ECET 4520

Industrial Distribution Systems, Illumination, and the NEC

NEC Design Requirements

(Part I)

NEC Design Requirements

Article 110

Requirements for Electrical Installations

<u>110.1 – Scope</u>

This article covers general requirements for the examination and approval, installation and use, access to and spaces about electrical conductors and equipment; enclosures intended for personnel entry; and tunnel installations.

Interrupting Rating

110.9 – Interrupting Rating

Equipment intended to interrupt current at fault levels shall have an interrupting rating sufficient for the nominal circuit voltage and the current that is available at the line terminals of the equipment.

Equipment intended to interrupt current at other than fault levels shall have an interrupting rating at nominal circuit voltage sufficient for the current that must be interrupted.

Interrupting Rating

110.9 – Interrupting Rating (Discussion)

The text:

> **"*…and the current that is available at the line terminals of the equipment…*"**

refers to the maximum current available, which will occur under short-circuit conditions.

Therefore, to adhere to this requirement, a complete short-circuit current analysis must be performed on the proposed system.

Short-Circuit Current Rating

110.10 – Circuit Impedance & Other Characteristics

The overcurrent protective devices, the total impedance, the component short-circuit current ratings, and other characteristics of the circuit to be protected shall be selected and coordinated to permit the circuit-protective devices used to clear a fault to do so without extensive damage to the electrical components of the circuit.

This fault shall be assumed to be either between two or more of the circuit conductors or between any circuit conductor and the grounding conductor or enclosing metal raceway.

Short-Circuit Current Rating

110.10 – Circuit Impedance (Discussion)

The text:

> **"*…to permit the circuit-protective devices used to clear a fault to do so without extensive damage to the electrical components of the circuit.*"**

refers to the short-circuit current rating of those components.

Short-Circuit Current Rating

<u>110.10 – Circuit Impedance</u> (Discussion)

If the available short-circuit current is larger than the rating of the circuit components, those components could sustain damage before the protective device is able to clear the fault.

In such cases, the chosen protective device must have the ability to limit the let-through fault current in addition to interrupting the fault current.

Ampacity/Temperature Concerns

<u>110.14(C) – Temperature Limitations</u>

The temperature rating associated with the ampacity of a conductor shall be selected and coordinated so as not to exceed the lowest temperature rating of any connected termination, conductor, or device.

Conductors with temperature ratings higher than specified for terminations shall be permitted to be used for ampacity adjustment, correction, or both.

Ampacity/Temperature Concerns

110.14(C)(1) – Equipment Provisions

The determination of termination provisions of equipment shall be based on 110.14(C)(1)(a) or (C)(1)(b). Unless the equipment is listed and marked otherwise, conductor ampacity used in determining equipment termination provisions shall be based on Table 310.15(B)(16) as appropriately modified by 310.l5(B)(7).

Ampacity/Temperature Concerns

110.14(C)(1)(a) – Equipment Provisions

Termination provisions of equipment for circuits rated ≤ 100 amps, or marked for 14 AWG through 1 AWG conductors, shall be used only for one of the following:

(1) Conductors rated 60°C (140°F).

(2) Conductors with higher temperature ratings, provided the ampacity of such conductors is determined based on the 60°C (140°F) ampacity of the conductor size used.

(3) Conductors with higher temperature ratings if the equipment is listed and identified for use with such.

Ampacity/Temperature Concerns

110.14(C)(1)(a) – Equipment Provisions (cont)

Termination provisions of equipment for circuits rated ≤ 100 amps, or marked for 14 AWG through 1 AWG conductors, shall be used only for one of the following:

(4) For motors marked with design letters B, C, or D, conductors having an insulation rating of 75°C (167°F) or higher, provided the ampacity of such conductors does not exceed the 75°C (167°F) ampacity.

Ampacity/Temperature Concerns

110.14(C)(1)(b) – Equipment Provisions

Termination provisions of equipment for circuits rated > 100 amps, or marked for conductors larger than 1 AWG, shall be used only for one of the following:

(1) Conductors rated 75°C (167°F)

(2) Conductors with higher temperature ratings, provided the ampacity of such conductors does not exceed the 75°C (167°F) ampacity of the conductor size used, or up to their ampacity if the equipment is listed and identified for use with such conductors.

