

NEMA Standards Publication RV 3-2021

*Application and Installation Guidelines for Flexible and
Liquid-tight Flexible Metal and Nonmetallic Conduits*

Published by:

National Electrical Manufacturers Association

1300 North 17th Street

Rosslyn, VA 22209

www.nema.org

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Foreword

These application and installation guidelines offer practical information on correct usage and industry recommended practices for the installation of Flexible Metal Conduit (Type FMC) and Liquid-tight Flexible Metal Conduit (Type LFMC) in accordance with the *National Electrical Code*[®] (NEC).

These guidelines have been developed by the NEMA Building Wire and Cable Group. The 'Group's Flexible Metal Conduit Technical Committee has committed to periodically reviewing them for any revisions necessary to address changing conditions, product listing and installation requirements, and technical progress. Comments for proposed revisions are welcomed and should be submitted to:

NEMA Technical Operations Department
National Electrical Manufacturers Association
1300 North 17th Street
Rosslyn, Virginia 22209

At the time of approval, the NEMA Building Wire and Cable Group's Flexible Metal Conduit Technical Committee had the following Members:

AFC Cable Systems, Inc., A part of Atkore International
Anamet Electrical, Inc.
Electri-Flex Company
Encore Wire Corporation
International Metal Hose Company
Southwire Company

New Bedford, MA
Mattoon, IL
Roselle, IL
McKinney, TX
Bellevue, OH
Carrollton, GA





Section 1 APPLICATION GUIDELINES FOR FLEXIBLE METAL CONDUIT

1.1 CONSTRUCTION

1.1.1 General

Flexible Metal Conduit (Type FMC) is constructed in accordance with the *National Electrical Code*[®] (*NEC*) and complies with the safety requirements of Underwriters Laboratories (UL), UL 1 *Standard for Safety for Flexible Metal Conduit*.

National Electrical Code[®] and *NEC*[®] are registered trademarks of the:

National Fire Protection Association, Inc.
1 Batterymarch Park
Quincy, MA 02269

1.1.2 Conduit

Flexible Metal Conduit (Type FMC) is constructed with an interlocked corrosion-resistant steel or aluminum strip and is manufactured in accordance with UL 1, which specifies strip thickness, splices, convolutions, interior surfaces, conduit diameters (internal and external), and the quality requirements of the aluminum strip and zinc-coated steel.

1.2 Grounding and Bonding

FMC is approved for bonding when installed in accordance with Articles 348 and 250 of the *NEC* but limited to 6-foot lengths when used for this purpose.

1.3 Equipment Grounding Conductor

One or more equipment grounding conductors are allowed but are not required. However, *NEC* Section 348.60 states that an equipment grounding conductor is required when FMC is used to connect equipment where flexibility is necessary to minimize the transmission of vibration from equipment or to provide flexibility for equipment that requires movement after installation.

1.4 Codes and Standards

1.4.1 *National Electrical Code*[®]

Flexible Metal Conduit Type FMC is designed, manufactured, and tested for use in accordance with the *National Electrical Code*[®] (*NEC*) Article 348 and with UL 1.

1.4.1.1 Uses Permitted

NEC Section 348.10 specifies the permitted uses of FMC as follows:

“““““FMC shall be permitted to be used in exposed and concealed locations.”””””

These permitted uses are not all-inclusive but only guide where FMC may be used.

In addition to permitted uses covered in Section 348.10, FMC is permitted for installation as follows:

- a. Outside Branch Circuits and Feeders;
- b. Services;
- c. Ducts or plenums used for environmental air;
- d. In other spaces used for environmental air;

- e. Under raised floors of computer rooms;
- f. Lighting whips; and
- g. Motor leads.

These permitted uses could imply that there is no limitation on the use of FMC. However, limitations are covered in *NEC* Section 348.12, Uses Not Permitted. Additionally, a key provision of the *NEC* for permitted uses is that wiring methods are required to comply with all applicable Sections of the *NEC*. For example, Article 348 does not impose a length limitation on FMC trade sizes ½ and larger; however, when used following Section 430.223 for raceway connections to motor circuits over 1000 V, a 6-foot limitation is imposed.

1.4.1.2 Uses Not Permitted

As with permitted uses, those uses not permitted by the *NEC* are not all-inclusive. The Code language is intended to provide guidance on where and how FMC may be used. *NEC* Section 348.12 specifies the uses of FMC that are not permitted, which are as follows:

- a. In wet locations.
- b. In hoistways, other than as permitted in 620.21(A)(1).
- c. In storage battery rooms.
- d. In any hazardous (classified) location except as permitted by other articles in the code.
- e. Where exposed to materials having a deteriorating effect on the installed conductors, such as oil or gasoline.
- f. Underground or embedded in poured concrete or aggregate.
- g. Where subject to physical damage.

