

CHAPTER 36
BRANCH CIRCUIT AND FEEDER REQUIREMENTS
Reserved

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E3603.5 Number of branch circuits. The minimum number of branch circuits shall be determined from the total computed load and the size or rating of the circuits used. The number of circuits shall be sufficient to supply the load served. In no case shall the load on any circuit exceed the maximum specified by Section E3602.

E3603.6 Branch-circuit load proportioning. Where the branch-circuit load is computed on a volt-amperes/per-square-foot (m²) basis, the wiring system, up to and including the branch-circuit panelboard(s), shall have the capacity to serve not less than the calculated load. This load shall be evenly proportioned among multioutlet branch circuits within the panelboard(s). Branch-circuit overcurrent devices and circuits shall only be required to be installed to serve the connected load.

**SECTION E3604
FEEDER REQUIREMENTS**

E3604.1 Conductor size. Feeder conductors that do not serve 100 percent of the dwelling unit load and branch-circuit conductors shall be of a size sufficient to carry the load as determined by this chapter. Feeder conductors shall not be required to be larger than the service-entrance conductors that supply the dwelling unit. The load for feeder conductors that serve as the main power feeder to a dwelling unit shall be determined as specified in Chapter 35 for services.

E3604.2 Minimum feeder conductor size. The size of feeder conductors shall not be less than 10 AWG copper or 8 AWG

aluminum where the load supplied consists of any of the following number and types of circuits: (1) two or more two-wire branch circuits supplied by a two-wire feeder; (2) three or more two-wire branch circuits supplied by a three-wire feeder; or (3) two or more three-wire branch circuits supplied by a three-wire feeder.

E3604.3 Feeder loads. The minimum load in volt-amperes shall be computed in accordance with the load calculation procedure prescribed in Table E3604.3(1). The associated table demand factors shall be applied to the actual load to determine the minimum load for feeders.

E3604.4 Feeder neutral load. The feeder neutral load shall be the maximum unbalance of the load determined in accordance with this chapter. The maximum unbalanced load shall be the maximum net computed load between the neutral and any one ungrounded conductor. For a feeder or service supplying electric ranges, wall-mounted ovens, counter-mounted cooking units and electric dryers, the maximum unbalanced load shall be considered as 70 percent of the load on the ungrounded conductors.

E3604.5 Lighting and convenience receptacle load. A unit load of not less than 3 volt-amperes shall constitute the minimum lighting and convenience receptacle load for each square foot of floor area (33 VA for each square meter of floor area). The floor area for each floor shall be computed from the outside dimensions of the building. The computed floor area shall not include open porches, garages, or unused or unfinished spaces not adaptable for future use.

**TABLE E3604.3(1)
FEEDER LOAD CALCULATION**

LOAD CALCULATION PROCEDURE	APPLIED DEMAND FACTOR
Lighting and receptacles: A unit load of not less than 3 VA per square foot of total floor area shall constitute the lighting and 120-volt, 15- and 20-ampere convenience receptacle load. 1,500 VA shall be added for each 20-ampere branch circuit serving receptacles in the kitchen, dining room, pantry, breakfast area and laundry area.	100 percent of first 3,000 VA or less and 35 percent of that in excess of 3,000 VA.
Plus	
Appliances and motors: The nameplate rating load of all fastened-in-place appliances other than dryers, ranges, air-conditioning and space-heating equipment.	100 percent of load for three or less appliances. 75 percent of load for four or more appliances.
Plus	
Fixed motors: Full-load current of motors plus 25 percent of the full load current of the largest motor.	
Plus	
Electric clothes dryer: The dryer load shall be 5,000 VA for each dryer circuit or the nameplate rating load of each dryer, whichever is greater.	
Plus	
Cooking appliances: The nameplate rating of ranges, wall-mounted ovens, counter-mounted cooking units, and other cooking appliances rated in excess of 1.75 kVA shall be summed.	Demand factors shall be as allowed by Table E3604.3(2).
Plus the largest of either the heating or cooling load	
Largest of the following two selections:	
1. 100 percent of the nameplate rating(s) of the air conditioning and cooling, including heat pump compressors.	
2. 100 percent of the fixed electric space heating.	

For SI: 1 square foot = 0.0929 m².