NEC Design Requirements

Article 310
Conductors for General Wiring

310.1 – Scope

This article covers general requirements for conductors and their type designations, insulations, …, ampacity ratings, and uses.

This article does not apply to conductors that form an integral part of equipment, or to conductors specifically provided for elsewhere in this Code.

Ampacity/Temperature Concerns

310.15(A)(2) – Selection of Ampacity

Where more than one ampacity applies for a given circuit length, the lowest value shall be used.

Exception: Where two different ampacities apply to adjacent portions of a circuit, the higher ampacity shall be permitted to be used beyond the point of transition, a distance equal to 3.0 m (10 ft) or 10 percent of the circuit length figured at the higher ampacity, whichever is less.

(For example – what if a circuit having an ambient temperature of 30°C passes by a furnace near which the ambient temperature is 50°C…?)

Ampacity/Temperature Concerns

310.15(A)(3) – Temperature Limitation of Conductors

No conductor shall be used in such a manner that its operating temperature exceeds that designated for the type of insulated conductor involved…

Ampacity/Temperature Concerns

310.15(A)(3) – Temperature Limitation of Conductors

Informational Note No. 1: The temperature rating of a conductor is the maximum temperature, at any location along its length, that the conductor can withstand over a prolonged time period without serious degradation.

The allowable ampacity tables, the ampacity tables of Article 310… the ambient temperature correction factors in 310.15(B)(2), and the notes to the tables provide guidance for coordinating conductor sizes, types, allowable ampacities, ampacities, ambient temperatures, and number of associated conductors.

Ampacity/Temperature Concerns

310.15(A)(3) – Temperature Limitation of Conductors

Informational Note No. 1 (cont): The principal determinants of operating temperature are as follows:

(1) Ambient temperature - ambient temperature may vary along the conductor length and/or with time.

(2) Heat generated internally in the conductor resulting from (fundamental & harmonic) load current flow.

(3) The rate at which generated heat dissipates into the ambient medium. Thermal insulation that covers or surrounds conductors affects the rate of dissipation.

(4) Adjacent load-carrying conductors have the effect of raising ambient temperature / impeding dissipation.

Ampacity/Temperature Concerns

310.15(A)(3) – Temperature Limitation (Discussion)

Since:

"*No conductor shall be used in such a manner that its operating temperature exceeds that designated...*"

the de-rating of ampacities when conductors are exposed to high ambient temperatures or are in close proximity to other current-carrying conductors becomes a necessity.

Ampacity/Temperature Concerns

310.15(B) – Tables

Ampacities for conductors rated 0 to 2000 volts shall be as specified in the Allowable Ampacity Table 310.15(B)(16) through Table 310.15(B)(19) … as modified by 310.15(B)(1) through 310.15(B)(7).

Informational Notes:

Table 310.15(B)(16) is for Ampacities of Insulated Conductors rated 0-2000V, 60°C-90°C, ≤ 3 Current-Carrying Conductors in Raceway, with an Ambient Temp of 30°C.

Tables 310.15(B)(17-19) are for other locations and/or temperatures.

Ampacity Table 310.15(B)(16)

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

	Temperature Rating of Conductor [See Table 310.104(A).]						
	60°C (140°F)	75°C (167°F)	90°C (194°F)	60°C (140°F)	75°C (167°F)	90°C (194°F)	
Size AWG or kcmil	Types TW, UF	Types RHW, THHW, THW, THWN, XHHW, USE, ZW	Types TBS, SA, RHH, RHW-2, THHN, THHW, USE-2, XHH, XHHW-2, ZW-2	Types TW, UF	Types RHW, THHW, THW, THWN, XHHW, USE	Types TBS, SA, RHH, RHW-2, THHN, THHW, USE-2, XHH, XHHW-2, ZW-2	Size AWG or kcmil
	COPPER			ALUMINUM			
14**	15	20	25	—	—	—	—
12**	20	25	30	15	20	25	12**
10**	30	35	40	25	30	35	10**
8	40	50	55	35	40	45	8
6	55	65	75	40	50	55	6
4	70	85	95	55	65	75	4
3	85	100	115	65	75	85	3
2	95	115	130	75	90	100	2
1	110	130	145	85	100	115	1
1/0	125	150	170	100	120	135	1/0
2/0	145	175	195	115	135	150	2/0
3/0	165	200	225	130	155	175	3/0
4/0	195	230	260	150	180	205	4/0
250	215	255	290	170	205	230	250
300	240	285	320	195	230	260	300
350	260	310	350	210	250	280	350
400	280	335	380	225	270	305	400
500	320	380	430	260	310	350	500
600	350	420	475	285	340	385	600
700	385	460	520	315	375	425	700
750	400	475	535	320	385	435	750
800	410	490	555	330	395	445	800
900	435	520	585	355	425	480	900
1000	455	545	615	375	445	500	1000
1250	495	590	665	405	485	545	1250
1500	525	625	705	435	520	585	1500
1750	545	650	735	455	545	615	1750
2000	555	665	750	470	560	630	2000

