

**N** **TABLE 400.51(A)(1)** Ampacity for Portable Power Feeder Cables Over 2000 Volts [Based on Ambient Temperature of 30°C (86°F)]

Copper Conductor Size (AWG) or kcmil	Single Conductor*			Three Conductor			Copper Conductor Size (AWG) or kcmil
	2001–8000 Volts Shielded	8001–15,000 Volts Shielded	15,001–25,000 Volts Shielded	2001–8000 Volts Shielded	8001–15,000 Volts Shielded	8001–15,000 Volts Shielded	
6	123	—	—	102	—	—	6
4	163	—	—	134	—	—	4
3	188	—	—	154	—	—	3
2	214	214	—	175	180	196	2
1	247	247	244	202	205	210	1
1/0	286	285	280	232	236	240	1/0
2/0	329	328	322	267	270	274	2/0
3/0	379	377	371	307	311	315	3/0
4/0	440	437	428	353	357	360	4/0
250	488	484	473	390	395	396	250
300	545	540	528	438	—	—	300
350	604	597	582	478	—	—	350
400	656	649	629	470	—	—	400
450	704	696	676	503	—	—	450
500	757	746	725	536	—	—	500

Note: Ampacities are based on a conductor temperature of 90°C (194°F) and an ambient air temperature of 30°C (86°F).

\*Ampacities are based on single isolated cable in air operated with open-circuited shield.

**N** **TABLE 400.51(A)(2)** Adjustment Factors for Different Ambient Temperatures

Ambient Temperature, Degrees		Multiplying Correction Factor
°C	°F	
10	50	1.26
20	68	1.18
30	86	1.10
40	104	1.00
50	122	0.90

**N** **TABLE 400.51(A)(3)** Adjustment Factors for Number of Layers of Cable Wound on a Reel

Number of Layers	Multiplying Correction Factor
1	0.85
2	0.65
3	0.45
4*	0.35

\*If more than four layers of cable are wound on the reel, ampacity derating should be calculated using engineering supervision.

## ARTICLE 402

## Fixture Wires

**402.1 Scope.** This article covers general requirements and construction specifications for fixture wires.

**402.2 Other Articles.** Fixture wires shall comply with this article and also with the applicable provisions of other articles of this *Code*.

Informational Note: See Part VI of Article 410 for application in luminaires.

**402.3 Types.** Fixture wires shall be of a type listed in Table 402.3, and they shall comply with all requirements of that table. The fixture wires listed in Table 402.3 are all suitable for service at 600 volts, nominal, unless otherwise specified.

Informational Note: Thermoplastic insulation may stiffen at temperatures lower than -10°C (+14°F). Thermoplastic insulation

may also be deformed at normal temperatures where subjected to pressure, such as at points of support.

**402.5 Ampacities for Fixture Wires.** The ampacity of fixture wire shall be as specified in Table 402.5.

No conductor shall be used under such conditions that its operating temperature exceeds the temperature specified in Table 402.3 for the type of insulation involved.

Informational Note: See 310.14(A)(3) for temperature limitation of conductors.

**TABLE 402.5** Ampacity for Fixture Wires

Size (AWG)	Ampacity
18	6
16	8
14	17
12	23
10	28

TABLE 402.3 Fixture Wires

Name	Type Letter	Insulation	AWG	Thickness of Insulation		Outer Covering	Maximum Operating Temperature	Application Provisions
				mm	mils			
Heat-resistant rubber-covered fixture wire — flexible stranding	FFH-2	Heat-resistant rubber or cross-linked synthetic polymer	18–16	0.76	30	Nonmetallic covering	75°C (167°F)	Fixture wiring
	FFHH-2						90°C (194°F)	
ECTFE — solid or 7-strand	HF	Ethylene chloro-trifluoroethylene	18–14	0.38	15	None	150°C (302°F)	Fixture wiring
ECTFE — flexible stranding	HFF	Ethylene chlorotrifluoroethylene	18–14	0.38	15	None	150°C (302°F)	Fixture wiring
Tape insulated fixture wire — solid or 7-strand	KF-1	Aromatic polyimide tape	18–10	0.14	5.5	None	200°C (392°F)	Fixture wiring — limited to 300 volts
	KF-2	Aromatic polyimide tape	18–10	0.21	8.4	None	200°C (392°F)	Fixture wiring
Tape insulated fixture wire — flexible stranding	KFF-1	Aromatic polyimide tape	18–10	0.14	5.5	None	200°C (392°F)	Fixture wiring — limited to 300 volts
	KFF-2	Aromatic polyimide tape	18–10	0.21	8.4	None	200°C (392°F)	Fixture wiring
Perfluoro-alkoxy — solid or 7-strand (nickel or nickel-coated copper)	PAF	Perfluoro-alkoxy	18–14	0.51	20	None	250°C (482°F)	Fixture wiring (nickel or nickel-coated copper)
Perfluoro-alkoxy — flexible stranding	PAFF	Perfluoro-alkoxy	18–14	0.51	20	None	150°C (302°F)	Fixture wiring
Fluorinated ethylene propylene fixture wire — solid or 7-strand	PF	Fluorinated ethylene propylene	18–14	0.51	20	None	200°C (392°F)	Fixture wiring
Fluorinated ethylene propylene fixture wire — flexible stranding	PFF	Fluorinated ethylene propylene	18–14	0.51	20	None	150°C (302°F)	Fixture wiring
Fluorinated ethylene propylene fixture wire — solid or 7-strand	PGF	Fluorinated ethylene propylene	18–14	0.36	14	Glass braid	200°C (392°F)	Fixture wiring
Fluorinated ethylene propylene fixture wire — flexible stranding	PGFF	Fluorinated ethylene propylene	18–14	0.36	14	Glass braid	150°C (302°F)	Fixture wiring
Extruded polytetrafluoroethylene — solid or 7-strand (nickel or nickel-coated copper)	PTF	Extruded polytetrafluoroethylene	18–14	0.51	20	None	250°C (482°F)	Fixture wiring (nickel or nickel-coated copper)
Extruded polytetrafluoroethylene — flexible stranding 26-36 (AWG silver or nickel-coated copper)	PTFF	Extruded polytetrafluoroethylene	18–14	0.51	20	None	150°C (302°F)	Fixture wiring (silver or nickel-coated copper)
Heat-resistant rubber-covered fixture wire — solid or 7-strand	RFH-1	Heat-resistant rubber	18	0.38	15	Nonmetallic covering	75°C (167°F)	Fixture wiring — limited to 300 volts
	RFH-2	Heat-resistant rubber Cross-linked synthetic polymer	18–16	0.76	30	None or non-metallic covering	75°C (167°F)	Fixture wiring



