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 a luminaire(s) or other equipment. For the purposes of the exceptions, listed FMC fittings shall be permitted as a means of securement and support.

Securing a raceway can be different from supporting the raceway. Specifying that the listed FMC fitting provides the securement also required by this section clarifies that the listed fitting provides both securement and support of the FMC.

(B) Supports. Horizontal runs of FMC 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.

348.42 Couplings and Connectors. Angle connectors shall not be concealed.

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

Δ **348.60 Grounding and Bonding.**

N **(A) Fixed Installation.** FMC shall be permitted to be used as an equipment grounding conductor when installed in accordance with 250.118(A)(5) where flexibility is not required after installation.

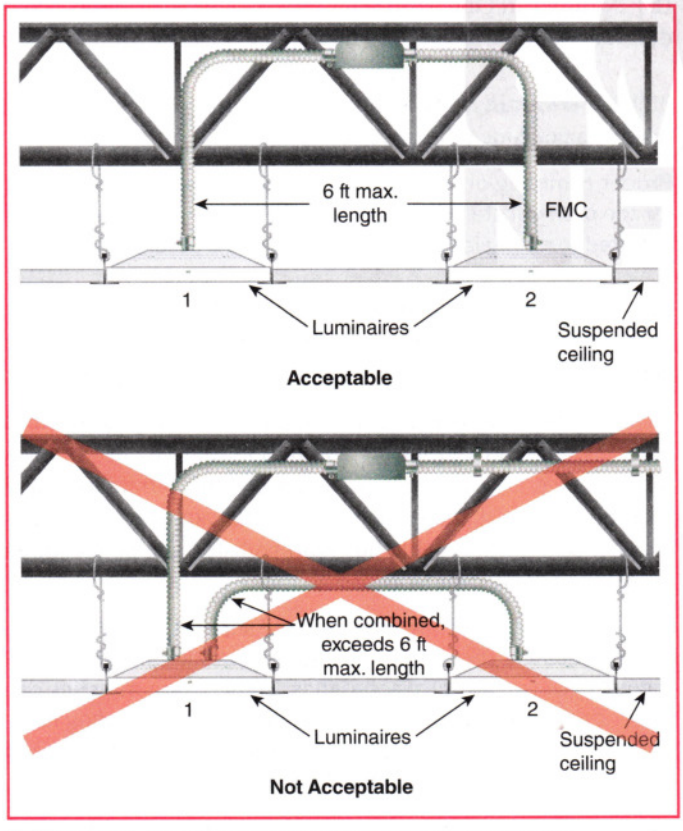

EXHIBIT 348.1 An example of acceptable and unacceptable applications of FMC without separate EGCs used as a luminaire whip, in accordance with 250.118(5)(d).

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.

An additional EGC is always required where FMC is used for flexibility. Examples of such installations include using FMC to minimize the transmission of equipment vibration such as motors or to provide flexibility for floodlights, spotlights, or other equipment that require adjustment after installation.

According to ANSI/UL 1, *Standard for Flexible Metal Conduit*, FMC longer than 6 feet has not been judged to be suitable for grounding purposes. If the length of the total ground-fault return path exceeds 6 feet or the circuit overcurrent protection exceeds 20 amperes, a separate EGC must be installed with the circuit conductors according to 250.118(5). The top figure in Exhibit 348.1 shows an acceptable application of FMC, where the total length of any ground return path is limited to 6 feet. The bottom figure shows an application that is unacceptable because the grounding return path for Luminaire 2 exceeds the permitted maximum of 6 feet to the box.

Where FMC is used in hazardous (classified) locations, a bonding jumper is required. Section 250.102(E) permits the routing of equipment bonding jumpers on the outside of the raceway in lengths that are no longer than 6 feet and bonded at each end.

N **(C) Equipment Grounding Conductors.** 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.

ARTICLE 350

Liquidtight Flexible Metal Conduit (LFMC)

Part I. General

350.1 Scope. This article covers the use, installation, and construction specifications for liquidtight flexible metal conduit (LFMC) and associated fittings.