*Refer to 310.15(B)(2) for the ampacity correction factors where the ambient temperature is other than 30°C (86°F).
**Refer to 240.4(D) for conductor overcurrent protection limitations.

NEC Ampacity Table for ≤ 3 Current-Carrying Conductors in a Raceway, 30°C Ambient Temp

Ampacity/Temperature Concerns

310.15(B) – Tables

Informational Note: **Tables 310.15(B)(16) – 310.15(B)(19) are application tables for use in determining conductor sizes for loads calculated in accordance with Article 220 (*Branch-Circuit, Feeder, and Service Calculations*). Allowable ampacities result from consideration of one or more of the following:**

(1) Temperature compatibility with connected equipment, especially the connection points.

(2) Coordination with circuit/system overcurrent protection.

(3) Compliance with the requirements of product listings or certifications. See 110.3(B).

(4) Preservation of the safety benefits of established industry practices and standardized procedures.

Ampacity/Temperature Concerns

310.15(B)(1) – General

For explanation of type letters used in tables and for recognized sizes of conductors for various conductor insulations, see Tables 310.104(A) and (B)…

Table 310.104(A) ***(partial)***

Trade Name	Type Letter	Maximum Operating Temperature	Application Provisions	Insulation	Thickness of Insulation			Outer Covering[1]
					AWG or kcmil	mm	mils	
Extended polytetra-fluoro-ethylene	TFE	250°C 482°F	Dry locations only. Only for leads within apparatus or within raceways connected to apparatus, or as open wiring (nickel or nickel-coated copper only)	Extruded polytetra-fluoro-ethylene	14–10 8–2 1–40	0.51 0.76 1.14	20 30 45	None
Heat-resistant thermoplastic	THHN	90°C 194°F	Dry and damp locations	Flame-retardant, heat-resistant thermoplastic	14–12 10 8–6 4–2 1–40 250–500 501–1000	0.38 0.51 0.76 1.02 1.27 1.52 1.78	15 20 30 40 50 60 70	Nylon jacket or equivalent
Moisture- and heat-resistant thermoplastic	THHW	75°C 167°F 90°C 194°F	Wet location Dry location	Flame-retardant, moisture- and heat-resistant thermoplastic	14–10 8 6–2 1–40 213–500 501–1000	0.76 1.14 1.52 2.03 2.41 2.79	30 45 60 80 95 110	None

Ampacity/Temperature Concerns

310.15(B)(2) – Ambient Temperature Correction Factors

Ampacities for ambient temperatures other than those shown in the ampacity tables shall be corrected in accordance with Table 310.15(B)(2)(a) or Table 310.15(B)(2)(b)…

Table 310.15(B)(2)(a) Ambient Temperature Correction Factors Based on 30°C (86°F)

For ambient temperatures other than 30°C (86°F), multiply the allowable ampacities specified in the ampacity tables by the appropriate correction factor shown below.

