

(1) The disconnecting means shall open all ungrounded conductors simultaneously.

(2) The disconnecting means shall be permitted to disconnect the capacitor from the line as a regular operating procedure.

(3) The rating of the disconnecting means shall not be less than 135 percent of the rated current of the capacitor.

Exception: A separate disconnecting means shall not be required where a capacitor is connected on the load side of a motor controller.

460.9 Rating or Setting of Motor Overload Device. Where a motor installation includes a capacitor connected on the load side of the motor overload device, the rating or setting of the motor overload device shall be based on the improved power factor of the motor circuit.

The effect of the capacitor shall be disregarded in determining the motor circuit conductor rating in accordance with 430.22.

460.10 Grounding. Capacitor cases shall be connected to the equipment grounding conductor.

Exception: Capacitor cases shall not be connected to the equipment grounding conductor where the capacitor units are supported on a structure designed to operate at other than ground potential.

460.12 Marking. Each capacitor shall be provided with a nameplate giving the name of the manufacturer, rated voltage, frequency, kilovar or amperes, number of phases, and, if filled with a combustible liquid, the volume of liquid. Where filled with a nonflammable liquid, the nameplate shall so state. The nameplate shall also indicate whether a capacitor has a discharge device inside the case.

~~**Part II. Over 1000 Volts, Nominal**~~

~~**460.24 Switching.**~~

~~**(A) Load Current.** Group-operated switches shall be used for capacitor switching and shall be capable of the following:~~

~~(1) Carrying continuously not less than 135 percent of the rated current of the capacitor installation~~

~~(2) Interrupting the maximum continuous load current of each capacitor, capacitor bank, or capacitor installation that will be switched as a unit~~

~~(3) Withstanding the maximum inrush current, including contributions from adjacent capacitor installations~~

~~(4) Carrying currents due to faults on capacitor side of switch~~

~~**B) Isolation.**~~

~~**(1) General.** A means shall be installed to isolate from all sources of voltage each capacitor, capacitor bank, or capacitor installation that will be removed from service as a unit. The isolating means shall provide a visible gap in the electrical circuit adequate for the operating voltage.~~

~~**(2) Isolating or Disconnecting Switches with No Interrupting Rating.** Isolating or disconnecting switches (with no interrupting rating) shall be interlocked with the load-interrupting device or shall be provided with prominently displayed caution signs in accordance with 490.22 to prevent switching load current.~~

~~**(C) Additional Requirements for Series Capacitors.** The proper switching sequence shall be ensured by use of one of the following:~~

~~(1) Mechanically sequenced isolating and bypass switches~~

~~(2) Interlocks~~

~~(3) Switching procedure prominently displayed at the switching location~~

~~**460.25 Overcurrent Protection.**~~

~~**(A) Provided to Detect and Interrupt Fault Current.** A means shall be provided to detect and interrupt fault current likely to cause dangerous pressure within an individual capacitor.~~

~~**(B) Single Pole or Multipole Devices.** Single-pole or multipole devices shall be permitted for this purpose.~~

~~**(C) Protected Individually or in Groups.** Capacitors shall be permitted to be protected individually or in groups.~~

~~**(D) Protective Devices Rated or Adjusted.** Protective devices for capacitors or capacitor equipment shall be rated or adjusted to operate within the limits of the safe zone for individual capacitors.~~

~~**460.26 Identification.** Each capacitor shall be provided with a permanent nameplate giving the manufacturer's name, rated voltage, frequency, kilovar or amperes, number of phases, and the volume of liquid identified as flammable, if such is the case.~~

~~**460.27 Grounding.** Capacitor cases shall be connected to the equipment grounding conductor. If the capacitor neutral point is connected to a grounding electrode conductor, the connection shall be made in accordance with Part III of Article 250.~~

~~*Exception: Capacitor cases shall not be connected to the equipment grounding conductor where the capacitor units are supported on a structure designed to operate at other than ground potential.*~~

~~**460.28 Means for Discharge.**~~

~~**(A) Means to Reduce the Residual Voltage.** A means shall be provided to reduce the residual voltage of a capacitor to 50 volts or less within 5 minutes after the capacitor is disconnected from the source of supply.~~

~~**(B) Connection to Terminals.** A discharge circuit shall be either permanently connected to the terminals of the capacitor or provided with automatic means of connecting it to the terminals of the capacitor bank after disconnection of the capacitor from the source of supply. The windings of motors, transformers, or other equipment directly connected to capacitors without a switch or overcurrent device interposed shall meet the requirements of 460.28(A).~~

ARTICLE 470 Resistors and Reactors

(Part II, Over 1000 Volts deleted / relocate to Article 495 Part X. Part I is deleted as a part in Article 470)

~~Part I. 1000 Volts, Nominal, and Under~~

470.1 Scope. This article covers the installation of separate resistors and reactors on electrical circuits rated no more than 1000 volts ac, 1500 volts dc, nominal.

Exception: Resistors and reactors that are component parts of other apparatus.

This article also covers the installation of resistors and reactors in hazardous (classified) locations as modified by Articles 501 through 504.

> Informational Note: Article 495 includes requirements for resistors and reactors rated over 1000 volts ac, 1500 volts dc, nominal.

470.2 Location. Resistors and reactors shall not be placed where exposed to physical damage.

470.3 Space Separation. A thermal barrier shall be required if the space between the resistors and reactors and any combustible material is less than 305 mm (12 in.).

470.4 Conductor Insulation. Insulated conductors used for connections between resistance elements and controllers shall be suitable for an operating temperature of not less than 90°C (194°F).

Exception: Other conductor insulations shall be permitted for motor starting service.

~~Part II. Over 1000 Volts, Nominal~~

~~470.18 General.~~

~~(A) Protected Against Physical Damage.~~ ~~Resistors and reactors shall be protected against physical damage.~~

~~(B) Isolated by Enclosure or Elevation.~~ ~~Resistors and reactors shall be isolated by enclosure or elevation to protect personnel from accidental contact with energized parts.~~

~~(C) Combustible Materials.~~ ~~Resistors and reactors shall not be installed in close enough proximity to combustible materials to constitute a fire hazard and shall have a clearance of not less than 305 mm (12 in.) from combustible materials.~~

~~(D) Clearances.~~ ~~Clearances from resistors and reactors to grounded surfaces shall be adequate for the voltage involved.~~

~~(E) Temperature Rise from Induced Circulating Currents.~~ ~~Metallic enclosures of reactors and adjacent metal parts shall be installed so that the temperature rise from induced circulating currents is not hazardous to personnel or does not constitute a fire hazard.~~

~~470.19 Grounding.~~ ~~Resistor and reactor cases or enclosures shall be connected to the equipment grounding conductor.~~

~~*Exception: Resistor or reactor cases or enclosures supported on a structure designed to operate at other than ground potential shall not be connected to the equipment grounding conductor.*~~

~~**470.20 Oil-Filled Reactors.** Installation of oil-filled reactors, in addition to the above requirements, shall comply with applicable requirements of Article~~ 450~~.~~

ARTICLE 495~~0~~ Equipment Over 1000 Volts AC, 1500 VDC, Nominal

(Article 490 is renumbered Article 495. Changes to 490 shown below, along with additions from other Chapter 4 Articles where MV requirements have been relocated to 495)

Part I. General

495~~0~~.1 Scope. This article covers the general requirements for equipment operating at more than 1000 volts ac, 1500 volts dc, nominal.

Informational Note No. 1: See *NFPA 70E*-2018, *Standard for Electrical Safety in the Workplace*, for electrical safety requirements for employee workplaces.

Informational Note No. 2: For further information on hazard signs and labels, see ANSI Z535.4-2011, *Product Signs and Safety Labels*.

Informational Note No. 3: For information regarding power distribution apparatus, see IEEE 3001.5-2013, *Recommended Practice for the Application of Power Distribution Apparatus in Industrial and Commercial Power Systems*.

495~~0~~.2 Definition. The definition in this section shall apply only within this article.

High Voltage. A potential difference of more than 1000 volts, nominal.

Safe Zone. Low probability of damage other than a slight swelling of the capacitor case, as identified by the case rupture curve of the capacitor.

Transformer.
An individual transformer, single- or polyphase, identified by a single nameplate, unless otherwise indicated in this article

495~~0~~.3 Other Articles. Enclosures in damp or wet locations shall meet the requirements of 312.2.

