

consists of a connector body and a screw-on potting fitting. The fitting is assembled with a special tool and consists of a screw-on pot, insulating cap, insulating sleeving, anchoring bead, and sealing compound.

**(B) Terminal Seals.** Where Type MI cable terminates, an end seal fitting shall be installed immediately after stripping to prevent the entrance of moisture into the insulation. The conductors extending beyond the sheath shall be individually provided with an insulating material.

**332.80 Ampacity.** The ampacity of Type MI cable shall be determined in accordance with 310.14. The conductor temperature at the end seal fitting shall not exceed the temperature rating of the listed end seal fitting, and the installation shall not exceed the temperature ratings of terminations or equipment.

**(A) Type MI Cable Installed in Cable Tray.** The ampacities for Type MI cable installed in cable tray shall be determined in accordance with 392.80(A).

**(B) Single Type MI Conductors Grouped Together.** Where single Type MI conductors are grouped together in a triangular or square configuration, as required by 332.31, and installed on a messenger or exposed with a maintained free air space of not less than 2.15 times one conductor diameter ( $2.15 \times \text{O.D.}$ ) of the largest conductor contained within the configuration and adjacent conductor configurations or cables, the ampacity of the conductors shall not exceed the allowable ampacities of Table 310.17.

### Part III. Construction Specifications

**332.104 Conductors.** Type MI cable conductors shall be of solid copper, nickel, or nickel-coated copper with a resistance corresponding to standard AWG and kcmil sizes.

**332.108 Equipment Grounding Conductor.** Where the outer sheath is made of copper, it shall provide an adequate path to serve as an equipment grounding conductor. Where the outer sheath is made of steel, a separate equipment grounding conductor shall be provided.

The copper sheath of Type MI cable must be constructed as an equipment grounding conductor (EGC) and is permitted to be used as an EGC according to 250.118(A)(9), but an alloy steel outer sheath is not. A separate EGC is required to be used with steel-sheathed cable.

**332.112 Insulation.** The conductor insulation in Type MI cable shall be a highly compressed refractory mineral that provides proper spacing for all conductors.

**332.116 Sheath.** The outer sheath shall be of a continuous construction to provide mechanical protection and moisture seal.

#### ARTICLE

### 334

## Nonmetallic-Sheathed Cable: Types NM and NMC

### Part I. General

**334.1 Scope.** This article covers the use, installation, and construction specifications of nonmetallic-sheathed cable.

Nonmetallic-sheathed, Type NM and Type NMC, cable was first recognized in the 1928 *NEC*® as a substitute for concealed knob-and-tube wiring (Article 394) and open wiring on insulators (Article 398). The original advantages of nonmetallic-sheathed cable over knob-and-tube wiring were that the outer sheath provided continuous protection in addition to the insulation applied to the conductors; the cable was easily fished in partitions of finished buildings; no insulating supports were required; and only one hole needed to be bored, and that hole could accommodate more than one cable passing through a wood cross member. Type NMC cable has been removed from Article 334 because it has not been available for many years.

**334.6 Listing Requirements.** Type NM and Type NMC cables and associated fittings shall be listed.

*ANSI/UL 719, Standard for Nonmetallic-Sheathed Cables*, requires a construction and performance evaluation, including testing related to flammability, dielectric voltage-withstand, unwinding at low temperatures, pulling through joists, conductor pullout, crushing, and abrasion.

### Part II. Installation

**334.10 Uses Permitted.** Type NM and Type NMC cables shall be permitted to be used in the following, except as prohibited in 334.12:

- (1) One- and two-family dwellings and their attached or detached garages, and their storage buildings.
- (2) Multi-family dwellings and their detached garages permitted to be of Types III, IV, and V construction.
- (3) Other structures permitted to be of Types III, IV, and V construction. Cables shall be concealed within walls, floors, or ceilings that provide a thermal barrier of material that has at least a 15-minute finish rating as identified in listings of fire-rated assemblies.

Informational Note No. 1: See NFPA 220-2021, *Standard on Types of Building Construction*, or the applicable building code, or both for types of building construction and occupancy classification definitions.

Informational Note No. 2: See Informative Annex E for determination of building types.

- (4) Cable trays in structures permitted to be Types III, IV, or V where the cables are identified for the use.



