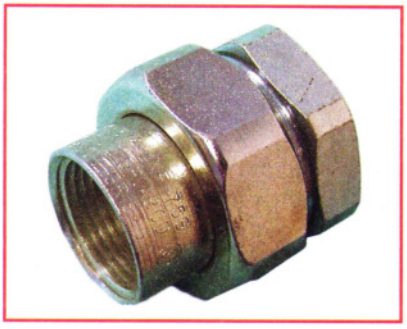

EXHIBIT 344.4 A three-piece (union-type) coupling. *(Courtesy of Appleton™, Emerson Electric Co.)*

344.46 Bushings. Where a conduit enters a box, fitting, or other enclosure, a bushing shall be provided to protect the wires from abrasion unless the box, fitting, or enclosure is designed to provide such protection.

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

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

344.60 Grounding. RMC shall be permitted as an equipment grounding conductor.

Part III. Construction Specifications

344.100 Construction. RMC shall be made of one of the following:

(1) Steel with protective coatings
(2) Aluminum
(3) Red brass
(4) Stainless steel

344.120 Marking. Each length shall be clearly and durably identified in every 3 m (10 ft) as required in the first sentence of 110.21(A). Nonferrous conduit of corrosion-resistant material shall have suitable markings.

ARTICLE 348 Flexible Metal Conduit (FMC)

Part I. General

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

•N **348.2 Reconditioned Equipment.** FMC shall not be reconditioned.

348.6 Listing Requirements. FMC and associated fittings shall be listed.

Part II. Installation

348.10 Uses Permitted. FMC shall be permitted to be used in exposed and concealed locations.

FMC ½ inch and larger may be installed in unlimited lengths, provided an equipment grounding conductor (EGC) is installed with the circuit conductors.

See also

250.118(A)(5) and **348.60(A)** for specific requirements related to the use of FMC as an EGC

348.12 Uses Not Permitted. FMC shall not be used in the following:

(1) In wet locations
(2) In hoistways, other than as permitted in 620.21(A)(1)
(3) In storage battery rooms
(4) In any hazardous (classified) location except as permitted by other articles in this *Code*
(5) Where exposed to materials having a deteriorating effect on the installed conductors, such as oil or gasoline
(6) Underground or embedded in poured concrete or aggregate
(7) Where subject to physical damage

348.20 Size.

(A) Minimum. FMC less than metric designator 16 (trade size ½) shall not be used unless permitted in 348.20(A)(1) through (A)(5) for metric designator 12 (trade size ⅜).

(1) For enclosing the leads of motors as permitted in 430.245(B)
(2) In lengths not in excess of 1.8 m (6 ft) for any of the following uses:
   a. For utilization equipment
   b. As part of a listed assembly
   c. For tap connections to luminaires as permitted in 410.117(C)

Trade size ⅜ FMC is permitted to be used as the manufactured or field-installed metal raceway (1½ feet to 6 feet in length) to enclose tap conductors between the outlet box and the terminal housing of recessed luminaires. FMC is also permitted to be used as a 6-foot luminaire whip from an outlet box to a luminaire.

(3) For manufactured wiring systems as permitted in 604.100(A)

A smaller minimum size for manufactured wiring systems is permitted [see Exception No. 3 to 604.100(A)(2)] because conductors assembled under factory-controlled conditions are not as prone to physical damage.

(4) In hoistways as permitted in 620.21(A)(1)
(5) As part of a listed assembly to connect wired luminaire sections as permitted in 410.137(C)

(B) Maximum. FMC larger than metric designator 103 (trade size 4) shall not be used.

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.

348.22 Number of Conductors. The number of conductors shall not exceed that permitted by the percentage fill specified in Table 1, Chapter 9, or as permitted in Table 348.22, or for metric designator 12 (trade size ⅜).

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 FMC, see the appropriate sub-table for Article 348, Flexible Metal Conduit (FMC), in Table 4 of Chapter 9. If the conductors are of the same wire size and insulation type, Tables C.3 and C.3(A) for FMC in Informative Annex C can be used instead of performing the calculations.