LFMC is intended for use in wet locations or where exposed to oil or coolants, at a maximum temperature of 140°F. LFMC is not intended for use where exposed to gasoline or similar light petroleum solvents unless so marked on the product. If properly marked for the application, LFMC is permitted for direct burial in the earth. LFMC is on the permitted list of wiring methods for services (see 230.43), provided the length does not exceed 6 feet and an equipment bonding jumper is installed in accordance with 250.102. LFMC may be installed in unlimited lengths, provided it

meets the other requirements of Article 350 and a separate equipment grounding conductor (EGC) is installed with the circuit conductors.

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N **350.2 Reconditioned Equipment.** LFMC shall not be reconditioned.

350.6 Listing Requirements. LFMC and associated fittings shall be listed.

Part II. Installation

Δ **350.10 Uses Permitted.** LFMC shall be permitted to be used in exposed or concealed locations as follows:

(1) Where conditions of installation, operation, or maintenance require flexibility or protection from machine oils, liquids, vapors, or solids.
(2) In hazardous (classified) locations where specifically permitted by Chapter 5.
(3) For direct burial where listed and marked for the purpose.
(4) Conductors or cables rated at a temperature higher than the listed temperature rating of LFMC shall be permitted to be installed in LFMC, provided the conductors or cables are not operated at a temperature higher than the listed temperature rating of the LFMC.

350.12 Uses Not Permitted. LFMC shall not be used where subject to physical damage.

350.20 Size.

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

Exception: LFMC of metric designator 12 (trade size ⅜) shall be permitted as covered in 348.20(A).

(B) Maximum. The maximum size of LFMC shall be metric designator 103 (trade size 4).

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

350.22 Number of Conductors or Cables.

(A) Metric Designators 16 through 103 (Trade Sizes ½ through 4). 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.

(B) Metric Designator 12 (Trade Size ⅜). The number of conductors shall not exceed that permitted in Table 348.22, "Fittings Outside Conduit" columns.

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 LFMC, see the appropriate sub-table for Article 350, Liquidtight Flexible Metal Conduit (LFMC), in Table 4 of Chapter 9. If the conductors are of the same wire size, Tables C.8 and C.8(A) for LFMC in Informative Annex C can be used instead of performing the calculations.

The exception to 350.20(A) permits the use of trade size ⅜ LFMC under the limited conditions specified for flexible metal conduit (FMC) in 348.20(A).

See also

Table 348.22 for the number of conductors permitted in trade size ⅜ LFMC

Δ **350.24 Bends.**

N **(A) How Made.** Bends in conduit shall be so made that the conduit will not be damaged and the internal diameter of the conduit will not be effectively reduced. Bends shall be permitted to be made manually without auxiliary equipment. The radius of the curve to the centerline of any bend shall not be less than required in Table 2, Chapter 9 using the column "Other Bends."

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

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350.28 Trimming. All cut ends of conduit shall be trimmed inside and outside to remove rough edges.

Proper trimming of the cut ends of LFMC is necessary to allow for the proper installation of the steel grounding ferrule, which is required to maintain ground continuity of the steel sheath.

350.30 Securing and Supporting. LFMC shall be securely fastened in place and supported in accordance with 350.30(A) and (B).

(A) Securely Fastened. LFMC shall be securely fastened in place by an approved means within 300 mm (12 in.) of each box, cabinet, conduit body, or other conduit termination and shall be supported and secured at intervals not to exceed 1.4 m (4½ ft). Where used, cable ties shall be listed and be identified for securement and support.

Listing of cable ties for securement and support of LFMC is necessary because the standard requires markings that identify critical performance characteristics. These characteristics can affect their suitability for the conditions of use, including minimum and maximum operating temperatures, and resistance to ultraviolet light for outdoor installations.

Exception No. 1: Where LFMC is fished between access points through concealed spaces in finished buildings or structures and supporting is impractical.

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