TABLE 402.3 Continued

Name	Type Letter	Insulation	AWG	Thickness of Insulation		Outer Covering	Maximum Operating Temperature	Application Provisions
				mm	mils			
Heat-resistant cross-linked synthetic polymer-insulated fixture wire — solid or 7-strand	RFHH-2* RFHH-3*	Cross-linked synthetic polymer	18–16 18–16	0.76 1.14	30 45	None or non-metallic covering	90°C (194°F)	Fixture wiring
Silicone insulated fixture wire — solid or 7-strand	SF-1	Silicone rubber	18	0.38	15	Nonmetallic covering	200°C (392°F)	Fixture wiring — limited to 300 volts
	SF-2	Silicone rubber	18–12 10	0.76 1.14	30 45	Nonmetallic covering	200°C (392°F)	Fixture wiring
Silicone insulated fixture wire — flexible stranding	SFF-1	Silicone rubber	18	0.38	15	Nonmetallic covering	150°C (302°F)	Fixture wiring — limited to 300 volts
	SFF-2	Silicone rubber	18–12 10	0.76 1.14	30 45	Nonmetallic covering	150°C (302°F)	Fixture wiring
Thermoplastic covered fixture wire — solid or 7-strand	TF*	Thermoplastic	18–16	0.76	30	None	60°C (140°F)	Fixture wiring
Thermoplastic covered fixture wire — flexible stranding	TFF*	Thermoplastic	18–16	0.76	30	None	60°C (140°F)	Fixture wiring
Heat-resistant thermoplastic covered fixture wire — solid or 7-strand	TFN*	Thermoplastic	18–16	0.38	15	Nylon-jacketed or equivalent	90°C (194°F)	Fixture wiring
Heat-resistant thermoplastic covered fixture wire — flexible stranded	TFFN*	Thermoplastic	18–16	0.38	15	Nylon-jacketed or equivalent	90°C (194°F)	Fixture wiring
Cross-linked polyolefin insulated fixture wire — solid or 7-strand	XF*	Cross-linked polyolefin	18–14 12–10	0.76 1.14	30 45	None	150°C (302°F)	Fixture wiring — limited to 300 volts
Cross-linked polyolefin insulated fixture wire — flexible stranded	XFF*	Cross-linked polyolefin	18–14 12–10	0.76 1.14	30 45	None	150°C (302°F)	Fixture wiring — limited to 300 volts
Modified ETFE — solid or 7-strand	ZF	Modified ethylene tetrafluoro-ethylene	18–14	0.38	15	None	150°C (302°F)	Fixture wiring
Modified ETFE — flexible stranding	ZFF	Modified ethylene tetrafluoro-ethylene	18–14	0.38	15	None	150°C (302°F)	Fixture wiring
High temp. modified ETFE—solid or 7-strand	ZHF	Modified ethylene tetrafluoro-ethylene	18–14	0.38	15	None	200°C (392°F)	Fixture wiring

\*Insulations and outer coverings that meet the requirements of flame retardant, limited smoke, and are so listed, shall be permitted to be marked for limited smoke after the Code type designation.