**Informational Note No. 3:** See 310.14(A)(3) for temperature limitation of conductors.

- (5) Types I and II construction where installed within raceways permitted to be installed in Types I and II construction.

A well-established means of codifying fire protection and fire safety requirements is to classify buildings by types of construction, based on materials used for the structural elements and the degree of fire resistance afforded by each element. The five fundamental construction types used by the model building codes are as follows:

- Type I (fire resistive)
- Type II (noncombustible)
- Type III (combination of combustible and noncombustible)
- Type IV (heavy timber)
- Type V (wood frame)

Types I and II basically require all structural elements to be noncombustible, whereas Types III, IV, and V allow some or all of the structural elements to be combustible (wood).

The selection of building construction types is regulated by the local building code, based on the occupancy, height, and area of the building. If a building of a selected height (in feet or stories above grade) and area is permitted to be built of combustible construction (i.e., Types III, IV, or V), the installation of nonmetallic-sheathed cable is permitted. Common areas (corridors) and incidental and subordinate uses (such as laundry rooms and lounge rooms) that serve a multifamily dwelling occupancy are also considered part of the multifamily occupancy. Type NM cable is allowed in such areas.

If a building is of noncombustible construction (Type I or II) by the owner's choice, even though the building code would permit combustible construction, the building is allowed to be wired with Type NM cable. In such an instance, Type NM cable may be installed in the noncombustible building because the building code would have permitted the building to be of combustible construction.

If Type I or Type II construction is required, Section 334.10(5) permits Type NM cables to be installed if the cables are in a raceway. A raceway is permitted to be used only if it complies with the article for the raceway and its use does not violate another article in the NEC.

#### See also

**Informative Annex E** for information on the types of construction as well as a table that cross-references the five construction types to the types described in the model building codes

**(A) Type NM.** Type NM cable shall be permitted as follows:

- (1) For both exposed and concealed work in normally dry locations except as prohibited in 334.10(3)
- (2) To be installed or fished in air voids in masonry block or tile walls

For concealed work, cable should be installed where it is protected from physical damage often caused by nails or screws. Where practical, care should be taken to avoid areas where trim, door and window casings, baseboards, moldings, and so forth are likely to be nailed.

#### See also

**300.4** for details on protection against physical damage

**(B) Type NMC.** Type NMC cable shall be permitted as follows:

- (1) For both exposed and concealed work in dry, wet, damp, or corrosive locations, except as prohibited by 334.10(3)
- (2) In outside and inside walls of masonry block or tile
- (3) In a shallow chase in masonry, concrete, or adobe protected against nails or screws by a steel plate at least 1.59 mm ( $\frac{1}{16}$  in.) thick and covered with plaster, adobe, or similar finish

If Type NM cable is used in dairy barns and similar agricultural buildings (see Article 547), it must be Type NMC (corrosion resistant). The cable will be exposed to fumes, vapors, or liquids such as ammonia and barnyard acids. Under such circumstances, ordinary Type NM cable can deteriorate rapidly due to ammonia fumes or the growth of fungus or mold.

### 334.12 Uses Not Permitted.

Restrictions of use of Type NM cable also exist elsewhere in the NEC. For example, Type NM cables are not permitted to be installed in ducts, plenums, and other air-handling spaces.

#### See also

**300.22**, which limits the use of materials in ducts, plenums, and other air-handling spaces that can contribute smoke and products of combustion during a fire

**Δ (A) Types NM and NMC.** Types NM and NMC cables shall not be permitted as follows:

- (1) In any dwelling or structure not specifically permitted in 334.10(1), 334.10(2), 334.10(3), and 334.10(5)
- (2) Exposed within a dropped or suspended ceiling cavity in other than one- and two-family and multifamily dwellings

Nonmetallic-sheathed cables are prohibited in the space above hung ceilings that allow access. This requirement does not apply to dwelling-type occupancies. The term *exposed*, as used in this requirement, meets the definition of *exposed (as applied to wiring methods)* found in Article 100, which states "on or attached to the surface or behind panels designed to allow access."

For example, cables installed above a gypsum board ceiling or soffit would not be considered exposed cable, if the area above the ceiling is not accessible (does not have removable tiles or does not contain an access panel). Because hung or dropped ceilings are often accessible, cables installed above those types of ceilings would be considered exposed cables if the cables do not have additional physical protection.