TABLE E3604.3(2)
DEMAND LOADS FOR ELECTRIC RANGES, WALL-MOUNTED OVENS, COUNTER-MOUNTED COOKING UNITS AND OTHER COOKING APPLIANCES OVER 1³/₄ kVA RATING^{a,b}

NUMBER OF APPLIANCES	MAXIMUM DEMAND ^{b,c}		
	Column A maximum 12 kVA rating	Column B less than 3 ¹ / ₂ kVA rating	Column C 3 ¹ / ₂ to 8 ³ / ₄ kVA rating
1	8 kVA	80	80
2	11 kVA	75	65

- a. Column A shall be used in all cases except as provided for in Footnote d.
- b. For ranges all having the same rating and individually rated more than 12 kVA but not more than 27 kVA, the maximum demand in Column A shall be increased 5 percent for each additional kVA of rating or major fraction thereof by which the rating of individual ranges exceeds 12 kVA.
- c. For ranges of unequal ratings and individually rated more than 8.75 kVA, but none exceeding 27 kVA, an average value of rating shall be computed by adding together the ratings of all ranges to obtain the total connected load (using 12 kVA for any ranges rated less than 12 kVA) and dividing by the total number of ranges; and then the maximum demand in Column A shall be increased 5 percent for each kVA or major fraction thereof by which this average value exceeds 12 kVA.
- d. Over 1.75 kVA through 8.75 kVA. As an alternative to the method provided in Column A, the nameplate ratings of all ranges rated more than 1.75 kVA but not more than 8.75 kVA shall be added and the sum shall be multiplied by the demand factor specified in Column B or C for the given number of appliances.

E3604.6 Ampacity and computed loads. The computed load of a feeder shall be not less than the sum of the loads on the branch circuits supplied, as determined by Section E3604, after any applicable demand factors permitted by Section E3604 have been applied.

Feeder conductors shall have sufficient ampacity to supply the load served. In no case shall the computed load of a feeder be less than the sum of the loads on the branch circuits supplied as determined by this chapter after any permitted demand factors have been applied.

E3604.7 Feeder and branch-circuit conductors. Feeder and branch-circuit conductors shall be protected by overcurrent-protective devices connected at the point the conductors receive their supply.

SECTION E3605
CONDUCTOR SIZING AND OVERCURRENT PROTECTION

E3605.1 General. Ampacities for conductors shall be determined based in accordance with Table E3605.1 and Sections E3605.2 and E3605.3.

E3605.2 Correction factor for ambient temperatures. For ambient temperatures other than 30°C (86°F), multiply the allowable ampacities specified in Table E3605.1 by the appropriate correction factor shown in Table E3605.2.

TABLE E3605.1
ALLOWABLE AMPACITIES

CONDUCTOR SIZE	CONDUCTOR TEMPERATURE RATING						CONDUCTOR SIZE
	60°C	75°C	90°C	60°C	75°C	90°C	
	Types TW, UF	Types RHW, THHW, THW, THWN, USE, XHHW	Types RHW-2, THHN, THHW, THW-2, THWN-2, XHHW, XHHW-2	Types TW, UF	Types RHW, THHW, THW, THWN, USE, XHHW	Types RHW-2, THHN, THHW, THW-2, THWN-2, XHHW, XHHW-2	
AWG kcmil	Copper			Aluminum or copper-clad aluminum			AWG kcmil
18	—	—	14	—	—	—	—
16	—	—	18	—	—	—	—
14	20	20	25	—	—	—	—
12	25	25	30	20	20	25	12
10	30	35	40	25	30	35	10
8	40	50	55	30	40	45	8
6	55	65	75	40	50	60	6
4	70	85	95	55	65	75	4
3	85	100	110	65	75	85	3
2	95	115	130	75	90	100	2
1	110	130	150	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

For SI: °C = [(°F)-32]/1.8.