Fixture wire is permitted to be protected by branch-circuit overcurrent protective devices (OCPD) in accordance with 402.14, which in turn references 240.5 [specifically 240.5(B)(2)]. Fixture wire sizes 18 AWG and 16 AWG have ampacities of 6 and 8 amperes, respectively. While a 15- or 20-ampere OCPD provides a level of short-circuit and ground-fault protection for the fixture wires [limiting the length of the fixture wire per 240.5(B)(2) is necessary to limit the overall impedance under fault conditions], overload protection is not

provided by the OCPD typically used for lighting branch circuits. Supplemental overload is permitted, but not required, by the NEC®, so protection of the fixture wires is accomplished by limiting the load of the lamps, ballasts, or drivers of a listed luminaire to not more than the ampacities specified in Table 402.5.

**402.6 Minimum Size.** Fixture wires shall not be smaller than 18 AWG.



**402.7 Number of Conductors in Conduit or Tubing.** The number of fixture wires permitted in a single conduit or tubing shall not exceed the percentage fill specified in Table 1, Chapter 9.

#### See also

**Chapter 9, Table 4**, which provides the usable area within the selected conduit or tubing

**Chapter 9, Table 5**, which provides the required area for each of the conductors

The following examples show how to determine the minimum size conduit where the conductors are different sizes and, where the conductors are all the same size, how to select the minimum size conduit directly from the tables in Informative Annex C.

#### Calculation Example 1

A remote ballast installation requires a single flexible metal conduit (FMC) to contain fourteen 16 AWG TFFN fixture wires and three 12 AWG THHN conductors. What size FMC is required?

#### Solution

**Step 1.** Using Table 1 in Chapter 9, look up the maximum percent of cross section of conduit permitted for conductors. Table 1 limits the raceway fill for more than two conductors at 40 percent of the total cross-sectional area of the raceway. Note 6 in the Notes to Tables refers to Tables 5 and 5A for conductor dimensions and Table 4 for the raceway dimensions.

**Step 2.** Find the individual conductor cross-sectional areas in Chapter 9, Table 5:

$$16 \text{ AWG TFFN} = 0.0072 \text{ in.}^2$$

$$12 \text{ AWG THHN} = 0.0133 \text{ in.}^2$$

**Step 3.** Calculate the total area occupied by the wires as follows:

$$\text{Fourteen } 16 \text{ AWG TFFN} \times 0.0072 = 0.1008 \text{ in.}^2$$

$$\text{Three } 12 \text{ AWG THHN} \times 0.0133 = 0.0399 \text{ in.}^2$$

$$\text{Total area} = 0.1407 \text{ in.}^2$$

**Step 4.** Using the 40-percent column of Table 4, Chapter 9, in the section entitled "Article 348, Flexible Metal Conduit (FMC)," find the appropriate FMC size based on 40-percent fill and a total conductor area fill of 0.1407 in.<sup>2</sup> Because 0.1407 in.<sup>2</sup> is greater than 0.127 and less than 0.213, select trade size ¾.

#### Calculation Example 2

If the conductors in the FMC are all of the same wire size (16 AWG), Informative Annex C tables can be used instead of doing the calculations. This example uses Informative Annex C tables to determine FMC size.

What size FMC is required for seventeen 16 AWG TFFN conductors?

#### Solution

**Step 1.** In Informative Annex C, Table C.3, find TFFN insulation in the first column.

**Step 2.** Find 16 AWG in the second column. Proceed across the table until the desired number of conductors is equal to or less than the number shown in the table for the respective conduit sizes. Trade size ½ is required.

**402.8 Grounded Conductor Identification.** Fixture wires that are intended to be used as grounded conductors shall be identified by one or more continuous white stripes on other than green insulation or by the means described in 400.22(A) through (E).

This requirement is similar to that required for flexible cords and cable to ensure that the grounded conductor is easily recognized. Because connection of the grounded conductor to the screw shell of lampholders is necessary to reduce exposure to an electric shock hazard when lamps are being replaced or changed, the grounded conductor must be easily recognized.

#### 402.9 Marking.

**(A) Method of Marking.** Thermoplastic insulated fixture wire shall be durably marked on the surface at intervals not exceeding 610 mm (24 in.). All other fixture wire shall be marked by means of a printed tag attached to the coil, reel, or carton.

**(B) Optional Marking.** Fixture wire types listed in Table 402.3 shall be permitted to be surface marked to indicate special characteristics of the cable materials. These markings include, but are not limited to, markings for limited smoke, sunlight resistance, and so forth.

**402.10 Uses Permitted.** Fixture wires shall be permitted (1) for installation in luminaires and in similar equipment where enclosed or protected and not subject to bending or twisting in use, or (2) for connecting luminaires to the branch-circuit conductors supplying the luminaires.

Fixture wire is permitted to be used as a tap conductor to connect a luminaire(s) to the branch-circuit conductors. The transition from the branch-circuit wiring method to the fixture wire tap conductors can be accomplished via a junction box or other fitting that is allowed to contain splices.

#### See also

**240.5(B)(2)** for overcurrent protection of fixture wire tapped to branch-circuit conductors

**402.12 Uses Not Permitted.** Fixture wires shall not be used as branch-circuit conductors except as permitted elsewhere in this Code.

**402.14 Overcurrent Protection.** Overcurrent protection for fixture wires shall be as specified in 240.5.