~~**(A) Oil-Filled Equipment.** Installation of electrical equipment, other than transformers covered in Article 450, containing more than 38 L (10 gal) of flammable oil per unit shall meet the requirements of Parts II and III of Article 450.~~

~~**(A**~~**B**~~**) Enclosures in Damp or Wet Locations.**~~ ~~Enclosures in damp or wet locations shall meet the requirements of 312.2.~~

495.4 Flexible Cords and Flexible Cable Types.

Flexible cords and flexible cables over 1000 volts shall conform to the description in Table 495~~00~~.4. The use of flexible cords and flexible cables other than those in Table 495~~00~~.4shall require permission by the authority having jurisdiction.

Table 4~~0~~95~~0~~.4 Flexible Cords and Flexible Cables

Trade Name	Type Letter	Voltage	AWG or kcmil	Number of Conductors	Insulation	AWG or kcmil	Nominal Insulation Thickness mm	mils	Braid on Each Conductor	Outer Covering	Use
Portable power cable	G	2000	12–500	2–6 plus equipment grounding conductor(s)	Thermoset	12–2 1–4/0 250–500	1.52 2.03 2.41	60 80 95		Oil-resistant thermoset	Portable and extra-hard usage
	G-GC[7]	2000	12–500	3–6 plus equipment grounding conductors and 1 ground check conductor	Thermoset	12–2 1–4/0 250–500	1.52 2.03 2.41	60 80 95		Oil-resistant thermoset	
Portable power cable	PPE[7]	2000	12–500	1–6 plus optional equipment grounding conductor(s)	Thermoplastic elastomer	12–2 1–4/0 250–500	1.52 2.03 2.41	60 80 95		Oil-resistant thermo-plastic elastomer	Portable, extra-hard usage
Portable power cable	W[7]	2000	12–500 501–1000	1–6 1	Thermoset	12–2 1–4/0 250–500 501–1000	1.52 2.03 2.41 2.80	60 80 95 110		Oil-resistant thermoset	Portable, extra-hard usage

Notes:
[7]Types G, G-GC, S, SC, SCE, SCT, SE, SEO, SEOO, SEW, SEOW, SEOOW, SO, SOO, SOW, SOOW, ST, STO, STOO, STW, STOW, STOOW, PPE, and W shall be permitted for use on theater stages, in garages, and elsewhere where flexible cords are permitted by this *Code*.

Part II. Equipment — Specific Provisions

~~490.21 Circuit-Interrupting Devices.~~
~~490.21(A) Circuit Breakers.~~
~~490.21(A)(1) Location.~~

~~(a) Circuit breakers installed indoors shall be mounted either in metal-enclosed units or fire-resistant cell-mounted units, or they shall be permitted to be open-mounted in locations accessible to qualified persons only.~~

~~(b) Circuit breakers used to control oil-filled transformers in a vault shall either be located outside the transformer vault or be capable of operation from outside the vault.~~

~~(c) Oil circuit breakers shall be arranged or located so that adjacent readily combustible structures or materials are safeguarded in an approved manner.~~

~~490.21(A)(2) Operating Characteristics.~~
~~Circuit breakers shall have the following equipment or operating characteristics:~~

~~(1 An accessible mechanical or other identified means for manual tripping, independent of control power~~

~~(2) Be release free (trip free)~~

~~(3) If capable of being opened or closed manually while energized, main contacts that operate independently of the speed of the manual operation~~

~~(4) A mechanical position indicator at the circuit breaker to show the open or closed position of the main contacts~~

~~(5) A means of indicating the open and closed position of the breaker at the point(s) from which they may be operated~~

~~490.21(A)(3) Nameplate.~~
~~A circuit breaker shall have a permanent and legible nameplate showing manufacturer's name or trademark, manufacturer's type or identification number, continuous current rating, interrupting rating in megavolt-amperes (MVA) or amperes, and maximum voltage rating. Modification of a circuit breaker affecting its rating(s) shall be accompanied by an appropriate change of nameplate information.~~

~~490.21(A)(4) Rating.~~
~~Circuit breakers shall have the following ratings:~~

~~(1)The continuous current rating of a circuit breaker shall not be less than the maximum continuous current through the circuit breaker.~~

~~(2) The interrupting rating of a circuit breaker shall not be less than the available fault current the circuit breaker will be required to interrupt, including contributions from all connected sources of energy.\~~

~~(3) The closing rating of a circuit breaker shall not be less than the maximum asymmetrical fault current into which the circuit breaker can be closed.~~

~~(4) The momentary rating of a circuit breaker shall not be less than the maximum asymmetrical fault current at the point of installation.~~

~~(5) The rated maximum voltage of a circuit breaker shall not be less than the maximum circuit voltage.~~

~~490.21(A)(5) Retrofit Trip Units.~~

~~Retrofit trip units shall be listed for use with the specific circuit breaker with which it is installed.~~

~~490.21(B) Power Fuses and Fuseholders.~~
~~490.21(B)(1) Use.~~
~~Where fuses are used to protect conductors and equipment, a fuse shall be placed in each ungrounded conductor. Two power fuses shall be permitted to be used in parallel to protect the same load if both fuses have identical ratings and both fuses are installed in an identified common mounting with electrical connections that divide the current equally. Power fuses of the vented type shall not be used indoors, underground, or in metal enclosures unless identified for the use.~~

~~490.21(B)(2) Interrupting Rating.~~
~~The interrupting rating of power fuses shall not be less than the available fault current the fuse is required to interrupt, including contributions from all connected sources of energy.~~

~~490.21(B)(3) Voltage Rating.~~
~~The maximum voltage rating of power fuses shall not be less than the maximum circuit voltage. Fuses having a minimum recommended operating voltage shall not be applied below this voltage.~~

~~490.21(B)(4) Identification of Fuse Mountings and Fuse Units.~~
~~Fuse mountings and fuse units shall have permanent and legible nameplates showing the manufacturer's type or designation, continuous current rating, interrupting current rating, and maximum voltage rating.~~

~~490.21(B)(5) Fuses.~~
~~Fuses that expel flame in opening the circuit shall be designed or arranged so that they function properly without hazard to persons or property.~~

~~490.21(B)(6) Fuseholders.~~
~~Fuseholders shall be designed or installed so that they are de-energized while a fuse is being replaced. A field-applied permanent and legible sign, in accordance with 110.21(B), shall be installed immediately adjacent to the fuseholders and shall be worded as follows:~~

~~DANGER — DISCONNECT CIRCUIT BEFORE REPLACING FUSES.~~

~~Exception: Fuses and fuseholders designed to permit fuse replacement by qualified persons using identified equipment without de-energizing the fuseholder shall be permitted.~~

~~490.21(B)(7) High-Voltage Fuses.~~
~~Switchgear and substations that utilize high-voltage fuses shall be provided with a gang-operated disconnecting switch. Isolation of the fuses from the circuit shall be provided by either connecting a switch between the source and the fuses or providing roll-out switch and fuse-type construction. The switch shall be of the load-interrupter type, unless mechanically or electrically interlocked with a load-interrupting device arranged to reduce the load to the interrupting capability of the switch.~~

~~Exception: More than one switch shall be permitted as the disconnecting means for one set of fuses where the switches are installed to provide connection to more than one set of supply conductors. The switches shall be mechanically or electrically interlocked to permit access to the fuses only when all switches are open. A conspicuous sign shall be placed at the fuses identifying the presence of more than one source.~~

~~490.21(C) Distribution Cutouts and Fuse Links — Expulsion Type.~~
~~490.21(C)(1) Installation.~~
~~Cutouts shall be located so that they may be readily and safely operated and re-fused, and so that the exhaust of the fuses does not endanger persons. Distribution cutouts shall not be used indoors, underground, or in metal enclosures.~~

~~490.21(C)(2) Operation.~~

~~Where fused cutouts are not suitable to interrupt the circuit manually while carrying full load, an approved means shall be installed to interrupt the entire load. Unless the fused cutouts are interlocked with the switch to prevent opening of the cutouts under load, a conspicuous sign shall be placed at such cutouts identifying that they shall not be operated under load.~~

~~490.21(C)(3) Interrupting Rating.~~
~~The interrupting rating of distribution cutouts shall not be less than the available fault current the cutout is required to interrupt, including contributions from all connected sources of energy.~~

~~490.21(C)(4) Voltage Rating.~~
~~The maximum voltage rating of cutouts shall not be less than the maximum circuit voltage.~~

~~490.21(C)(5) Identification.~~
~~Distribution cutouts shall have on their body, door, or fuse tube a permanent and legible nameplate or identification showing the manufacturer's type or designation, continuous current rating, maximum voltage rating, and interrupting rating.~~

~~490.21(C)(6) Fuse Links.~~
~~Fuse links shall have a permanent and legible identification showing continuous current rating and type.~~

