Exception No. 2: Where flexibility is necessary after installation, lengths from the last point where the raceway is securely fastened shall not exceed the following:

(1) 900 mm (3 ft) for metric designators 16 through 35 (trade sizes ½ through 1¼)
(2) 1200 mm (4 ft) for metric designators 41 through 53 (trade sizes 1½ through 2)
(3) 1500 mm (5 ft) for metric designators 63 (trade size 2½) and larger

Exception No. 3: Lengths not exceeding 1.8 m (6 ft) from a luminaire terminal connection for tap conductors to luminaires, as permitted in 410.117(C).

Exception No. 4: Lengths not exceeding 1.8 m (6 ft) from the last point where the raceway is securely fastened for connections within an accessible ceiling to luminaire(s) or other equipment.

Securing LFMC can be different from supporting it. The listed fittings are now recognized to provide the securement as well as the support required by this section.

For the purposes of the exceptions, listed LFMC fittings shall be permitted as a means of securement and support.

(B) Supports. Horizontal runs of LFMC supported by openings through framing members at intervals not greater than 1.4 m (4½ ft) and securely fastened within 300 mm (12 in.) of termination points shall be permitted.

350.42 Couplings and Connectors. Only fittings listed for use with LFMC shall be used. Angle connectors shall not be concealed. Straight LFMC fittings shall be permitted for direct burial where marked.

350.56 Splices and Taps. Splices and taps shall be made in accordance with 300.15.

Δ **350.60 Grounding and Bonding.**

N **(A) Fixed Installation.** LFMC shall be permitted to be used as an equipment grounding conductor when installed in accordance with 250.118(A)(6) where flexibility is not required after installation.

N **(B) Flexible Installation.** An equipment grounding conductor shall be installed where flexibility is necessary to minimize the transmission of vibration from equipment or to provide flexibility for equipment that requires movement after installation.

N **(C) Equipment Grounding Conductor.** Where required or installed, equipment grounding conductors shall be installed in accordance with 250.134.

N **(D) Equipment Bonding Jumpers.** Where required or installed, equipment bonding jumpers shall be installed in accordance with 250.102.

Informational Note: See 501.30(B)(2), 502.30(B)(2), 503.30(B)(2), 505.30(B)(2), and 506.30(B)(2) for types of equipment grounding conductors.

Part III. Construction Specifications

350.120 Marking. LFMC shall be marked according to 110.21. The trade size and other information required by the listing shall also be marked on the conduit. Conduit suitable for direct burial shall be so marked.

ARTICLE
352 Rigid Polyvinyl Chloride Conduit (PVC)

Part I. General

Δ **352.1 Scope.** This article covers the use, installation, and construction specifications for rigid polyvinyl chloride conduit (PVC) and associated fittings.

The UL *Guide Information for Electrical Equipment* describes rigid PVC conduit, Type PVC, for use in accordance with Article 352. Schedule 40 is suitable for locations not subject to physical damage for underground, aboveground, indoor, and outdoor locations. Schedule 80 is suitable for locations where the conduit will be subject to damage. Types A and EB are intended for underground installations.

• **352.6 Listing Requirements.** PVC conduit, factory elbows, and associated fittings shall be listed.

Part II. Installation

352.10 Uses Permitted. The use of PVC conduit shall be permitted in accordance with 352.10(A) through (K).

Informational Note: Extreme cold may cause some nonmetallic conduits to become brittle and, therefore, more susceptible to damage from physical contact.

(A) Concealed. PVC conduit shall be permitted in walls, floors, and ceilings.

Δ **(B) Encased in Concrete.** PVC conduit shall be permitted to be encased in concrete.

(C) Corrosive Influences. PVC conduit shall be permitted in locations subject to severe corrosive influences as covered in 300.6 and where subject to chemicals for which the materials are specifically approved.

(D) Cinders. PVC conduit shall be permitted in cinder fill.