A simple change to an architectural finish schedule during construction could change the acceptability of the wiring method. For example, if a corridor ceiling in an occupancy (other than a dwelling type) calls for a painted gypsum board ceiling and the finish schedule changes the ceiling construction to a suspended ceiling, Type NM cable would not be permitted unless the cable is installed using additional protection.

#### See also

**334.15(B)** for examples of additional protection

- (3) As service-entrance cable
- (4) In commercial garages having hazardous (classified) locations as defined in 511.3
- (5) In theaters and similar locations, except where permitted in 518.4(C)
- (6) In motion picture studios
- (7) In storage battery rooms
- (8) In hoistways or on elevators or escalators
- (9) Embedded in poured cement, concrete, or aggregate
- (10) In hazardous (classified) locations, except where specifically permitted by other articles in this *Code*

**(B) Type NM.** Type NM cables shall not be used under the following conditions or in the following locations:

- (1) Where exposed to corrosive fumes or vapors
- (2) Where embedded in masonry, concrete, adobe, fill, or plaster
- (3) In a shallow chase in masonry, concrete, or adobe and covered with plaster, adobe, or similar finish
- (4) In wet or damp locations

**334.15 Exposed Work.** In exposed work, except as provided in 300.11(B), cable shall be installed as specified in 334.15(A) through (C).

**(A) To Follow Surface.** Cable shall closely follow the surface of the building finish or of running boards.

**Δ (B) Protection from Physical Damage.** Cable shall be protected from physical damage where necessary by rigid metal conduit, intermediate metal conduit, electrical metallic tubing, Schedule 80 PVC conduit, RTRC marked with the suffix -XW, or other approved means. Where passing through a floor, the cable shall be enclosed in rigid metal conduit, intermediate metal conduit, electrical metallic tubing, Schedule 80 PVC conduit, RTRC marked with the suffix -XW, or other approved means extending at least 150 mm (6 in.) above the floor. Conduit or tubing shall be provided with a bushing or adapter that provides protection from abrasion at the point the cable enters and exits the raceway.

Type NMC cable installed in shallow chases or grooves in masonry, concrete, or adobe shall be protected in accordance with the requirements in 300.4(F) and covered with plaster, adobe, or similar finish.

**Δ (C) In Unfinished Basements and Crawl Spaces.** Where cable is run at angles with joists in unfinished basements and crawl spaces, it shall be permissible to secure cables not smaller than two 6 AWG or three 8 AWG conductors directly to the lower edges of the joists. Smaller cables shall be run either through bored holes in joists or on running boards. Nonmetallic-sheathed cable installed on the wall of an unfinished basement shall be permitted to be installed in a listed conduit or tubing or shall be protected in accordance with 300.4. Conduit or tubing shall be provided with a bushing or adapter that provides protection from abrasion at the point the cable enters and exits the raceway. The sheath of the nonmetallic-sheathed cable shall extend through the conduit or tubing and into the outlet, device, or junction box not less than 6 mm (¼ in.). The cable shall be secured within 300 mm (12 in.) of the point where the cable enters the conduit or tubing. Metal conduit, tubing, and metal outlet boxes shall be connected to an equipment grounding conductor complying with 250.86 and 250.148.

Type NM cable installed in crawl spaces is more susceptible to physical damage due to the limited height of the space. Specific means of physical protection in crawl spaces and unfinished basements can include the use of raceways, guard strips, and so forth.

Nonmetallic-sheathed cables installed in an unfinished basement or crawl space can be run through holes in joists, attached to the side of joists or beams, and installed on running boards, as shown on the left side in Exhibit 334.1.

#### See also

**300.4(D)**, which requires cables that run parallel to framing members be installed at least 1¼ inches from the nearest edge of studs, joists, or rafters

**334.17 Through or Parallel to Framing Members.** Types NM and NMC cable shall be protected in accordance with 300.4 where installed through or parallel to framing members. Grommets used as required in 300.4(B)(1) shall remain in place and be listed for the purpose of cable protection.

Cable that passes through factory- or field-punched holes in metal studs or similar members is required to be protected in accordance with 300.4(B)(1). Listed bushings or listed grommets covering all metal edges must be securely fastened in the opening before the cable is installed.

**N 334.19 Cable Entries.** The sheath on nonmetallic-sheathed cable shall extend not less than 6 mm (¼ in.) beyond any cable clamp or cable entry.