~~490.21(C)(7) Structure Mounted Outdoors.~~
~~The height of cutouts mounted outdoors on structures shall provide safe clearance between lowest energized parts (open or closed position) and standing surfaces, in accordance with 110.34(E).~~

~~490.21(D) Oil-Filled Cutouts.~~
~~490.21(D)(1) Continuous Current Rating.~~
~~The continuous current rating of oil-filled cutouts shall not be less than the maximum continuous current through the cutout.~~

~~490.21(D)(2) Interrupting Rating.~~
~~The interrupting rating of oil-filled cutouts shall not be less than the available fault current the oil-filled cutout is required to interrupt, including contributions from all connected sources of energy.~~

~~490.21(D)(3) Voltage Rating.~~
~~The maximum voltage rating of oil-filled cutouts shall not be less than the maximum circuit voltage.~~

~~490.21(D)(4) Fault Closing Rating.~~
~~Oil-filled cutouts shall have a fault closing rating not less than the maximum asymmetrical fault current that can occur at the cutout location, unless suitable interlocks or operating procedures preclude the possibility of closing into a fault.~~

~~490.21(D)(5) Identification.~~
~~Oil-filled cutouts shall have a permanent and legible nameplate showing the rated continuous current, rated maximum voltage, and rated interrupting current.~~

~~490.21(D)(6) Fuse Links.~~
~~Fuse links shall have a permanent and legible identification showing the rated continuous current.~~

~~490.21(D)(7) Location.~~
~~Cutouts shall be located so that they are readily and safely accessible for re-fusing, with the top of the cutout not over 1.5 m (5 ft) above the floor or platform.~~

~~490.21(D)(8) Enclosure.~~
~~Suitable barriers or enclosures shall be provided to prevent contact with nonshielded cables or energized parts of oil-filled cutouts.~~

~~**490.21(E) Load Interrupters.**~~
~~Load-interrupter switches shall be permitted if suitable fuses or circuit breakers are used in conjunction with these devices to interrupt available fault currents. Where these devices are used in combination, they shall be coordinated electrically so that they will safely withstand the effects of closing, carrying, or interrupting all possible currents up to the assigned maximum short-circuit rating.~~

~~Where more than one switch is installed with interconnected load terminals to provide for alternate connection to different supply conductors, each switch shall be provided with a warning sign identifying the presence of more than one source. Each warning sign or label shall comply with 110.21.~~

~~**490.21(E)(1) Continuous Current Rating.**~~
~~The continuous current rating of interrupter switches shall equal or exceed the maximum continuous current at the point of installation.~~

~~**490.21(E)(2) Voltage Rating.**~~
~~The maximum voltage rating of interrupter switches shall equal or exceed the maximum circuit voltage.~~

~~**490.21(E)(3) Identification.**~~
~~Interrupter switches shall have a permanent and legible nameplate including the following information: manufacturer's type or designation, continuous current rating, interrupting current rating, fault closing rating, maximum voltage rating.~~

~~**490.21(E)(4) Switching of Conductors.**~~
~~The switching mechanism shall be arranged to be operated from a location where the operator is not exposed to energized parts and shall be arranged to open all ungrounded conductors of the circuit simultaneously with one operation. Switches shall be arranged to be locked in the open position. Metal-enclosed switches shall be operable from outside the enclosure.~~

~~**490.21(E)(5) Stored Energy for Opening.**~~
~~The stored-energy operator shall be permitted to be left in the uncharged position after the switch has been closed if a single movement of the operating handle charges the operator and opens the switch.~~

~~**490.21(E)(6) Supply Terminals.**~~
~~The supply terminals of fused interrupter switches shall be installed at the top of the switch enclosure, or, if the terminals are located elsewhere, the equipment shall have barriers installed so as to prevent persons from accidentally contacting energized parts or dropping tools or fuses into energized parts.~~

495~~0~~.22 Isolating Means. Means shall be provided to completely isolate an item of equipment from all ungrounded conductors. The use of isolating switches shall not be required where there are other ways of de-energizing the equipment for inspection and repairs, such as draw-out-type switchgear units and removable truck panels.

Isolating switches not interlocked with an approved circuit-interrupting device shall be provided with a sign warning against opening them under load. The warning sign(s) or label(s) shall comply with 110.21(B).

An identified fuseholder and fuse shall be permitted as an isolating switch.

495~~0~~.23 Voltage Regulators. Proper switching sequence for regulators shall be ensured by use of one of the following:

(1) Mechanically sequenced regulator bypass switch(es)

(2) Mechanical interlocks

(3) Switching procedure prominently displayed at the switching location

495~~0~~.24 Minimum Space Separation. In field-fabricated installations, the minimum air separation between bare live conductors and between such conductors and adjacent grounded surfaces shall not be less than the values given in Table 495~~0~~.24. These values shall not apply to interior portions or exterior terminals of equipment designed, manufactured, and tested in accordance with accepted national standards.

Table 495~~0~~.24 Minimum Clearance of Live Parts

Nominal Voltage Rating (kV)	Impulse Withstand, Basic Impulse Level B.I.L (kV)		Minimum Clearance of Live Parts							
			Phase-to-Phase				Phase-to-Ground			
			Indoors		Outdoors		Indoors		Outdoors	
	Indoors	Outdoors	mm	in.	mm	in.	mm	in.	Mm	in.
2.4–4.16	60	95	115	4.5	180	7	80	3.0	155	6
7.2	75	95	140	5.5	180	7	105	4.0	155	6
13.8	95	110	195	7.5	305	12	130	5.0	180	7
14.4	110	110	230	9.0	305	12	170	6.5	180	7
23	125	150	270	10.5	385	15	190	7.5	255	10
34.5	150	150	320	12.5	385	15	245	9.5	255	10
	200	200	460	18.0	460	18	335	13.0	335	13
46	—	200	—	—	460	18	—	—	335	13
	—	250	—	—	535	21	—	—	435	17
69	—	250	—	—	535	21	—	—	435	17
	—	350	—	—	790	31	—	—	635	25
115	—	550	—	—	1350	53	—	—	1070	42

Table 495~~0~~.24 Minimum Clearance of Live Parts

Nominal Voltage Rating (kV)	Impulse Withstand, Basic Impulse Level B.I.L (kV)		Minimum Clearance of Live Parts							
			Phase-to-Phase				Phase-to-Ground			
			Indoors		Outdoors		Indoors		Outdoors	
	Indoors	Outdoors	mm	in.	mm	in.	mm	in.	Mm	in.
138	—	550	—	—	1350	53	—	—	1070	42
	—	650	—	—	1605	63	—	—	1270	50
161	—	650	—	—	1605	63	—	—	1270	50
	—	750	—	—	1830	72	—	—	1475	58
230	—	750	—	—	1830	72	—	—	1475	58
	—	900	—	—	2265	89	—	—	1805	71
	—	1050	—	—	2670	105	—	—	2110	83

Note: The values given are the minimum clearance for rigid parts and bare conductors under favorable service conditions. They shall be increased for conductor movement or under unfavorable service conditions or wherever space limitations permit. The selection of the associated impulse withstand voltage for a particular system voltage is determined by the characteristics of the surge protective equipment.

495~~0~~.25 Backfeed. Installations where the possibility of backfeed exists shall comply with 495~~0~~.25(A) and (B), which follow.

(A) Sign. A permanent sign in accordance with 110.21(B) shall be installed on the disconnecting means enclosure or immediately adjacent to open disconnecting means with the following words or equivalent: DANGER — CONTACTS ON EITHER SIDE OF THIS DEVICE MAY BE ENERGIZED BY BACKFEED.

(B) Diagram. A permanent and legible single-line diagram of the local switching arrangement, clearly identifying each point of connection to the high-voltage section, shall be provided within sight of each point of connection.

495.26 ~~(A)~~ Oil-Filled Equipment. Installation of electrical equipment, other than transformers covered in ~~Article~~ Part VII~~450~~, containing more than 38 L (10 gal) of flammable oil per unit shall meet the requirements of Part~~s~~ V~~II and III of Article 450~~.

Informational Note: The same requirements for oil used in oil-filled transformers are also applicable to other oil-filled equipment.

Part III. Equipment — Switchgear and Industrial Control Assemblies

495~~0~~.30 General. Part III covers assemblies of switchgear and industrial control equipment including, but not limited to, switches and interrupting devices and their control, metering, protection, and regulating equipment where they are an integral part of the assembly, with associated interconnections and supporting structures.

495~~0~~.31 Arrangement of Devices in Assemblies. Arrangement of devices in assemblies shall be such that individual components can safely perform their intended function without adversely affecting the safe operation of other components in the assembly.