(E) Wet Locations. PVC conduit shall be permitted in portions of dairies, laundries, canneries, or other wet locations, and in locations where walls are frequently washed, the entire conduit

system, including boxes and fittings used therewith, shall be installed and equipped so as to prevent water from entering the conduit. All supports, bolts, straps, screws, and so forth, shall be of corrosion-resistant materials or be protected against corrosion by approved corrosion-resistant materials.

(F) Dry and Damp Locations. PVC conduit shall be permitted for use in dry and damp locations not prohibited by 352.12.

Δ **(G) Exposed.** PVC conduit shall be permitted for exposed work.

(H) Underground Installations. For underground installations, PVC shall be permitted for direct burial and underground encased in concrete. See 300.5 and 305.15.

Schedule 40 and Schedule 80 PVC are both permitted for underground installations, such as under driveways, provided that the required burial depth is met.

See also

Table 300.5(A) for burial depth minimum cover requirements for 1000 V ac or less underground installations

Table 305.15(A) for burial depth minimum cover requirements for over 1000 V ac underground installations

(I) Support of Conduit Bodies. PVC conduit shall be permitted to support nonmetallic conduit bodies not larger than the largest trade size of an entering raceway. These conduit bodies shall not support luminaires or other equipment and shall not contain devices other than splicing devices as permitted by 110.14(B) and 314.16(C)(2).

(J) Insulation Temperature Limitations. Conductors or cables rated at a temperature higher than the listed temperature rating of PVC conduit shall be permitted to be installed in PVC conduit, provided the conductors or cables are not operated at a temperature higher than the listed temperature rating of the PVC conduit.

Conductors marked with a rated temperature higher than that of the raceway can be used if the conductors are to be operated within the raceway temperature rating. One application is the use of 105°C-rated medium-voltage cables, Type MV, where the cable ampacity at the 105°C rating is reduced to the cable ampacity at 75°C or 90°C to match the listed operating temperature rating of the PVC conduit (75°C or 90°C).

N **(K) Physical Damage.** Where subject to physical damage, Schedule 80 PVC conduit, Schedule 80 PVC elbows, and listed fittings for PVC conduit shall be used.

Informational Note: All listed PVC conduit fittings are suitable for connection to both Schedule 40 and Schedule 80 PVC conduit.

352.12 Uses Not Permitted. PVC conduit shall not be used under the conditions specified in 352.12(A) through (E).

(A) Hazardous (Classified) Locations. In any hazardous (classified) location, except as permitted by other articles of this *Code*.

(B) Support of Luminaires. For the support of luminaires or other equipment not described in 352.10(I).

(C) Physical Damage. Where subject to physical damage, except as permitted in 352.10(K).

(D) Ambient Temperatures. Where subject to ambient temperatures in excess of 50°C (122°F) unless listed otherwise.

(E) Theaters and Similar Locations. In theaters and similar locations, except as provided in 518.4 and 520.5.

In addition to the conditions in 352.12(A) through (E), PVC conduits are not permitted to be installed in ducts, plenums, and other air-handling spaces.

See also

300.22 for limitations of the use of materials in ducts, plenums, and other air-handling spaces, which could contribute smoke and products of combustion during a fire

352.20 Size.

(A) Minimum. PVC conduit smaller than metric designator 16 (trade size ½) shall not be used.

Δ **(B) Maximum.** PVC conduit larger than metric designator 155 (trade size 6) shall not be used.

Informational Note: See 300.1(C) for the trade sizes and metric designators that are for identification purposes only and do not relate to actual dimensions.

352.22 Number of Conductors. The number of conductors shall not exceed that permitted by the percentage fill specified in Table 1, Chapter 9.

Cables shall be permitted to be installed where such use is not prohibited by the respective cable articles. The number of cables shall not exceed the allowable percentage fill specified in Table 1, Chapter 9.

Table 4 of Chapter 9 provides the usable area within the selected conduit or tubing, and Table 5 provides the required area for each conductor. Examples using these tables to calculate a conduit or tubing size are provided in the commentary following Chapter 9, Notes to Tables, Note 6.