Ambient Temperature (°C)	Temperature Rating of Conductor			Ambient Temperature (°F)
	60°C	75°C	90°C	
10 or less	1.29	1.20	1.15	50 or less
11–15	1.22	1.15	1.12	51–59
16–20	1.15	1.11	1.08	60–68
21–25	1.08	1.05	1.04	69–77
26–30	1.00	1.00	1.00	78–86
31–35	0.91	0.94	0.96	87–95
36–40	0.82	0.88	0.91	96–104
41–45	0.71	0.82	0.87	105–113
46–50	0.58	0.75	0.82	114–122
51–55	0.41	0.67	0.76	123–131
56–60	—	0.58	0.71	132–140

Ampacity/Temperature Concerns

310.15(B)(2) – Ambient Temperature Correction Factors

Ampacities for ambient temperatures other than those shown in the ampacity tables shall be corrected in accordance with Table 310.15(B)(2)(a) or Table 310.15(B)(2)(b)… or shall be permitted to be calculated using the following equation:

$$I' = I \cdot \sqrt{\frac{T_c - T_a'}{T_c - T_a}}$$

where:
- I' is the ampacity corrected for ambient temperature
- I is the ampacity shown in the tables
- T_c is the temperature rating of the conductor (°C)
- T_a' is the new ambient temperature (°C)
- T_a is the ambient temperature used in the table (°C)

Ampacity/Temperature Concerns

310.15(B)(3) – Adjustment Factors

Where the number of current-carrying conductors in a raceway or cable exceeds three, …, the allowable ampacity of each conductor shall be reduced as shown in Table 310.15(B)(3)(a).

Table 310.15(B)(3)(a) Adjustment Factors for More Than Three Current-Carrying Conductors

Number of Conductors[1]	Percent of Values in Table 310.15(B)(16) through Table 310.15(B)(19) as Adjusted for Ambient Temperature if Necessary
4–6	80
7–9	70
10–20	50
21–30	45
31–40	40
41 and above	35

NEC Design Requirements

Article 210

Branch Circuits

210.1 – Scope

This article covers branch circuits except for those that supply only motor loads, which are covered in Article 430. Provisions of this article and Article 430 apply to branch circuits with combination loads.

Branch Circuits

210.2 – Other Articles for Specific-Purpose Branch Circuits

Branch circuits shall comply with this article and also with the applicable provisions of other articles of this *Code*. The provisions for branch circuits supplying equipment listed in Table 210.2 amend or supplement the provisions in this article.

Table 210.2 Specific-Purpose Branch Circuits

Equipment	Article	Section
Air-conditioning and refrigerating equipment		440.6, 440.31, 440.32
Audio signal processing, amplification, and reproduction equipment		640.8
Busways		368.17
Circuits and equipment operating at less than 50 volts	720	
...		
Recreational vehicles and recreational vehicle parks	551	
Switchboards and panelboards		408.52
Theaters, audience areas of motion picture and television studios, and similar locations		520.41, 520.52, 520.62
X-ray equipment		660.2, 517.73

Branch Circuits

210.3 – Rating

Branch circuits recognized by this article shall be rated in accordance with the maximum permitted ampere rating or setting of the overcurrent device.

The ratings for "other than individual" branch circuits shall be 15, 20, 30, 40, and 50 amperes.

Where conductors of higher ampacity are used for any reason, the ampere rating or setting of the specified overcurrent device shall determine the circuit rating.

Branch Circuits

210.4(A) – Multiwire Branch Circuits – General

Branch circuits recognized by this article shall be permitted as multiwire circuits. A multiwire circuit shall be permitted to be considered as multiple circuits.

All conductors shall originate from the same panelboard or similar distribution equipment.

Branch Circuits

100 – 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.

Branch Circuits

210.4(B) – Disconnecting Means

Each multiwire branch circuit shall be provided with a means that will simultaneously disconnect all ungrounded conductors at the point where the branch circuit originates.

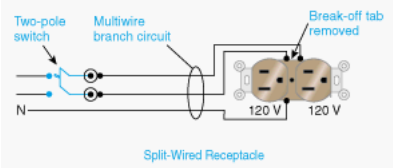

Figure showing the overcurrent protection required for a split-wired receptacle that is supplied by two single-phase branch circuits that were derived from a single multiwire branch circuit.

Borrowed from The National Electric Code Handbook, 10th Ed. © NFPA

Branch Circuits

210.4(C) – Line-to-Neutral Loads

Multiwire branch circuits shall supply only line-to-neutral loads.

Exception No. 1: A multiwire branch circuit that supplies only one utilization equipment.

Exception No. 2: Where all ungrounded conductors of the multiwire branch circuit are opened simultaneously by the branch-circuit overcurrent device.