495~~0~~.32 Guarding of High-Voltage Energized Parts Within a Compartment. Where access for other than visual inspection is required to a compartment that contains energized high-voltage parts, barriers shall be provided to prevent accidental contact by persons, tools, or other equipment with energized parts. Exposed live parts shall only be permitted in compartments accessible to qualified persons. Fuses and fuseholders designed to enable future replacement without de-energizing the fuseholder shall only be permitted for use by qualified persons.

495~~0~~.33 Guarding of Energized Parts Operating at 1000 Volts, Nominal, or Less Within Compartments. Energized bare parts mounted on doors shall be guarded where the door must be opened for maintenance of equipment or removal of draw-out equipment.

495~~0~~.34 Clearance for Cable Conductors Entering Enclosure. The unobstructed space opposite terminals or opposite raceways or cables entering a switchgear or control assembly shall be approved for the type of conductor and method of termination.

495~~0~~.35 Accessibility of Energized Parts.

(A) High-Voltage Equipment. Doors that would provide unqualified persons access to high-voltage energized parts shall be locked. Permanent signs in accordance with 110.21(B) shall be installed on panels or doors that provide access to live parts over 1000 volts and shall read DANGER — HIGH VOLTAGE — KEEP OUT.

(B) Control Equipment. Where operating at 1000 volts, nominal, or less, control equipment, relays, motors, and the like shall not be installed in compartments with high-voltage parts or high-voltage wiring, unless:

> (1) The access means is interlocked with the high-voltage switch or disconnecting means to prevent the access means from being opened or removed when the high-voltage switch is in the closed position or a withdrawable disconnecting means is in the connected position, and
>
> (2) All high-voltage parts or high-voltage wiring in the compartment that remain energized when a fixed mounted high-voltage switch is in the open position or a withdrawable disconnecting means is in the isolating (fully withdrawn) position are protected by insulating or grounded metal barriers to prevent accidental contact with energized high-voltage parts or wiring.

(C) High-Voltage Instruments or Control Transformers and Space Heaters. High-voltage instrument or control transformers and space heaters shall be permitted to be installed in the high-voltage compartment without access restrictions beyond those that apply to the high-voltage compartment generally.

495~~0~~.36 Grounding. Frames of switchgear and control assemblies shall be connected to an equipment grounding conductor or, where permitted, the grounded conductor.

495~~0~~.37 Grounding of Devices. The metal cases or frames, or both, such as those of instruments, relays, meters, and instrument and control transformers, located in or on switchgear or control assemblies, shall be connected to an equipment grounding conductor or, where permitted, the grounded conductor.

495~~0~~.38 Door Stops and Cover Plates. External hinged doors or covers shall be provided with stops to hold them in the open position. Cover plates intended to be removed for inspection of energized parts or wiring shall be equipped with lifting handles and shall not exceed 1.1 m^2 (12 ft^2) in area or 27 kg (60 lb) in weight, unless they are hinged and bolted or locked.

495~~0~~.39 Gas Discharge from Interrupting Devices. Gas discharged during operating of interrupting devices shall be directed so as not to endanger personnel.

495~~0~~.40 Visual Inspection Windows. Windows intended for visual inspection of disconnecting switches or other devices shall be of suitable transparent material.

495~~0~~.41 Location of Industrial Control Equipment. Routinely operated industrial control equipment shall meet the requirements of 495~~0~~.41(A) unless infrequently operated, as covered in 495~~0~~.41(B).

(A) Control and Instrument Transfer Switch Handles or Push Buttons. Control and instrument transfer switch handles or push buttons shall be in a readily accessible location at an elevation of not over 2.0 m (6 ft 7 in.).

Exception: Operating handles requiring more than 23 kg (50 lb) of force shall be located no higher than 1.7 m (66 in.) in either the open or closed position.

(B) Infrequently Operated Devices. Where operating handles for such devices as draw-out fuses, fused potential or control transformers and their primary disconnects, and bus transfer and isolating switches are only operated infrequently, the handles shall be permitted to be located where they are safely operable and serviceable from a portable platform.

495~~0~~.42 Interlocks — Interrupter Switches. Interrupter switches equipped with stored energy mechanisms shall have mechanical interlocks to prevent access to the switch compartment unless the stored energy mechanism is in the discharged or blocked position.

495~~0~~.43 Stored Energy for Opening. The stored energy operator shall be permitted to be left in the uncharged position after the switch has been closed if a single movement of the operating handle charges the operator and opens the switch.

495~~0~~.44 Fused Interrupter Switches.

(A) Supply Terminals. The supply terminals of fused interrupter switches shall be installed at the top of the switch enclosure or, if the terminals are located elsewhere, the equipment shall have barriers installed so as to prevent persons from accidentally contacting energized parts or dropping tools or fuses into energized parts.

(B) Backfeed. Where fuses can be energized by backfeed, a sign shall be placed on the enclosure door identifying this hazard.

(C) Switching Mechanism. The switching mechanism shall be arranged to be operated from a location outside the enclosure where the operator is not exposed to energized parts and shall be arranged to open all ungrounded conductors of the circuit simultaneously with one operation. Switches shall be lockable open in accordance with 110.25.

495~~0~~.45 Circuit Breakers — Interlocks.

(A) Circuit Breakers. Circuit breakers equipped with stored energy mechanisms shall be designed to prevent the release of the stored energy unless the mechanism has been fully charged.

(B) Mechanical Interlocks. Mechanical interlocks shall be provided in the housing to prevent the complete withdrawal of the circuit breaker from the housing when the stored energy mechanism is in the fully charged position, unless a suitable device is provided to block the closing function of the circuit breaker before complete withdrawal.

495~~0~~.46 Circuit Breaker Locking. Circuit breakers shall be capable of being locked in the open position or, if they are installed in a drawout mechanism, that mechanism shall be capable of being locked in such a position that the mechanism cannot be moved into the connected position. In either case, the provision for locking shall be lockable open in accordance with 110.25.

495~~0~~.47 Switchgear Used as Service Equipment. Switchgear installed as high-voltage service equipment shall include a ground bus for the connection of service cable shields and to facilitate the attachment of safety grounds for personnel protection. This bus shall be extended into the compartment where the service conductors are terminated. Where the compartment door or panel provides access to parts that can only be de-energized and visibly isolated by the serving utility, the warning sign required by 495~~0~~.35(A) shall include a notice that access is limited to the serving utility or is permitted only following an authorization of the serving utility.

495~~0~~.48 Substation Design, Documentation, and Required Diagram.
(A) Design and Documentation. Substations shall be designed by a qualified licensed professional engineer. Where components or the entirety of the substation are listed by a qualified electrical testing laboratory, documentation of internal design features subject to the listing investigation shall not be required. The design shall address but not be limited to the following topics, and the documentation of this design shall be made available to the authority having jurisdiction:

(1) Clearances and exits

(2) Electrical enclosures

(3) Securing and support of electrical equipment

(4) Fire protection

(5) Safety ground connection provisions

(6) Guarding live parts

(7) Transformers and voltage regulation equipment

(8) Conductor insulation, electrical and mechanical protection, isolation, and terminations

(9) Application, arrangement, and disconnection of circuit breakers, switches, and fuses

(10) Provisions for oil filled equipment

(11) Switchgear

(12) Surge arresters

495~~0~~.48(B) Diagram. A permanent, single-line diagram of the switchgear shall be provided in a readily visible location within the same room or enclosed area with the switchgear, and this diagram shall clearly identify interlocks, isolation means, and all possible sources of voltage to the installation under normal or emergency conditions, and the marking on the switchgear shall cross-reference the diagram.

Exception: Where the equipment consists solely of a single cubicle or metal-enclosed substation containing only one high-voltage switching device, diagrams shall not be required.

495~~0~~.49 Reconditioned Switchgear. Switchgear, or sections of switchgear, within the scope of this article shall be permitted to be reconditioned. The reconditioning process shall use design qualified parts verified under applicable standards and be performed in accordance with any instructions provided by the manufacturer. Reconditioned switchgear shall be listed or field labeled as *reconditioned*, and previously applied listing marks, if any, within the portions reconditioned shall be removed. If equipment has been damaged by fire, products of combustion, or water, it shall be specifically evaluated by its manufacturer or a qualified testing laboratory prior to being returned to service.

Part IV. Mobile and Portable Equipment

495~~0~~.51 General.

(A) Covered. The provisions of this part shall apply to installations and use of high-voltage power distribution and utilization equipment that is portable, mobile, or both, such as substations and switch houses mounted on skids, trailers, or cars; mobile shovels; draglines; cranes; hoists; drills; dredges; compressors; pumps; conveyors; underground excavators; and the like.