**334.23 In Accessible Attics.** The installation of cable in accessible attics or roof spaces shall also comply with 320.23.

**334.24 Bending Radius.** Bends in Types NM and NMC cable shall be so made that the cable will not be damaged. The radius of



**EXHIBIT 334.1** Nonmetallic-sheathed cables (on plywood running board) and Type SE cables (installed directly to bottom of joists) in an unfinished basement or crawl space.



the curve of the inner edge of any bend during or after installation shall not be less than five times the diameter of the cable. For flat cables, the major diameter dimension of the cable shall be used to determine the bending radius.

**334.30 Securing and Supporting.** Nonmetallic-sheathed cable shall be supported and secured by staples, cable ties listed and identified for securement and support, or straps, hangers, or similar fittings designed and installed so as not to damage the cable, at intervals not exceeding 1.4 m (4½ ft) and within 300 mm (12 in.) of every cable entry into enclosures such as outlet boxes, junction boxes, cabinets, or fittings. The cable length between the cable entry and the closest cable support shall not exceed 450 mm (18 in.). Flat cables shall not be stapled on edge.

Sections of cable protected from physical damage by raceway shall not be required to be secured within the raceway.

Draping the cable over air ducts, rafters, timbers, joists, pipes, and ceiling grid members without securing the cable with approved means is not permitted, except where the cable is fished, as allowed in 334.30(B)(1).

Two-conductor Type NM cable (or other flat configurations) is prohibited from being stapled on edge (i.e., with its short dimension against a wood joist). If the staple is driven too far into the stud, damage to the insulation and conductors could occur.

#### See also

**300.4(C)** for support requirements of cables through spaces behind panels designed to allow access

**(A) Horizontal Runs Through Holes and Notches.** In other than vertical runs, cables installed in accordance with 300.4 shall be considered to be supported and secured where such support does not exceed 1.4-m (4½-ft) intervals and the nonmetallic-sheathed cable is securely fastened in place by an approved means within 300 mm (12 in.) of each box, cabinet, conduit body, or other nonmetallic-sheathed cable termination.

Informational Note: See 314.17(B)(1) for support where nonmetallic boxes are used.

Cable running horizontally through framing members (spaced less than 54 inches apart) and passing through bored or punched holes in the framing members is considered to be supported by the framing members. Additional securing or fastening with cable ties is not required. However, the cable must be secured within 12 inches of the outlet box. Where the cable terminates at a single gang nonmetallic box that does not contain a cable clamping device, the cable may be secured (fastened in place) within 8 inches of the outlet box, according to 314.17(B)(2), Exception.

**(B) Unsupported Cables.** Nonmetallic-sheathed cable shall be permitted to be unsupported where the cable:

- (1) Is fished between access points through concealed spaces in finished buildings or structures and supporting is impracticable.
- (2) Is not more than 1.4 m (4½ ft) from the last point of cable support to the point of connection to a luminaire or other piece of electrical equipment and the cable and point of connection are within an accessible ceiling in one-, two-, or multifamily dwellings.

**(C) Wiring Device Without a Separate Outlet Box.** A wiring device identified for the use, without a separate outlet box, and incorporating an integral cable clamp shall be permitted where the cable is secured in place at intervals not exceeding 1.4 m (4½ ft) and within 300 mm (12 in.) from the wiring device wall opening, and there shall be at least a 300 mm (12 in.) loop of unbroken cable or 150 mm (6 in.) of a cable end available on the interior side of the finished wall to permit replacement.

#### 334.40 Boxes and Fittings.

**(A) Boxes of Insulating Material.** Nonmetallic outlet boxes shall be permitted as provided by 314.3.

**(B) Devices of Insulating Material.** Self-contained switches, self-contained receptacles, and listed nonmetallic-sheathed cable interconnector devices of insulating material that are listed for use without a box shall be permitted to be used without boxes



in exposed or concealed installations. Openings in such devices shall form a close fit around the outer covering of the cable, and the device shall fully enclose the part of the cable from which any part of the covering has been removed. Where connections to conductors are by binding-screw terminals, there shall be available as many terminals as conductors.

**(C) Devices with Integral Enclosures.** Wiring devices with integral enclosures identified for such use shall be permitted as provided by 300.15(E).