Δ **348.24 Bends.**

N **(A) How Made.** Bends in conduit shall be made so that the conduit is not damaged and the internal diameter of the conduit is not 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 shown 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.

•

348.28 Trimming. All cut ends shall be trimmed or otherwise finished to remove rough edges, except where fittings that thread into the convolutions are used.

348.30 Securing and Supporting. FMC shall be securely fastened in place and supported in accordance with 348.30(A) and (B).

(A) Securely Fastened. FMC 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 FMC 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 FMC is fished between access points through concealed spaces in finished buildings or structures and supporting is impracticable.

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

An example of the phrase "where flexibility is necessary after installation" is an installation of FMC to a motor mounted on an adjustable or sliding frame, where the frame is required to be movable for drive belt maintenance. The length that the exception addresses is the length from the last point where the FMC is securely fastened.

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

TABLE 348.22 *Maximum Number of Insulated Conductors in Metric Designator 12 (Trade Size ⅜) Flexible Metal Conduit (FMC)**

	Types RFH-2, SF-2		Types TF, XHHW, TW		Types TFN, THHN, THWN		Types FEP, FEBP, PF, PGF	
Size (AWG)	Fittings Inside Conduit	Fittings Outside Conduit	Fittings Inside Conduit	Fittings Outside Conduit	Fittings Inside Conduit	Fittings Outside Conduit	Fittings Inside Conduit	Fittings Outside Conduit
18	2	3	3	5	5	8	5	8
16	1	2	3	4	4	6	4	6
14	1	2	2	3	3	4	3	4
12	—	—	1	2	2	3	2	3
10	—	—	1	1	1	1	1	2

*In addition, one insulated, covered, or bare equipment grounding conductor of the same size shall be permitted.

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.

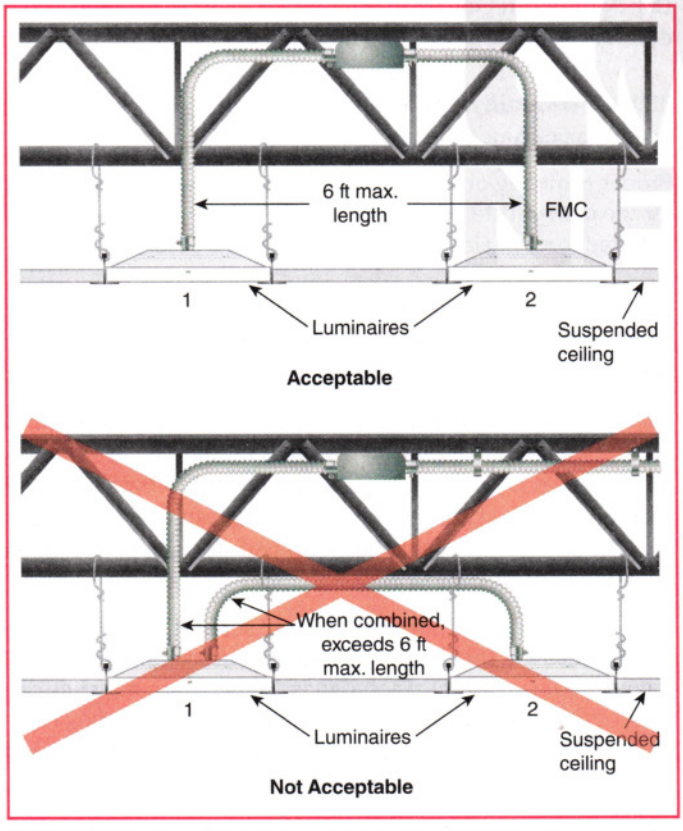

EXHIBIT 348.1 An example of acceptable and unacceptable applications of FMC without separate EGCs used as a luminaire whip, in accordance with 250.118(5)(d).

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