(B) Other Requirements. The requirements of this part shall be additional to, or amendatory of, those prescribed in Articles 100 through 725 of this *Code*. Special attention shall be paid to Article 250.

(C) Protection. Approved enclosures or guarding, or both, shall be provided to protect portable and mobile equipment from physical damage.

(D) Disconnecting Means. Disconnecting means shall be installed for mobile and portable high-voltage equipment according to the requirements of Part VIII of Article 230 and shall disconnect all ungrounded conductors.

495~~0~~.52 Overcurrent Protection. Motors driving single or multiple dc generators supplying a system operating on a cyclic load basis do not require overload protection, provided that the thermal rating of the ac drive motor cannot be exceeded under any operating condition. The branch-circuit protective device(s) shall provide short-circuit and locked-rotor protection and shall be permitted to be external to the equipment.

495~~0~~.53 Enclosures. All energized switching and control parts shall be enclosed in grounded metal cabinets or enclosures. These cabinets or enclosures shall be marked DANGER — HIGH VOLTAGE — KEEP OUT and shall be locked so that only authorized and qualified persons can enter. The danger marking(s) or label(s) shall comply with 110.21(B). Circuit breakers and protective equipment shall have the operating means projecting through the metal cabinet or enclosure so these units can be reset without opening locked doors. With doors closed, safe access for normal operation of these units shall be provided.

495~~0~~.54 Collector Rings. The collector ring assemblies on revolving-type machines (shovels, draglines, etc.) shall be guarded to prevent accidental contact with energized parts by personnel on or off the machine.

495~~0~~.55 Power Cable Connections to Mobile Machines. A metallic enclosure shall be provided on the mobile machine for enclosing the terminals of the power cable. The enclosure shall include terminal connections to the machine frame for the equipment grounding conductor. Ungrounded conductors shall be attached to insulators or be terminated in approved high-voltage cable couplers (which include equipment grounding conductor connectors) of proper voltage and ampere rating. The method of cable termination used shall prevent any strain or pull on the cable from stressing the electrical connections. The enclosure shall have provision for locking so that only authorized and qualified persons may open it and shall be marked as follows:

DANGER — HIGH VOLTAGE — KEEP OUT.

The danger marking(s) or label(s) shall comply with 110.21(B).

495~~0~~.56 High-Voltage Portable Cable for Main Power Supply. Flexible high-voltage cable supplying power to portable or mobile equipment shall comply with Article 250 and Article 400, Part III.

Part V. Electrode-Type Boilers

495~~0~~.70 General. The provisions of Part V shall apply to boilers operating over 1000 volts, nominal, in which heat is generated by the passage of current between electrodes through the liquid being heated.

495~~0~~.71 Electrical Supply System. Electrode-type boilers shall be supplied only from a 3-phase, 4-wire solidly grounded wye system, or from isolating transformers arranged to provide such a system. Control circuit voltages shall not exceed 150 volts, shall be supplied from a grounded system, and shall have the controls in the ungrounded conductor.

495~~0~~.72 Branch-Circuit Requirements.

(A) Rating. Each boiler shall be supplied from an individual branch circuit rated not less than 100 percent of the total load.

(B) Common-Trip Fault-Interrupting Device. The circuit shall be protected by a 3-phase, common-trip fault-interrupting device, which shall be permitted to automatically reclose the circuit upon removal of an overload condition but shall not reclose after a fault condition.

(C) Phase-Fault Protection. Phase-fault protection shall be provided in each phase, consisting of a separate phase-overcurrent relay connected to a separate current transformer in the phase.

(D) Ground Current Detection. Means shall be provided for detection of the sum of the neutral conductor and equipment grounding conductor currents and shall trip the circuit-interrupting device if the sum of those currents exceeds the greater of 5 amperes or 7½ percent of the boiler full-load current for 10 seconds or exceeds an instantaneous value of 25 percent of the boiler full-load current.

(E) Grounded Neutral Conductor. The grounded neutral conductor shall be as follows:

(1) Connected to the pressure vessel containing the electrodes

(2) Insulated for not less than 1000 volts

(3) Have not less than the ampacity of the largest ungrounded branch-circuit conductor

(4) Installed with the ungrounded conductors in the same raceway, cable, or cable tray, or, where installed as open conductors, in close proximity to the ungrounded conductors

(5) Not used for any other circuit

495~~0~~.73 Pressure and Temperature Limit Control. Each boiler shall be equipped with a means to limit the maximum temperature, pressure, or both, by directly or indirectly interrupting all current flow through the electrodes. Such means shall be in addition to the temperature, pressure, or both, regulating systems and pressure relief or safety valves.

495~~0~~.74 Bonding. All exposed non–current-carrying metal parts of the boiler and associated exposed metal structures or equipment shall be bonded to the pressure vessel or to the neutral conductor to which the vessel is connected in accordance with 250.102, except the ampacity of the bonding jumper shall not be less than the ampacity of the neutral conductor.

Part VI. Motors, Motor Circuits and Controllers

495.80 ~~430.221~~ General. Part ~~XI~~ VI recognizes the additional hazard due to the use of higher voltages. It adds to or amends the other provisions of ~~this~~ article 430.

~~430.222~~495.81 Marking on Controllers. In addition to the marking required by 430.8, a controller shall be marked with the control voltage.

~~430.223~~495.82 Raceway Connection to Motors. Flexible metal conduit or liquidtight flexible metal conduit not exceeding 1.8 m (6 ft) in length shall be permitted to be employed for raceway connection to a motor terminal enclosure.

~~430.224~~495.83 Size of Conductors. Conductors supplying motors shall have an ampacity not less than the current at which the motor overload protective device(s) is selected to trip.

~~430.225~~495.84 Motor-Circuit Overcurrent Protection.

(A) General. Each motor circuit shall include coordinated protection to automatically interrupt overload and fault currents in the motor, the motor-circuit conductors, and the motor control apparatus.

Exception: Where a motor is critical to an operation and the motor should operate to failure if necessary to prevent a greater hazard to persons, the sensing device(s) shall be permitted to be connected to a supervised annunciator or alarm instead of interrupting the motor circuit.

(B) Overload Protection.

(1) Type of Overload Device. Each motor shall be protected against dangerous heating due to motor overloads and failure to start by a thermal protector integral with the motor or external current-sensing devices, or both. Protective device settings for each motor circuit shall be determined under engineering supervision.

(2) Wound-Rotor Alternating-Current Motors. The secondary circuits of wound-rotor ac motors, including conductors, controllers, and resistors rated for the application, shall be considered as protected against overcurrent by the motor overload protection means.

(3) Operation. Operation of the overload interrupting device shall simultaneously disconnect all ungrounded conductors.

(4) Automatic Reset. Overload sensing devices shall not automatically reset after trip unless resetting of the overload sensing device does not cause automatic restarting of the motor or there is no hazard to persons created by automatic restarting of the motor and its connected machinery.

(C) Fault-Current Protection.

(1) Type of Protection. Fault-current protection shall be provided in each motor circuit as specified by either ~~430.225(C)(1)~~495.84(C)(1)(a) or (C)(1)(b).

(a) A circuit breaker of suitable type and rating arranged so that it can be serviced without hazard. The circuit breaker shall simultaneously disconnect all ungrounded conductors. The circuit breaker shall be permitted to sense the fault current by means of integral or external sensing elements.

(b) Fuses of a suitable type and rating placed in each ungrounded conductor. Fuses shall be used with suitable disconnecting means, or they shall be of a type that can also serve as the disconnecting means. They shall be arranged so that they cannot be serviced while they are energized.

(2) Reclosing. Fault-current interrupting devices shall not automatically reclose the circuit.

Exception: Automatic reclosing of a circuit shall be permitted where the circuit is exposed to transient faults and where such automatic reclosing does not create a hazard to persons.

(3) Combination Protection. Overload protection and fault-current protection shall be permitted to be provided by the same device.

~~430.226~~495.85 Rating of Motor Control Apparatus. The ultimate trip current of overcurrent (overload) relays or other motor-protective devices used shall not exceed 115 percent of the controller's continuous current rating. Where the motor branch-circuit disconnecting means is separate from the controller, the disconnecting means current rating shall not be less than the ultimate trip setting of the overcurrent relays in the circuit.

~~430.227~~495.86 Disconnecting Means. The controller disconnecting means shall be lockable in accordance with 110.25.