The following provides additional guidance on the uses of FMC:

Corrosive environments and use underground:

Review of the uses not permitted shows that FMC cannot be installed where corrosive environments may be present or in concrete or underground locations. A Flexible Metal Conduit with a protective outer covering such as a Liquid-tight Flexible Metal Conduit with an outer nonmetallic jacket approved for use should be used for such installations.

Where subject to physical damage:

FMC must be protected from physical damage. This includes installing FMC at heights and locations where it will not be exposed to damage. It also includes providing mechanical protection such as from nails and screws in accordance with section 300.4(D) by maintaining a 1-1/4 in (32 mm) distance from the edge of a framing member or by providing a metal plate where the distance cannot be maintained from the edge of a framing member or a furring strip.

1.4.2 Related *NEC* Articles

The following *NEC* Articles also contain provisions for the use of FMC:

Wiring and Protection

ARTICLE 225 Outside Branch Circuits and Feeders
225.10 Wiring on Buildings

ARTICLE 230 Services
230.43 Wiring Methods for 1000 Volts, Nominal, or Less

ARTICLE 250 Grounding and Bonding
250.118 (5) Use of the Armor of FMC as Equipment Grounding Conductor

Wiring Methods and Materials

ARTICLE 300 Wiring Methods

- 300.22 Wiring in Ducts Not used for Air Handling, Fabricated Ducts for Environmental Air, and Other Spaces for Environmental Air (Plenums)
 - (B) Ducts Specifically Fabricated for Environmental Air
 - (C) Other Space Used for Environmental Air

ARTICLE 348 Flexible Metal Conduit: Type FMC

- ARTICLE 368 Busways
 - 368.56 Branches from Busways

- ARTICLE 374 Cellular Metal Floor Raceways
 - 374.18 (A) Connection to Cabinets and Extensions from Cells

- ARTICLE 392 Cable Trays
 - 392.10 Uses Permitted (A) Wiring Methods

Equipment for General Use

- ARTICLE 410 Luminaires (Lighting Fixtures), Lampholders, and Lamps
 - XII. Special Provisions for Electric-Discharge Lighting Systems of 1000 Volts or Less
 - 410.137 Equipment Not Integral with Luminaire
 - (C) Wired Luminaire (Fixture) Sections

- ARTICLE 430 Motors, Motor Circuits, and Controllers
 - XI. Over 600 Volts, Nominal
 - 430.223 Raceway Connection to Motors
 - XIII. Grounding—All Voltages
 - 430.245 Method of Grounding
 - (B) Separation of Junction Box from Motor

Special Occupancies

- ARTICLE 501 Class I Locations
 - 501.10 Wiring Methods
 - (B) Class I, Division 2-(2) Flexible Connections
 - 501.30 Grounding and Bonding, Class I, Divisions 1 and 2
 - (B) Types of Grounding Conductors

- ARTICLE 505 Class I, Zone 0, 1, and 2 Locations
 - 505.15 Wiring Methods
 - (C) Class I, Zone 2-(2) Flexible Connections
 - 505.25 Grounding and Bonding
 - (B) Types of Equipment Grounding Conductors

- ARTICLE 511 Commercial Garages, Repair and Storage
 - 511.7 Wiring and Equipment Installed Above Class I Locations
 - (A) Wiring in Spaces Above Class I Locations
 - (1) Fixed Wiring Above Class I Locations

- ARTICLE 520 Theaters, Audience Areas of Motion Picture and Television Studios, Performance Areas, and Similar Locations
 - III. Fixed Stage Equipment Other Than Switchboards
 - 520.43 Footlights
 - (B) Other Than-Metal Trough Construction

- ARTICLE 550 Mobile Homes, Manufactured Homes, and Mobile Home Parks
 - II. Mobile and Manufactured Homes

- 550.15 Wiring Methods and Materials
 - (E) Installation Requirements
- 550.16 Grounding
 - (2) Connections of Ranges and Clothes Dryers

- ARTICLE 551 Recreational Vehicles and Recreational Vehicle Parks
IV. Nominal 120-Volt or 120/240-Volt Systems
- 551.47 Wiring Methods
 - (A) Wiring Systems