To select the proper trade size of PVC conduit, see the appropriate sub-table for Article 352, Rigid PVC Conduit (PVC), in Table 4 of Chapter 9. If the conductors are of the same wire size and insulation type, Tables C.10 and C.10(A) through Tables C.13 and C.13(A) can be used instead of performing the calculations, provided the appropriate table for the given type of PVC conduit is used.

Δ **352.24 Bends.**

N **(A) How Made.** Bends shall be so made that the conduit will not be damaged and the internal diameter of the conduit will not be effectively reduced. Field bends shall be made only with identified bending equipment. The radius of the curve to the

centerline of such bends shall not be less than shown in Table 2, Chapter 9.

Pulling conductors in underground conduit can damage nonmetallic elbows. Metal elbows are often used to ensure the raceway's integrity. Metal elbows in runs of PVC conduit that are buried at least 18 inches are not required to be bonded to the system grounded conductor or the grounding electrode conductor (GEC).

See also

250.80, Exception, for more information on metal elbows in service raceways and enclosures

Chapter 9, Table 2, for common raceway field bend measurements

N **(B) Number in One Run.** The total degrees of bends in a conduit run shall not exceed 360 degrees between pull points.

The number of bends in a conduit run is limited, to reduce pulling tension on the conductors and to help ensure easy insertion or removal of conductors during later phases of construction, when the conduit may be permanently enclosed by the building finish. The *NEC*® does not limit the pull points to conduit bodies and boxes, which are only examples of pull points.

352.28 Trimming. All cut ends shall be trimmed inside and outside to remove rough edges.

352.30 Securing and Supporting. PVC conduit shall be installed as a complete system as provided in 300.18 and shall be fastened so that movement from thermal expansion or contraction is permitted. PVC conduit shall be securely fastened and supported in accordance with 352.30(A) and (B).

(A) Securely Fastened. PVC conduit shall be securely fastened within 900 mm (3 ft) of each outlet box, junction box, device box, conduit body, or other conduit termination. Conduit listed for securing at other than 900 mm (3 ft) shall be permitted to be installed in accordance with the listing.

(B) Supports. PVC conduit shall be supported as required in Table 352.30(B). Conduit listed for support at spacings other than as shown in Table 352.30(B) shall be permitted to be installed in accordance with the listing. Horizontal runs of PVC conduit supported by openings through framing members at intervals not exceeding those in Table 352.30(B) and securely fastened within 900 mm (3 ft) of termination points shall be permitted.

TABLE 352.30(B) *Support of Rigid Polyvinyl Chloride Conduit (PVC)*

Conduit Size		Maximum Spacing Between Supports	
Metric Designator	Trade Size	mm or m	ft
16–27	½–1	900 mm	3
35–53	1¼–2	1.5 m	5
63–78	2½–3	1.8 m	6
91–129	3½–5	2.1 m	7
155	6	2.5 m	8

Δ **352.44 Expansion Fittings.**

N **(A) Thermal Expansion and Contraction.** Expansion fittings for PVC conduit shall be provided to compensate for thermal expansion and contraction where the length change, in accordance with Table 352.44(A), is expected to be 6 mm (¼ in.) or greater in a straight run between securely mounted items such as boxes, cabinets, elbows, or other conduit terminations.

Because PVC conduit exhibits a considerable change in length during a change in temperature, expansion fittings are required for specific temperature variations. According to Table 352.44(A), a 100-foot run of PVC conduit will change 4.06 inches in length if the temperature change is 100°F.

The allowable range of expansion for many PVC conduit expansion couplings is generally 6 inches. Information concerning installation and application of this type of coupling can be obtained from manufacturers' instructions.

Expansion fittings are seldom used underground, where temperatures are relatively constant. If PVC conduit is buried or covered immediately, expansion and contraction are not considered a problem.

See also

300.7(B) and its commentary regarding the expansion of PVC

N **(B) Earth Movement.** Expansion fittings for underground runs of direct buried PVC conduit emerging from the ground shall be provided above grade when required to compensate for earth settling or movement, including frost heave.

Informational Note: See 300.5(J).