Part ~~XI~~IV~~V~~. Tables

Table 495.87 Full-Load Current, Two-Phase Alternating-Current Motors (4-Wire)

The following values of full-load current are for motors running at speeds usual for belted motors and motors with normal torque characteristics. Current in the common conductor of a 2-phase, 3-wire system will be 1.41 times the value given. The voltages listed are rated motor voltages. ~~The currents listed shall be permitted for system voltage ranges of 110 to 120, 220 to 240, 440 to 480, and 550 to 600 volts.~~ The currents listed shall be permitted for system voltage ranges of 2300 to 2400 volts.

Horsepower	Induction-Type Squirrel Cage and Wound Rotor (Amperes)				
	~~115 Volts~~	~~230 Volts~~	~~460 Volts~~	~~575 Volts~~	2300 Volts
60	—	~~133~~	~~67~~	~~53~~	14
75	—	~~166~~	~~83~~	~~66~~	18
100	—	~~218~~	~~109~~	~~87~~	23
125	—	~~270~~	~~135~~	~~108~~	28
150	—	~~312~~	~~156~~	~~125~~	32
200	—	~~416~~	~~208~~	~~167~~	43

Table 495.88 Full-Load Current, Three-Phase Alternating-Current Motors

The following values of full-load currents are typical for motors running at speeds usual for belted motors and motors with normal torque characteristics. The voltages listed are rated motor voltages. The currents listed shall be permitted for system voltage ranges of ~~110 to 120, 220 to 240, 440 to 480, and 550 to 600~~2300 to 2400 volts.

Horsepower	Induction-Type Squirrel Cage and Wound Rotor (Amperes)							-	Synchronous-Type Unity Power Factor* (Amperes)			
	~~115 Volts~~	~~200 Volts~~	~~208 Volts~~	~~230 Volts~~	~~460 Volts~~	~~575 Volts~~	2300 Volts	-	~~230 Volts~~	~~460 Volts~~	~~575 Volts~~	2300 Volts
60	—	~~177~~	~~169~~	~~154~~	~~77~~	~~62~~	16	_	~~123~~	~~61~~	~~49~~	12
100	—	~~285~~	~~273~~	~~248~~	~~124~~	~~99~~	26	_	~~202~~	~~101~~	~~81~~	20
125	—	~~359~~	~~343~~	~~312~~	~~156~~	~~125~~	31	_	~~253~~	~~126~~	~~101~~	25
150	—	~~414~~	~~396~~	~~360~~	~~180~~	~~144~~	37	_	~~302~~	~~151~~	~~121~~	30
200	_	~~552~~	~~528~~	~~480~~	~~240~~	~~192~~	49	_	~~400~~	~~201~~	~~161~~	40

*For 90 and 80 percent power factor, the figures shall be multiplied by 1.1 and 1.25, respectively.

Part VII. Transformers

~~ARTICLE 450 Transformers and Transformer Vaults (Including Secondary Ties)~~
~~Part I. General Provisions~~

~~450.1~~495.100 ~~Scope~~General Provisions. This ~~article~~ Part~~section~~ covers the installation of all transformers over 1000 volts on either the Primary or Secondary. Part VII supplements or amends the other provisions of article 450.

Exception No. 1: Current transformers.

Exception No. 2: Dry-type transformers that constitute a component part of other apparatus and comply with the requirements for such apparatus.

Exception No. 3: Transformers that are an integral part of an X-ray, high-frequency, or electrostatic-coating apparatus.

~~*Exception No. 4: Transformers used with Class 2 and Class 3 circuits that comply with Article 725.*~~

Exception No. ~~4~~5: Transformers for sign and outline lighting that comply with Article 600.

Exception No. ~~5~~6: Transformers for electric-discharge lighting that comply with Article 410.

~~*Exception No. 7: Transformers used for power-limited fire alarm circuits that comply with Part III of Article 760.*~~

Exception No. ~~6~~8: Transformers used for research, development, or testing, where effective arrangements are provided to safeguard persons from contacting energized parts.

This article covers the installation of transformers dedicated to supplying power to a fire pump installation as modified by Article 695.

This article also covers the installation of transformers in hazardous (classified) locations as modified by Articles 501 through 504.

x~~450.2~~495.102 ~~Definition.~~ ~~The definitions in this section shall apply only within this article.~~

~~**Transformer.** An individual transformer, single- or polyphase, identified by a single nameplate, unless otherwise indicated in this article.~~

495.102 Exposed Energized Parts. Switches or other equipment operating at 1000 volts, nominal, or less and serving only equipment within a transformer enclosure shall be permitted to be installed in the transformer enclosure if accessible to qualified persons only. All energized parts shall be guarded in accordance with 110.27 and 110.34.

~~450.3~~495.103 Overcurrent Protection. Overcurrent protection of transformers shall comply with ~~, (B), or (C).~~495.103 As used in this section, the word *transformer* shall mean a transformer or polyphase bank of two or more single-phase transformers operating as a unit.

Informational Note No. 1: See 240.4, 240.21, 240.100, and 240.101 for overcurrent protection of conductors.

Informational Note No. 2: Nonlinear loads can increase heat in a transformer without operating its overcurrent protective device.

~~**450.3(A) Transformers Over 1000 Volts, Nominal.**~~
~~Overcurrent protection shall be provided in accordance with Table 450.3(A).~~

Table ~~450.3~~495.103 ~~(A)~~ Maximum Rating or Setting of Overcurrent Protection for Transformers Over 1000 Volts (as a Percentage of Transformer-Rated Current)

				Secondary Protection (See Note 2.)		
		Primary Protection over 1000 Volts		**Over 1000 Volts**		**1000 Volts or Less**
Location Limitations	**Transformer Rated Impedance**	**Circuit Breaker (See Note 4.)**	**Fuse Rating**	**Circuit Breaker (See Note 4.)**	**Fuse Rating**	**Circuit Breaker or Fuse Rating**
Any location	Not more than 6%	600% (See Note 1.)	300% (See Note 1.)	300% (See Note 1.)	250% (See Note 1.)	125% (See Note 1.)
	More than 6% and not more than 10%	400% (See Note 1.)	300% (See Note 1.)	250% (See Note 1.)	225% (See Note 1.)	125% (See Note 1.)
Supervised locations only (See Note 3.)	Any	300% (See Note 1.)	250% (See Note 1.)	Not required	Not required	Not required
	Not more than 6%	600%	300%	300% (See Note 5.)	250% (See Note 5.)	250% (See Note 5.)
	More than 6% and not more than 10%	400%	300%	250% (See Note 5.)	225% (See Note 5.)	250% (See Note 5.)

Notes:

1. Where the required fuse rating or circuit breaker setting does not correspond to a standard rating or setting, a higher rating or setting that does not exceed the following shall be permitted:

a. The next higher standard rating or setting for fuses and circuit breakers 1000 volts and below, or

b. The next higher commercially available rating or setting for fuses and circuit breakers above 1000 volts.

2. Where secondary overcurrent protection is required, the secondary overcurrent device shall be permitted to consist of not more than six circuit breakers or six sets of fuses grouped in one location. Where multiple overcurrent devices are utilized, the total of all the device ratings shall not exceed the allowed value of a single overcurrent device. If both circuit breakers and fuses are used as the overcurrent device, the total of the device ratings shall not exceed that allowed for fuses.

3. A supervised location is a location where conditions of maintenance and supervision ensure that only qualified persons monitor and service the transformer installation.

4. Electronically actuated fuses that may be set to open at a specific current shall be set in accordance with settings for circuit breakers.

5. A transformer equipped with a coordinated thermal overload protection by the manufacturer shall be permitted to have separate secondary protection omitted.

~~450.21~~495.104 Dry-Type Transformers Installed Indoors.

(A) Not Over 112⁄2 kVA. Dry-type transformers installed indoors and rated 112⁄2 kVA or less shall have a separation of at least 300 mm (12 in.) from combustible material unless separated from the combustible material by a fire-resistant, heat-insulated barrier.

(B) Over 112⁄2 kVA. Individual dry-type transformers of more than 112⁄2 kVA rating shall be installed in a transformer room of fire-resistant construction having a minimum fire rating of 1 hour.

Exception No. 1: Transformers with Class 155 or higher insulation systems and separated from combustible material by a fire-resistant, heat-insulating barrier or by not less than 1.83 m (6 ft) horizontally and 3.7 m (12 ft) vertically.

Exception No. 2: Transformers with Class 155 or higher insulation systems and completely enclosed except for ventilating openings.

Informational Note: See ASTM E119-18a, *Standard Test Methods for Fire Tests of Building Construction and Materials*.

(C) Over 35,000 Volts. Dry-type transformers rated over 35,000 volts shall be installed in a vault complying with ~~Part III~~the provisions of this article.

~~450.22~~495.105 Dry-Type Transformers Installed Outdoors. Dry-type transformers installed outdoors shall have a weatherproof enclosure.