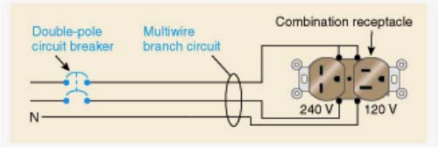

Figure showing multiwire branch circuit supplying both line-neutral and line-line loads.

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Branch Circuits

210.19(A)(1) – Conductors – Min Ampacity & Size

Branch-circuit conductors shall have an ampacity not less than the maximum load to be served. Conductors shall be sized to carry not less than the larger of 210.19(A)(1)(a) or (b).

(a) Where a branch circuit supplies continuous loads or any combination of continuous and non-continuous loads, the minimum branch-circuit conductor size shall have an allowable ampacity not less than (100% of) the non-continuous load plus 125% of the continuous load.

Branch Circuits

210.19(A)(1) – Conductors – Min Ampacity & Size

Branch-circuit conductors shall have an ampacity not less than the maximum load to be served. Conductors shall be sized to carry not less than the larger of 210.19(A)(1)(a) or (b).

(b) The minimum branch-circuit conductor size shall have an allowable ampacity not less than the maximum load to be served after the application of any adjustment or correction factors.

Branch Circuits

210.20 – Overcurrent Protection

Branch-circuit conductors and equipment shall be protected by overcurrent protective devices that have a rating or setting that complies with 210.20(A) through (D).

Branch Circuits

210.20(A) – Continuous & Non-continuous Loads

Where a branch circuit supplies … any combination of both continuous and non-continuous loads, the rating of the overcurrent device shall not be less than 100% of the non-continuous load plus 125% of the continuous load.

***Exception:** Where the assembly, including the overcurrent devices protecting the branch circuit, is listed for operation at 100 percent of its rating, the amp rating of the overcurrent device shall be permitted to be not less than the sum of the continuous and non-continuous loads.*

Branch Circuits

210.20(C) – Equipment

The rating or setting of the overcurrent protective device shall not exceed that specified in the articles referenced in Table 240.3 for equipment.

Table 240.3 Other Articles

Equipment	Article
Air-conditioning and refrigerating equipment	440
Appliances	422
Assembly occupancies	518
Audio signal processing, amplification, and reproduction equipment	640
Branch circuits	210
...	
Receptacles	406
Services	230
Solar photovoltaic systems	690
Switchboards and panelboards	408
Theaters, audience areas of motion picture and television studios, and similar locations	520
Transformers and transformer vaults	450
X-ray equipment	660

Branch Circuits

210.23 – Permissible Loads

In no case shall the load exceed the branch-circuit amp rating.

A branch circuit supplying two or more outlets or receptacles shall supply only the loads specified according to its size as specified in 210.23(A) through (D) and as summarized in 210.24 and Table 210.24.

Branch Circuits

210.23(A) – 15A & 20A Branch Circuits

A 15 or 20 ampere branch circuit shall be permitted to supply lighting units, other utilization equipment, or a combination of both, and shall comply with 210.23(A)(1) and (A)(2).

Exception: The small appliance, laundry, and bathroom branch circuits required in a dwelling unit by 210.11(C)(1), (C)(2), and (C)(3) shall supply only the receptacle outlets specified in that section.

Branch Circuits

210.23(A)(1) – Cord-and-Plug Equipment Not Fastened…

The rating of any one cord-and-plug-connected utilization equipment not fastened in place shall not exceed 80% of the branch-circuit ampere rating.

210.23(A)(2) – Utilization Equipment Fastened in Place

The total rating of utilization equipment fastened in place, other than luminaires (lighting fixtures), shall not exceed 50% of the branch-circuit ampere rating where lighting units, cord-and-plug-connected utilization equipment not fastened in place, or both, are also supplied.

Branch Circuits

210.23(B) – 30A Branch Circuits

A 30-ampere branch circuit shall be permitted to supply fixed lighting units with heavy-duty lamp-holders in other than a dwelling unit or utilization equipment in any occupancy.

A rating of any one cord-and-plug-connected utilization equipment shall not exceed 80% of the branch-circuit ampere rating.

Branch Circuits

210.23(C) – 40A & 50A Branch Circuits

A 40 or 50 ampere branch circuit shall be permitted to supply cooking appliances that are fastened in place in any occupancy.