**TABLE E3605.2
AMBIENT TEMPERATURE CORRECTION FACTORS**

AMBIENT TEMP. °C	FOR AMBIENT TEMPERATURES OTHER THAN 30°C (86°F), MULTIPLY THE ALLOWABLE AMPACITIES SPECIFIED IN TABLE E3605.1 BY THE APPROPRIATE FACTOR SHOWN BELOW						AMBIENT TEMP. °F
	CONDUCTOR TEMPERATURE RATING						
	60°C	75°C	90°C	60°C	75°C	90°C	
	Types TW, UF	Types RHW, THHW, THW, THWN, USE, XHHW	Types RHW-2, THHN, THHW, THW-2, THWN-2, XHHW, XHHW-2	Types TW, UF	Types RHW, THHW, THW, THWN, USE, XHHW	Types RHW-2, THHN, THHW, THW-2, THWN-2, XHHW, XHHW-2	
Copper			Aluminum or copper-clad aluminum				
21-25	1.08	1.05	1.04	1.08	1.05	1.04	70-77
26-30	1.00	1.00	1.00	1.00	1.00	1.00	78-86
31-35	0.91	0.94	0.96	0.91	0.94	0.96	87-95
36-40	0.82	0.88	0.91	0.82	0.88	0.91	96-104
41-45	0.71	0.82	0.87	0.71	0.82	0.87	105-113
46-50	0.58	0.75	0.82	0.58	0.75	0.82	114-122
51-55	0.41	0.67	0.76	0.41	0.67	0.76	123-131
56-60	—	0.58	0.71	—	0.58	0.71	132-140
61-70	—	0.33	0.58	—	0.33	0.58	141-158
71-80	—	—	0.41	—	—	0.41	159-176

For SI: °C = [(°F)-32]/1.8.

E3605.3 Adjustment factor for conductor proximity. Where the number of current-carrying conductors in a raceway or cable exceeds three, or where single conductors or multiconductor cables are stacked or bundled for distances greater than 24 inches (610 mm) without maintaining spacing and are not installed in raceways, the allowable ampacity of each conductor shall be reduced as shown in Table E3605.3.

Exceptions:

1. Adjustment factors shall not apply to conductors in nipples having a length not exceeding 24 inches (610 mm).
2. Adjustment factors shall not apply to underground conductors entering or leaving an outdoor trench if those conductors have physical protection in the form of rigid metal conduit, intermediate metal conduit, or rigid nonmetallic conduit having a length not exceeding 10 feet (3048 mm) and the number of conductors does not exceed four.
3. Adjustment factors shall not apply to type AC cable or to type MC cable without an overall outer jacket meeting all of the following conditions:
 - 3.1 Each cable has not more than three current-carrying conductors.
 - 3.2 The conductors are 12 AWG copper.
 - 3.3 Not more than 20 current-carrying conductors are bundled, stacked or supported on bridle rings. A 60 percent adjustment factor shall be applied where the current-carrying conductors in such cables exceed 20 and the cables are stacked or bundled for distances greater than 24 inches (610 mm) without maintaining spacing.

**TABLE E3605.3
CONDUCTOR PROXIMITY ADJUSTMENT FACTORS**

NUMBER OF CURRENT-CARRYING CONDUCTORS IN CABLE OR RACEWAY	PERCENT OF VALUES IN TABLE E3605.1
4-6	80
7-9	70
10-20	50
21-30	45
31-40	40
41 and above	35

E3605.4 Temperature limitations. The temperature rating associated with the ampacity of a conductor shall be so selected and coordinated to not 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.

E3605.4.1 Conductors rated 60 C. Termination provisions of equipment for circuits rated 100 amperes or less, or marked for 14 AWG through 1 AWG conductors, shall be used only for one of the following, except where the equipment is marked otherwise:

1. Conductors rated 60°C (140°F), or
2. Conductors with higher temperature ratings, provided that the ampacity of such conductors is determined based on the 60°C (140°F) ampacity of the conductor size used, or
3. Conductors with higher temperature ratings where the equipment is listed and identified for use with such conductors, or

- For motors marked with design letters B, C, D, or E, conductors having an insulation rating of 75°C (167°F) or higher shall be permitted to be used provided that the ampacity of such conductors does not exceed the 75°C (167°F) ampacity.

E3605.4.2 Conductors rated 75 C. Termination provisions of equipment for circuits rated over 100 amperes, or marked for conductors larger than 1 AWG, shall be used only for:

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

E3605.4.3 Separately installed pressure connectors. Separately installed pressure connectors shall be used with conductors at the ampacities not exceeding the ampacity at the listed and identified temperature rating of the connector.

E3605.4.4 Conductors of Type NM cable. Conductors in NM cable assemblies shall be rated at 90°C (194°F). Types NM, NMC, and NMS cable identified by the markings NM-B, NMC-B, and NMS-B meet this requirement. The ampacity of Types NM, NMC, and NMS cable shall be at 60°C (140°F) conductors and shall comply with Section E3605.1 and Table E3605.5.3. The 90°C (194°F) rating shall be permitted to be used for ampacity correction and adjustment purposes provided that the final corrected or adjusted ampacity does not exceed that for a 60°C (140°F) rated conductor.