Transformers exceeding 112⁄2 kVA shall not be located within 300 mm (12 in.) of combustible materials of buildings unless the transformer has Class 155 insulation systems or higher and is completely enclosed except for ventilating openings.

~~450.23~~495.106 Less-Flammable Liquid-Insulated Transformers. Transformers insulated with listed less-flammable liquids that have a fire point of not less than 300°C shall be permitted to be installed in accordance with 495.106~~450.23~~(A) or 495.106~~450.23~~(B).

~~450.23~~495.106(A) Indoor Installations. Indoor installations shall be permitted in accordance with one of the following:

(1) In Type I or Type II buildings, in areas where all of the following requirements are met:

a. The transformer is rated 35,000 volts or less.

b. No combustible materials are stored.

c. A liquid confinement area is provided.

d. The installation complies with all the restrictions provided for in the listing of the liquid.

Informational Note: Such restrictions can include, but are not limited to, maximum pressure of the tank, use of a pressure relief valve, appropriate fuse types, and proper sizing of overcurrent protection.

(2) If an automatic fire extinguishing system and a liquid confinement area is present, provided the transformer is rated 35,000 volts or less

(3) If the installation complies with 495.109 ~~450.26~~

(B) Outdoor Installations.
Less-flammable liquid-filled transformers shall be permitted to be installed outdoors, attached to, adjacent to, or on the roof of buildings, if installed in accordance with (1) or (2).

(1) For Type I and Type II buildings, the installation shall comply with all the restrictions provided for in the listing of the liquid.

Informational Note No. 1: Installations adjacent to combustible material, fire escapes, or door and window openings can require additional safeguards such as those listed in 495.110 ~~450.27~~.
Informational Note No. 2: Such restrictions can include, but are not limited to: maximum pressure of the tank, use of a pressure relief valve, appropriate fuse types, and proper sizing of overcurrent protection.

(2) In accordance with ~~450.27~~495.110.

Informational Note No. 1: As used in this section, *Type I and Type II buildings* refers to Type I and Type II building construction as defined in NFPA 220-2018, *Standard on Types of Building Construction*. *Combustible materials* refers to those materials not classified as noncombustible or limited-combustible as defined in NFPA 220-2018, *Standard on Types of Building Construction*.
Informational Note No. 2: See definition of *Listed* in Article 100.

~~450.24~~495.107 Nonflammable Fluid-Insulated Transformers. Transformers insulated with a dielectric fluid identified as nonflammable shall be permitted to be installed indoors or outdoors. Such transformers installed indoors and rated over 35,000 volts shall be installed in a vault. Such transformers installed indoors shall be furnished with a liquid confinement area and a pressure-relief vent. The transformers shall be furnished with a means for absorbing any gases generated by arcing inside the tank, or the pressure-relief vent shall be connected to a chimney or flue that will carry such gases to an environmentally safe area.

Informational Note: Safety may be increased if fire hazard analyses are performed for such transformer installations.

For the purposes of this section, a nonflammable dielectric fluid is one that does not have a flash point or fire point and is not flammable in air.

~~450.25~~495.108 Askarel-Insulated Transformers Installed Indoors. Askarel-insulated transformers installed indoors and rated over 25 kVA shall be furnished with a pressure-relief vent. Where installed in a poorly ventilated place, they shall be furnished with a means for absorbing any gases generated by arcing inside the case, or the pressure-relief vent shall be connected to a chimney or flue that carries such gases outside the building. Askarel-insulated transformers rated over 35,000 volts shall be installed in a vault.

495.109 Oil-Insulated Transformers Installed Indoors. Oil-insulated transformers installed indoors shall be installed in a vault constructed as specified in Part III of this article.

Exception No. 1: Where the total capacity does not exceed 112½ kVA, the vault specified in Part III of this article shall be permitted to be constructed of reinforced concrete that is not less than 100 mm (4 in.) thick.

Exception No. 2: Where the nominal voltage does not exceed 1000, a vault shall not be required if suitable arrangements are made to prevent a transformer oil fire from igniting other materials and the total capacity in one location does not exceed 10 kVA in a section of the building classified as combustible or 75 kVA where the surrounding structure is classified as fire-resistant construction.

Exception No. 3: Electric furnace transformers that have a total rating not exceeding 75 kVA shall be permitted to be installed without a vault in a building or room of fire-resistant construction, provided suitable arrangements are made to prevent a transformer oil fire from spreading to other combustible material.

Exception No. 4: A transformer that has a total rating not exceeding 75 kVA and a supply voltage of 1000 volts or less that is an integral part of charged-particle-accelerating equipment shall be permitted to be installed without a vault in a building or room of noncombustible or fire-resistant construction, provided suitable arrangements are made to prevent a transformer oil fire from spreading to other combustible material.

Exception No. 5: Transformers shall be permitted to be installed in a detached building that does not comply with Part III of this article if neither the building nor its contents present a fire hazard to any other building or property, and if the building is used only in supplying electric service and the interior is accessible only to qualified persons.

Exception No. 6: Oil-insulated transformers shall be permitted to be used without a vault in portable and mobile surface mining equipment (such as electric excavators) if each of the following conditions is met:

(1) Provision is made for draining leaking fluid to the ground.

(2) Safe egress is provided for personnel.

(3) A minimum 6-mm (¼-in.) steel barrier is provided for personnel protection.

495.110 Oil-Insulated Transformers Installed Outdoors.

Combustible material, combustible buildings, and parts of buildings, fire escapes, and door and window openings shall be safeguarded from fires originating in oil-insulated transformers installed on roofs, attached to or adjacent to a building or combustible material.

In cases where the transformer installation presents a fire hazard, one or more of the following safeguards shall be applied according to the degree of hazard involved:

(1) Space separations

(2) Fire-resistant barriers

(3) Automatic fire suppression systems

(4) Enclosures that confine the oil of a ruptured transformer tank

Oil enclosures shall be permitted to consist of fire-resistant dikes, curbed areas or basins, or trenches filled with coarse, crushed stone. Oil enclosures shall be provided with trapped drains where the exposure and the quantity of oil involved are such that removal of oil is important.

Informational Note: For additional information on transformers installed on poles or structures or under ground, see ANSI/IEEE C2-2017, *National Electrical Safety Code.*

495.111 Modification of Transformers.

When modifications are made to a transformer in an existing installation that change the type of the transformer with respect to Part VII of this article, such transformer shall be marked to show the type of insulating liquid installed, and the modified transformer installation shall comply with the applicable requirements for that type of transformer.

Part ~~III~~VIII. Transformer Vaults

~~450.41~~495.112 Location. Vaults shall be located where they can be ventilated to the outside air without using flues or ducts wherever such an arrangement is practicable.

495.113 Accessibility. All transformer vaults shall be readily accessible to qualified personnel for inspection and maintenance or shall meet the requirements of 450.13(A) or 450.13(B).

~~450.42~~495.11~~4~~3 Walls, Roofs, and Floors. The walls and roofs of vaults shall be constructed of materials that have approved structural strength for the conditions with a minimum fire resistance of 3 hours. The floors of vaults in contact with the earth shall be of concrete that is not less than 100 mm (4 in.) thick, but, where the vault is constructed with a vacant space or other stories below it, the floor shall have approved structural strength for the load imposed thereon and a minimum fire resistance of 3 hours. For the purposes of this section, studs and wallboard construction shall not be permitted.

Exception: Where transformers are protected with automatic sprinkler, water spray, carbon dioxide, or halon, construction of 1-hour rating shall be permitted.

Informational Note No. 1: For additional information, see ASTM E119-18a, *Methods for Fire Tests of Building Construction and Materials*.

Informational Note No. 2: A typical 3-hour construction is 150 mm (6 in.) thick reinforced concrete.

~~450.43~~495.11~~5~~4 Doorways. Vault doorways shall be protected in accordance with 495.11~~5~~4~~450.43~~(A), (B), and (C).

(A) Type of Door. Each doorway leading into a vault from the building interior shall be provided with a tight-fitting door that has a minimum fire rating of 3 hours. The authority having jurisdiction shall be permitted to require such a door for an exterior wall opening where conditions warrant.

Exception: Where transformers are protected with automatic sprinkler, water spray, carbon dioxide, or halon, construction of 1-hour rating shall be permitted.

Informational Note: For additional information, see NFPA 80-2016, *Standard for Fire Doors and Other Opening Protectives*.

(B) Sills. A door sill or curb that is of an approved height that will confine the oil from the largest transformer within the vault shall be provided, and in no case shall the height be less than 100 mm (4 in.).