In other than dwelling units, such circuits shall be permitted to supply fixed lighting units with heavy-duty lamp-holders, infrared heating units, or other utilization equipment.

210.23(D) – Branch Circuits Larger than 50A

Branch circuits larger than 50 amperes shall supply only non-lighting outlet loads.

Summary of Branch Circuit Requirements

210.24 – Branch-Circuit Requirements – Summary

Table 210.24 Summary of Branch-Circuit Requirements

Circuit Rating	15 A	20 A	30 A	40 A	50 A
Conductors (min. size):					
Circuit wires[1]	14	12	10	8	6
Taps	14	14	14	12	12
Fixture wires and cords — see 240.5					
Overcurrent Protection	**15 A**	**20 A**	**30 A**	**40 A**	**50 A**
Outlet devices:					
Lampholders permitted	Any type	Any type	Heavy duty	Heavy duty	Heavy duty
Receptacle rating[2]	15 max. A	15 or 20 A	30 A	40 or 50 A	50 A
Maximum Load	**15 A**	**20 A**	**30 A**	**40 A**	**50 A**
Permissible load	See 210.23(A)	See 210.23(A)	See 210.23(B)	See 210.23(C)	See 210.23(C)

[1]These gauges are for copper conductors.
[2]For receptacle rating of cord-connected electric-discharge luminaires (lighting fixtures), see 410.30(C).

NEC Design Requirements

Article 215

Feeders

215.1 – Scope

This article covers the installation requirements, overcurrent protection requirements, minimum size, and ampacity of conductors for feeders supplying branch-circuit loads.

Feeders

215.2(A)(1) – Min Rating & Size ≤ 600V – General

Feeder conductors shall have an ampacity not less than required to supply the load as calculated in Parts III, IV, and V of Article 220.

The minimum feeder-circuit conductor size, before the application of any adjustment or correction factors, shall have an allowable ampacity not less than (100% of) the non-continuous load plus 125% of the continuous load.

Feeders

215.2(A)(1) – Min Rating & Size ≤ 600V – General

Exception: Where the assembly, including the overcurrent devices protecting the feeder, is listed for operation at 100% of its rating, the allowable ampacity of the feeder conductors shall be permitted to be not less than the sum of the continuous load and the non-continuous load.

Feeders

215.3 – Overcurrent Protection

Feeders shall be protected against overcurrent in accordance with the provisions of Part I of Article 240.

Where a feeder supplies continuous loads or any combination of continuous and non-continuous loads, the rating of the overcurrent device shall not be less than (100% of) the non-continuous load plus 125% of the continuous load.

Feeders

215.3 – Overcurrent Protection

Exception No. 1: Where the assembly, including the overcurrent devices protecting the feeder, is listed for operation at 100% of its rating, the ampere rating of the overcurrent device shall be permitted to be not less than the sum of the continuous load and the non-continuous load.

NEC Design Requirements

Article 240
Overcurrent Protection

240.1 – Scope

Parts I through VII of this article provide the general requirements for overcurrent protection and overcurrent protective devices not more than 600 volts, nominal...

Overcurrent Protection

240.4 – Protection of Conductors

Conductors, other than flexible cords, flexible cables, and fixture wires, shall be protected against overcurrent in accordance with their ampacities specified in 310.15, unless otherwise permitted or required in 240.4(A) through (G).

240.4(A) – Power Loss Hazard

Conductor overload protection shall not be required where the interruption of the circuit would create a hazard, such as in a material-handling magnet circuit or fire pump circuit. Short-circuit protection shall be provided.

Overcurrent Protection

240.4(B) – Devices Rated 800A and Less

The next higher standard overcurrent device rating (above the ampacity of the conductors being protected) shall be permitted, provided all of the following conditions are met:

(1) The conductors being protected are not part of a multi-outlet branch circuit supplying receptacles for cord-and-plug-connected portable loads.

Overcurrent Protection

240.4(B) – Devices Rated 800A and Less

The next higher standard overcurrent device rating (above the ampacity of the conductors being protected) shall be permitted, provided all of the following conditions are met:

(2) The ampacity of the conductors does not correspond with the standard ampere rating of a fuse or a circuit breaker without overload trip adjustments above its rating.