Δ **334.80 Ampacity.** The ampacity of Types NM and NMC cable shall be determined in accordance with 310.14. The ampacity shall not exceed that of a 60°C (140°F) rated conductor. The 90°C (194°F) rating shall be permitted to be used for ampacity adjustment and correction calculations, provided the final calculated ampacity does not exceed that of a 60°C (140°F) rated conductor. The ampacity of Types NM and NMC cable installed in cable trays shall be determined in accordance with 392.80(A).

Where more than two NM cables containing two or more current-carrying conductors are installed, without maintaining spacing between the cables, through the same opening in wood framing that is to be sealed with thermal insulation, caulk, or sealing foam, the ampacity of each conductor shall be adjusted in accordance with Table 310.15(C)(1) and 310.14(A)(2), Exception, shall not apply.

Where more than two NM cables containing two or more current-carrying conductors are installed in contact with thermal insulation without maintaining spacing between cables, the ampacity of each conductor shall be adjusted in accordance with Table 310.15(C)(1) and 310.14(A)(2), Exception shall not apply.

As stated in 310.15(C)(1), "The ampacity of each conductor shall be reduced as shown in Table 310.15(C)(1), where the number of current-carrying conductors in a raceway or cable exceeds three, or where single conductors or multiconductor cables not installed in raceways are installed without maintaining spacing for a continuous length longer than 600 mm (24 in.)."

Failure to apply the appropriate ampacity adjustment factor called for by Table 310.15(C)(1), where Type NM cables are stacked or bundled without maintaining spacing, can lead to overheating of conductors. The ampacity adjustment requirements prevent overheating of the conductors where they pass through wood-framed draft- and fire-stopping material or are in direct contact with thermal insulation. Not only is thermal insulation provided within structures to reduce heat loss or heat gain, the same thermal insulation material can be used to control sound within structures as well.

#### Calculation Example

Four 2-conductor, size 12 AWG, copper with ground, Type NM cables are installed in direct contact with thermal insulation without maintaining spacing. Calculate the ampacity of the conductors according to the requirements of 334.80 and determine the maximum overcurrent protection permitted for the four circuits.

#### Solution

**Step 1.** Determine the number of current-carrying conductors:

$$4 \text{ cables} \times 2 \text{ conductors per cable} = \\ 8 \text{ current-carrying conductors}$$

**Step 2.** Determine the initial conductor ampacity. Using the 90°C copper ampacity from Table 310.16 for derating purposes, the initial ampacity of 12 AWG is 30 A.

**Step 3.** Determine the adjusted conductor ampacity. Due to the direct contact with thermal insulation, use Table 310.15(C)(1). Eight current-carrying conductors require an adjustment factor of 70 percent.

$$30 \text{ A} \times 0.7 = 21 \text{ A (adjusted)}$$

Section 334.80 does not allow an ampacity greater than that given in the 60°C column of Table 310.16; therefore, the conductor ampacity is limited to 20 A.

**Step 4.** Determine the maximum permitted overcurrent device for each circuit. According to the footnote in Table 310.16, conductor sizes 14 AWG through 10 AWG must also comply with 240.4(D), which limits protection of a 12 AWG copper conductor to a maximum of 20 A.

**Conclusion.** The final ampacity for each current-carrying conductor is 20 A, and the maximum overcurrent device permitted for each of the four circuits is 20 A.

This example points out that the 14 AWG to 10 AWG Type NM cable typically used for branch circuits can be installed without spacing and placed within thermal insulation with little impact on most installations. For similar installations, as long as the bundle is limited to not more than nine current-carrying conductors, the adjusted ampacity will not be below the overcurrent protection set in 240.4(D).

### Part III. Construction Specifications

**334.100 Construction.** The outer cable sheath of nonmetallic-sheathed cable shall be a nonmetallic material.

**334.104 Conductors.** The 600-volt insulated power conductors shall be sizes 14 AWG through 2 AWG copper conductors or sizes 12 AWG through 2 AWG aluminum or copper-clad aluminum conductors. Control and signaling conductors shall be no smaller than 18 AWG copper.

**334.108 Equipment Grounding Conductor.** In addition to the insulated conductors, the cable shall have an insulated, covered, or bare equipment grounding conductor.

**334.112 Insulation.** The insulated power conductors shall be one of the types listed in Table 310.4(1) that are suitable for branch-circuit wiring or one that is identified for use in these cables. Conductor insulation shall be rated at 90°C (194°F).