(C) Locks. Doors shall be equipped with locks, and doors shall be kept locked, with access being allowed only to qualified persons. Personnel doors shall open in the direction of egress and be equipped with listed fire exit hardware.

~~450.45~~495.11~~6~~5 Ventilation Openings. Where required by 450.9, openings for ventilation shall be provided in accordance with 495.11~~6~~5~~450.45~~(A) through (F).

(A) Location. Ventilation openings shall be located as far as possible from doors, windows, fire escapes, and combustible material.

(B) Arrangement. A vault ventilated by natural circulation of air shall be permitted to have roughly half of the total area of openings required for ventilation in one or more openings near the floor and the remainder in one or more openings in the roof or in the sidewalls near the roof, or all of the area required for ventilation shall be permitted in one or more openings in or near the roof.

(C) Size. For a vault ventilated by natural circulation of air to an outdoor area, the combined net area of all ventilating openings, after deducting the area occupied by screens, gratings, or louvers, shall not be less than 1900 mm^2 (3 $in.^2$) per kVA of transformer capacity in service, and in no case shall the net area be less than 0.1 m^2 (1 ft^2) for any capacity under 50 kVA.

(D) Covering. Ventilation openings shall be covered with durable gratings, screens, or louvers, according to the treatment required in order to avoid unsafe conditions.

(E) Dampers. All ventilation openings to the indoors shall be provided with automatic closing fire dampers that operate in response to a vault fire. Such dampers shall possess a standard fire rating of not less than 1½ hours.
Informational Note: See ANSI/UL 555-2016, *Standard for Fire Dampers*.

(F) Ducts. Ventilating ducts shall be constructed of fire-resistant material.

495.117~~6~~ ~~450.46~~ Drainage. Where practicable, vaults containing more than 100 kVA transformer capacity shall be provided with a drain or other means that will carry off any accumulation of oil or water in the vault unless local conditions make this impracticable. The floor shall be pitched to the drain where provided.

495.118~~7~~ ~~450.47~~ Water Pipes and Accessories. Any pipe or duct system foreign to the electrical installation shall not enter or pass through a transformer vault. Piping or other facilities provided for vault fire protection, or for transformer cooling, shall not be considered foreign to the electrical installation.

495.119~~8~~ ~~450.48~~ Storage in Vaults. Materials shall not be stored in transformer vaults.

Part IX. Capacitors

495.120~~119~~ Enclosing and Guarding.

(A) Containing More Than 11 L (3 gal) of Flammable Liquid. Capacitors containing more than 11 L (3 gal) of flammable liquid shall be enclosed in vaults or outdoor fenced enclosures complying with Article 110, Part III. This limit shall apply to any single unit in an installation of capacitors.

(B) Accidental Contact. Where capacitors are accessible to unauthorized and unqualified persons, they shall be enclosed, located, or guarded so that persons cannot come into accidental contact or bring conducting materials into accidental contact with exposed energized parts, terminals, or buses associated with them. However, no additional guarding is required for enclosures accessible only to authorized and qualified persons

495.121~~0~~ Not Covered.
Surge capacitors or capacitors included as a component part of other apparatus and conforming with the requirements of such apparatus are excluded from these requirements.

This Part also covers the installation of capacitors in hazardous (classified) locations as modified by Articles 501 through 503.

495.122~~1~~ Switching.

(A) Load Current. Group-operated switches shall be used for capacitor switching and shall be capable of the following:

(1) Carrying continuously not less than 135 percent of the rated current of the capacitor installation

(2) Interrupting the maximum continuous load current of each capacitor, capacitor bank, or capacitor installation that will be switched as a unit

(3) Withstanding the maximum inrush current, including contributions from adjacent capacitor installations

(4) Carrying currents due to faults on capacitor side of switch

(B) Isolation.

(1) General. A means shall be installed to isolate from all sources of voltage each capacitor, capacitor bank, or capacitor installation that will be removed from service as a unit. The isolating means shall provide a visible gap in the electrical circuit adequate for the operating voltage.

(2) Isolating or Disconnecting Switches with No Interrupting Rating. Isolating or disconnecting switches (with no interrupting rating) shall be interlocked with the load-interrupting device or shall be provided with prominently displayed caution signs in accordance with 495~~0~~.22 to prevent switching load current.

(C) Additional Requirements for Series Capacitors. The proper switching sequence shall be ensured by use of one of the following:

(1) Mechanically sequenced isolating and bypass switches

(2) Interlocks

(3) Switching procedure prominently displayed at the switching location

495.123~~2~~ Overcurrent Protection.

(A) Provided to Detect and Interrupt Fault Current. A means shall be provided to detect and interrupt fault current likely to cause dangerous pressure within an individual capacitor.

(B) Single Pole or Multipole Devices. Single-pole or multipole devices shall be permitted for this purpose.

(C) Protected Individually or in Groups. Capacitors shall be permitted to be protected individually or in groups.

(D) Protective Devices Rated or Adjusted. Protective devices for capacitors or capacitor equipment shall be rated or adjusted to operate within the limits of the safe zone for individual capacitors.

495.124~~3~~ ~~460.26~~ Identification. Each capacitor shall be provided with a permanent nameplate giving the manufacturer's name, rated voltage, frequency, kilovar or amperes, number of phases, and the volume of liquid identified as flammable, if such is the case.

495.125~~4~~ ~~460.27~~ Grounding. Capacitor cases shall be connected to the equipment grounding conductor. If the capacitor neutral point is connected to a grounding electrode conductor, the connection shall be made in accordance with Part III of Article 250.

Exception: Capacitor cases shall not be connected to the equipment grounding conductor where the capacitor units are supported on a structure designed to operate at other than ground potential.

495.126~~5~~ ~~460.28~~ Means for Discharge.

(A) Means to Reduce the Residual Voltage. A means shall be provided to reduce the residual voltage of a capacitor to 50 volts or less within 5 minutes after the capacitor is disconnected from the source of supply.

(B) Connection to Terminals. A discharge circuit shall be either permanently connected to the terminals of the capacitor or provided with automatic means of connecting it to the terminals of the capacitor bank after disconnection of the capacitor from the source of supply. The windings of motors, transformers, or other equipment directly connected to capacitors without a switch or overcurrent device interposed shall meet the requirements of 495.126~~60.28~~(A).

Part X. Resistors and Reactors

~~470.18~~495.130 General.

(A) Protected Against Physical Damage.

Resistors and reactors shall be protected against physical damage.

(B) Isolated by Enclosure or Elevation. Resistors and reactors shall be isolated by enclosure or elevation to protect personnel from accidental contact with energized parts.

(C) Combustible Materials. Resistors and reactors shall not be installed in close enough proximity to combustible materials to constitute a fire hazard and shall have a clearance of not less than 305 mm (12 in.) from combustible materials.

(D) Clearances. Clearances from resistors and reactors to grounded surfaces shall be adequate for the voltage involved.

(E) Temperature Rise from Induced Circulating Currents. Metallic enclosures of reactors and adjacent metal parts shall be installed so that the temperature rise from induced circulating currents is not hazardous to personnel or does not constitute a fire hazard.

495.131 ~~470.19~~ Grounding. Resistor and reactor cases or enclosures shall be connected to the equipment grounding conductor.

Exception: Resistor or reactor cases or enclosures supported on a structure designed to operate at other than ground potential shall not be connected to the equipment grounding conductor.

495.132 ~~470.20~~ Oil-Filled Reactors. Installation of oil-filled reactors, in addition to the above requirements, shall comply with applicable requirements of Article 495, Part VII~~450~~.

Public Input No. 2121-NFPA 70-2020 [Definition: Controller.]

Controller, Motor .

~~Any switch~~ A switch or other device(s) that is normally used to control the speed, or start and stop a motor by ~~making and breaking~~ opening and closing the motor branch circuit. Motor controllers are part of the motor ~~circuit current.~~ branch circuit and may include a motor overload protection device.

Informational Note No. 1: See definition of Motor Branch Circuit in Article 100.

Informational Note. No. 2: Motor controllers may be a separately derived system, such as an adjustable speed drive with integral overcurrent and overload protection.

Statement of Problem and Substantiation for Public Input

During the 2020 cycle, it was brought to light that the motor branch circuit includes the controller, even in cases where the controller is an adjustable speed drive.

The addition of the term "Motor" to "Controller" will differentiate the term "Controller" in Art. 100.

This is a companion proposal to a proposed new definition for a "motor branch circuit" in Art. 100.

Related Public Inputs for This Document

Related Input	Relationship
Public Input No. 2120-NFPA 70-2020 [Article 100]	Motor Branch Circuit

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