352.46 Bushings. Where a conduit enters a box, fitting, or other enclosure, a bushing or adapter shall be provided to protect the wire from abrasion unless the box, fitting, or enclosure design provides equivalent protection.

Informational Note: See 300.4(G) for the protection of conductors 4 AWG and larger at bushings.

352.48 Joints. All joints between lengths of conduit and between conduit and couplings, fittings, and boxes, shall be made by an approved method.

352.56 Splices and Taps. Splices and taps shall be made in accordance with 300.15.

Δ **352.60 Grounding.** Where equipment grounding is required, separate grounding conductor shall be installed in the conduit.

Exception No. 1: The equipment grounding conductor shall be permitted to be run separately from the circuit conductors as permitted in 250.134, Exception No. 2, for dc circuits and

Δ ***TABLE 352.44(A)*** *Expansion Characteristics of PVC Rigid Nonmetallic Conduit Coefficient of Thermal Expansion = 6.084 × 10^{-5} mm/mm/°C (3.38 × 10^{-5} in./in./°F)*

Temperature Change (°C)	Length Change of PVC Conduit (mm/m)	Temperature Change (°F)	Length Change of PVC Conduit (in./100 ft)	Temperature Change (°F)	Length Change of PVC Conduit (in./100 ft)
5	0.30	5	0.20	105	4.26
10	0.61	10	0.41	110	4.46
15	0.91	15	0.61	115	4.66
20	1.22	20	0.81	120	4.87
25	1.52	25	1.01	125	5.07
30	1.83	30	1.22	130	5.27
35	2.13	35	1.42	135	5.48
40	2.43	40	1.62	140	5.68
45	2.74	45	1.83	145	5.88
50	3.04	50	2.03	150	6.08
55	3.35	55	2.23	155	6.29
60	3.65	60	2.43	160	6.49
65	3.95	65	2.64	165	6.69
70	4.26	70	2.84	170	6.90
75	4.56	75	3.04	175	7.10
80	4.87	80	3.24	180	7.30
85	5.17	85	3.45	185	7.50
90	5.48	90	3.65	190	7.71
95	5.78	95	3.85	195	7.91
100	6.08	100	4.06	200	8.11

250.134, Exception No. 1, for separately run equipment grounding conductors.

Exception No. 2: The equipment grounding conductor shall not be required where the grounded conductor is used to ground equipment as permitted in 250.142.

Part III. Construction Specifications

352.100 Construction. PVC conduit shall be made of rigid (nonplasticized) polyvinyl chloride (PVC). PVC conduit and fittings shall be composed of suitable nonmetallic material that is resistant to moisture and chemical atmospheres. For use aboveground, it shall also be flame retardant, resistant to impact and crushing, resistant to distortion from heat under conditions likely to be encountered in service, and resistant to low temperature and sunlight effects. For use underground, the material shall be acceptably resistant to moisture and corrosive agents and shall be of sufficient strength to withstand abuse, such as by impact and crushing, in handling and during installation. Where intended for direct burial, without encasement in concrete, the material shall also be capable of withstanding continued loading that is likely to be encountered after installation.

352.120 Marking. Each length of PVC conduit shall be clearly and durably marked at least every 3 m (10 ft) as required in the first sentence of 110.21(A). The type of material shall also be included in the marking unless it is visually identifiable. For conduit recognized for use aboveground, these markings shall be permanent. For conduit limited to underground use only, these markings shall be sufficiently durable to remain legible until the material is installed. Conduit shall be permitted to be surface marked to indicate special characteristics of the material.

Informational Note: Examples of these markings include but are not limited to "limited smoke" and "sunlight resistant."

ARTICLE 353

High Density Polyethylene Conduit: (HDPE Conduit)

Part I. General

Δ **353.1 Scope.** This article covers the use, installation, and construction specifications for high density polyethylene (HDPE) conduit and associated fittings.

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353.6 Listing Requirements. HDPE conduit and associated fittings shall be listed.

Part II. Installation

353.10 Uses Permitted. The use of HDPE conduit shall be permitted under the following conditions:

(1) In discrete lengths or in continuous lengths from a reel