(3) The next higher standard rating selected does not exceed 800 amperes.

Overcurrent Protection

240.4(C) – Devices Rated Over 800A

Where the overcurrent device is rated over 800A, the ampacity of the conductors it protects shall be greater than or equal to the rating of the overcurrent device defined in 240.6.

Overcurrent Protection

240.4(G) – Specific Conductor Applications

Overcurrent protection for the specific conductors shall be permitted to be provided as referenced in Table 240.4(G).

Table 240.4(G) Specific Conductor Applications

Conductor	Article	Section
Air-conditioning and refrigeration equipment circuit conductors	440, Parts III, VI	
Capacitor circuit conductors	460	460.8(B) and 460.25(A)–(D)
Control and instrumentation circuit conductors (Type ITC)	727	727.9
Electric welder circuit conductors	630	630.12 and 630.32
...		

Overcurrent Protection

240.6(A) – Standard Amp Ratings – Fuses and CBs

The standard ampere ratings for fuses and inverse-time circuit breakers shall be considered:

15, 20, 25, 30, 35, 40, 45, 50, 60, 70, 80, 90, 100, 110, 125, 150, 175, 200, 225, 250, 300, 350, 400, 450, 500, 600, 700, 800, 1000, 1200, 1600, 2000, 2500, 3000, 4000, 5000, and 6000 amperes.

Overcurrent Protection

240.6(A) – Standard Amp Ratings – Fuses and CBs

Additional standard ampere ratings for fuses:

1, 3, 6, 10, and 601.

The use of fuses and inverse time circuit breakers with nonstandard ampere ratings shall be permitted.

Overcurrent Protection

240.8 – Fuses or Circuit Breakers in Parallel

Fuses and circuit breakers shall be permitted to be connected in parallel where they are factory assembled in parallel and listed as a unit.

Individual fuses, circuit breakers, or combinations thereof shall not otherwise be connected in parallel.

Overcurrent Protection

240.9 – Thermal Devices

Thermal relays and other devices *not designed to open short circuits or ground faults* shall not be used for the protection of conductors against overcurrent due to short circuits or ground faults, but the use of such devices shall be permitted to protect motor branch-circuit conductors from overload if protected in accordance with 430.40.

Overcurrent Protection

240.10 – Supplementary Overcurrent Protection

Where supplementary overcurrent protection is used for luminaires (lighting fixtures), appliances, and other equipment or for internal circuits and components of equipment, it shall not be used as a substitute for required branch-circuit overcurrent devices or in place of the required branch-circuit protection.

Supplementary overcurrent devices shall not be required to be readily accessible.

Overcurrent Protection

240.15(A) – Ungrounded Conductor – Req'd OCP

A fuse or an overcurrent trip unit of a circuit breaker shall be connected in series with each ungrounded conductor.

A combination of a current transformer and an overcurrent relay shall be considered equivalent to an overcurrent trip unit.

Overcurrent Protection

240.15(B) – Circuit Breaker as Overcurrent Device

Circuit breakers shall open all ungrounded conductors of the circuit both manually and automatically unless otherwise permitted in 240.15(B)(1), (B)(2), and (B)(3).

240.15(B)(1) – Multiwire Branch Circuit

Individual single-pole circuit breakers, with identified handle ties, shall be permitted as the protection for each ungrounded conductor of multiwire branch circuits that serve only single-phase line-to-neutral loads.

Overcurrent Protection

240.21 – Location in Circuit

Overcurrent protection shall be provided in each ungrounded circuit conductor and shall be located at the point where the conductors receive their supply except as specified in 240.21(A) through (G)…

Overcurrent Protection

240.21(A)-(G) – Location in Circuit

- **(A) – Branch-Circuit Conductors**
- **(B) – Feeder Taps**
- **(C) – Transformer Secondary Conductors**
- **(D) – Service Conductors**
- **(E) – Busway Taps**
- **(F) – Motor Circuit Taps**
- **(G) – Conductors from Generator Terminals**

Overcurrent Protection

240.40 – Disconnecting Means for Fuses

A disconnecting means shall be provided on the supply side of all fuses in circuits over 150 volts to ground and cartridge fuses in circuits of any voltage where accessible to other than qualified persons, so that each circuit containing fuses can be independently disconnected from the source of power…