- ARTICLE 552 Park Trailers
IV. Nominal 120-Volt or 120/240-Volt Systems
- 552.48 Wiring Methods
 - (A) Wiring Systems

- ARTICLE 600 Electric Signs and Outline Lighting
II. Field-Installed Skeleton Tubing, Outline Lighting and Secondary Wiring
- 600.31 Neon Secondary-Circuit Wiring, 1000 Volts or Less, Nominal
 - (A) Wiring Method
 - 600.32 Neon Secondary Circuit Wiring, Over 1000 Volts, Nominal
 - (A) Wiring Methods
 - (1) Installation

- ARTICLE 604 Manufactured Wiring Systems
- 604.100 Construction
 - (A) Cable or Conduit Types
 - (2) Conduits

- ARTICLE 610 Cranes and Hoists
II. Wiring
- 610.11 Wiring Method
 - (C) Flexible Connections to Motors and Similar Equipment

- ARTICLE 620 Elevators, Dumbwaiters, Escalators, Moving Walks, Platform Lifts, and Stairway Chair Lifts
III. Wiring
- 620.21 Wiring Methods
 - (A) Elevators
 - (1) Hoistways and Pits
 - (2) Cars
 - (3) Within Machine Rooms, Control Rooms, and Machinery Spaces and Control Spaces
 - (4) Counterweight
 - (B) Escalators
 - (1) Wiring Methods
 - (C) Platform Lifts and Stairway Chairlift Raceways.
 - (1) Wiring Methods

- ARTICLE 645 Information Technology Equipment
- 645.5 Supply Circuits and Interconnecting Cables
 - (E)(2) Under Raised Floors

- ARTICLE 680 Swimming Pools, Fountains, and Similar Installations
- 680.25 Feeders
 - (A) Wiring Methods

1.4.3 Underwriters Laboratories

1.4.3.1 UL Category Guide Information and Certifications

For each certification product category, UL publishes Guide Information that contains useful information on the products that it lists, classifies, certifies, and recognizes. The certification category guide information is frequently used by installers and by inspection authorities to better understand how to specify and install products according to their certification.

This information is readily available on UL's Product iQ™ (www.ul.com/apps/product-ig) (formerly known as the Online Certifications Directory). The easiest way to start is to enter a keyword or product type in the "Create a Search Now" field at the top of the page. While entering data into this field, relevant search terms will be suggested below. Once a search is performed, further options to refine the search will be available on the left side of the page. This website is helpful for locating the certification category guide information for products, the product certifications, and for understanding the details of how products are constructed and marked. Information on special or optional ratings and terminations is also available.

The following information on flexible metal conduit is reprinted from Product iQ™ with permission from UL © 2021 UL LLC. For the most current guide information, check the UL Product iQ™ website given above.

Flexible Metal Conduit, DXUZ

USE

This category covers flexible aluminum and steel conduit in trade sizes 3/8 to 4 (metric designators 12 to 103) inclusive, flexible aluminum and steel conduit Type RW (reduced wall), flexible aluminum and steel conduit Type XRW (extra reduced wall) in trade sizes from 3/8 to 3 (16 to 78) inclusive, for installation in accordance with Article 348 of ANSI/NFPA 70, *National Electrical Code*® (NEC). This product may also be used for installation of conductors in motor circuits, electric signs, and outline lighting in accordance with the NEC.

Flexible metal conduit (steel or aluminum) should not be used underground (directly buried or in a duct which is buried) or embedded in poured concrete or aggregate, or in direct contact with earth or where subjected to corrosive conditions. In addition, flexible aluminum conduit should not be installed in direct contact with masonry in damp locations.

For flexible metal conduit in 1-1/4 (35) trade size and smaller, where terminated in fittings investigated for grounding and where installed with not more than 6 ft. (total length) in any ground-return path, flexible metal conduit is suitable for grounding where used on circuits rated 20 A or less. See Conduit Fittings (DWTT) with respect to fittings suitable as a grounding means.

The following are not considered to be suitable as a grounding means:

1. The 1-1/2 (41) and larger trade sizes.
2. The 1-1/4 (35) trade size and smaller where used on circuits rated higher than 20 A, or where the total length in the ground-return path is greater than 6 ft.

To prevent possible damage to flexible aluminum conduit, flexible aluminum, and steel conduit Types RW and XRW care must be exercised when installing connectors employing direct bearing set screws.

PRODUCT MARKINGS

Flexible aluminum conduit is marked at intervals of not more than one foot with the letters “AL”.