E3605.5 Overcurrent protection required. All ungrounded branch-circuit and feeder conductors shall be protected against overcurrent by an overcurrent device installed at the point where the conductors receive their supply. Overcurrent devices shall not be connected in series with a grounded conductor. Overcurrent protection and allowable loads for branch circuits and feeders that do not serve as the main power feeder to the dwelling unit load shall be in accordance with this chapter.

Branch-circuit conductors and equipment shall be protected by overcurrent protective devices having a rating or setting not exceeding the allowable ampacity specified in Table E3605.1 and Sections E3605.2, E3605.3 and E3605.4 except where otherwise permitted or required in Sections E3605.5.1 through E3605.5.3.

E3605.5.1 Cords. Cords shall be protected in accordance with Section E3809.2.

E3605.5.2 Overcurrent devices of the next higher rating. The next higher standard overcurrent device rating, above the ampacity of the conductors being protected, shall be permitted to be used, provided that all of the following conditions are met:

- The conductors being protected are not part of a multioutlet branch circuit supplying receptacles for cord- and plug-connected portable loads.
- The ampacity of conductors does not correspond with the standard ampere rating of a fuse or a circuit breaker without overload trip adjustments above its

rating (but that shall be permitted to have other trip or rating adjustments).

- The next higher standard device rating does not exceed 400 amperes.

E3605.5.3 Small conductors. Except as specifically permitted by Section E3605.5.4, the rating of overcurrent protection devices shall not exceed the ratings shown in Table E3605.5.3 for the conductors specified therein.

E3605.5.4 Air-conditioning and heat pump equipment. Air-conditioning and heat pump equipment circuit conductors shall be permitted to be protected against overcurrent in accordance with Section E3602.11.

E3605.6 Fuses and fixed trip circuit breakers. 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 and 400 amperes.

**TABLE E3605.5.3
OVERCURRENT-PROTECTION RATING**

COPPER		ALUMINUM OR COPPER-CLAD ALUMINUM	
Size (AWG)	Maximum overcurrent-protection-device rating ^a (amps)	Size (AWG)	Maximum overcurrent-protection-device rating ^a (amps)
14	15	12	15
12	20	10	25
10	30	8	30

a. The maximum overcurrent-protection-device rating shall not exceed the conductor allowable ampacity determined by the application of the correction and adjustment factors in accordance with Sections E3605.2 and E3605.3.

E3605.7 Location of overcurrent devices in or on premises. Overcurrent devices shall:

- Be readily accessible.
- Not be located where they will be exposed to physical damage.
- Not be located where they will be in the vicinity of easily ignitable material such as in clothes closets.
- Not be located in bathrooms.

Exceptions:

- This section shall not apply to supplementary overcurrent protection that is integral to utilization equipment.
- Overcurrent devices installed adjacent to the utilization equipment that they supply shall be permitted to be accessible by portable means.

E3605.8 Ready access for occupants. Each occupant shall have ready access to all overcurrent devices protecting the conductors supplying that occupancy.

E3605.9 Enclosures for overcurrent devices. Overcurrent devices shall be enclosed in cabinets or cutout boxes except where an overcurrent device is part of an assembly that provides equivalent protection. The operating handle of a circuit breaker shall be permitted to be accessible without opening a door or cover.

**SECTION E3606
PANELBOARDS**

E3606.1 Panelboard rating. All panelboards shall have a rating not less than that of the minimum service entrance or feeder capacity required for the computed load.

E3606.2 Panelboard circuit identification. All circuits and circuit modifications shall be legibly identified as to purpose or use on a circuit directory located on the face or inside the door of the enclosure.

E3606.3 Panelboard overcurrent protection. Panelboards shall be protected on the supply side by not more than two main circuit breakers or two sets of fuses having a combined rating not greater than that of the panelboard.

Exception: Individual protection for a panelboard shall not be required if the panelboard feeder has overcurrent protection not greater than the rating of the panelboard.

E3606.4 Grounded conductor terminations. Each grounded conductor shall terminate within the panelboard on an individual terminal that is not also used for another conductor, except that grounded conductors of circuits with parallel conductors shall be permitted to terminate on a single terminal where the terminal is identified for connection of more than one conductor.