Flexible aluminum conduit Type RW is marked at intervals of not more than one foot with the letters “AL” and “RW”.

Flexible steel conduit Type RW is marked at intervals of not more than one foot with the letters “RW”.

Flexible aluminum conduit Type XRW is marked at intervals of not more than one foot with the letters “AL” and “XRW”.

Flexible steel conduit Type XRW is marked at intervals of not more than one foot with the letters “XRW”.

PRODUCT IDENTITY

One of the following product identities appears on the product:

Flexible Aluminum Conduit

Flexible Aluminum Conduit Type RW

Flexible Aluminum Conduit Type XRW

Flexible Steel Conduit

Flexible Steel Conduit Type RW

Flexible Steel Conduit Type XRW



RELATED PRODUCTS

See Conduit Fittings (DWTT) with respect to fittings suitable as a grounding means.

ADDITIONAL INFORMATION

For additional information, see Electrical Equipment for Use in Ordinary Locations (AALZ).

REQUIREMENTS

The basic Standard used to investigate products in this category is ANSI/UL 1, “Flexible Metal Conduit”.

UL MARK

The UL symbol on the product and the Certification Mark of UL on the attached tag, reel, or on the smallest unit container in which the product is packaged is the only method provided by UL to identify products manufactured under its Certification and Follow-Up Service. The Certification Mark for these products includes the UL symbol, the words “CERTIFIED” and “SAFETY”, the geographic identifier(s), and a file number.

ALTERNATE UL MARK

The UL symbol on the product and the Listing Mark of UL on the attached tag, the reel, or the smallest unit container in which the product is packaged is the only method provided by UL to identify these products manufactured under its Listing and Follow-Up Service. The Listing Mark for these products includes the UL symbol (as illustrated in the Introduction of this Directory) together with the word "LISTED", a control number, and one of the following product names as appropriate: "Flexible Aluminum Conduit", "Flexible Steel Conduit", "Flexible Aluminum Conduit Type RW", "Flexible Steel Conduit Type RW", "Flexible Aluminum Conduit Type XRW" or "Flexible Steel Conduit Type XRW."

1.4.3.2 UL Fire Resistance Ratings

UL information regarding fire-resistance ratings (previously included in the *UL Fire Resistance Directory*) is available and generally covers the construction detail necessary for constructing fire-rated walls, floors, and ceilings. It also covers the certified materials and methods for sealing the wall, ceiling, or floor that has been penetrated by electrical cables, conduit, cable tray, or other equipment. Cable manufacturers' classifications for through-penetrating products are also covered. The methods and materials are certified by UL under the category of through-penetration firestop systems. This information should always be consulted for the proper method of sealing the opening. Any such opening that is not properly sealed following UL-certified through-penetration firestop systems will be subject to rejection by the inspecting authority.

To access this information:

Go to www.ul.com/apps/product-iq

- a. Click on the blue "Access Product IQ" button
- b. Log in or sign up for access
- c. After log-in, you should see a screen with "Create a Search Now" near the top
- d. Scroll down the page and click on "Building Materials, Systems, and Installation Codes" (green icon)
- e. A list will open below with links for Firestop Systems and other related fire-resistance information
- f. Once an option is selected and opened, a keyword search for the cable or conductor type can be made
- g. The search can be further modified using the options on the left side of the page

Section 2 *NEC Application Guidelines for Liquid-Tight Flexible Metal and Nonmetallic Conduit*

2.1 Construction

2.1.1 General

2.1.1.1 LFNC

Liquid-tight Flexible Nonmetallic Conduit (LFNC) is constructed following the *NEC* and complies with the safety requirements of Underwriters Laboratories (UL) UL 1660 *Standard for Safety for Liquid-Tight Flexible Nonmetallic Conduit*. LFNC is made entirely of nonmetallic materials in trade sizes 3/8, 1/2, 3/4, 1, 1-1/4, 1-1/2, and 2. UL 1660 specifies the requirements for the inner and outer diameters, flexibility, tension properties, and crush resistance, as well as pipe stiffness in the case of conduit intended for direct burial and sunlight resistance in the case of conduit intended for use outdoors. Liquid-tight flexible nonmetallic conduit comes in three types, LFNC-A, LFNC-B, and LFNC-C.

Type LFNC-A has a smooth, seamless inner core and cover bonded together with one or more reinforcement layers between the core and cover.

Type LFNC-B has a smooth inner surface with integral reinforcement within the conduit wall.

Type LFNC-C has corrugated internal and external surfaces without integral reinforcement within the conduit.

2.1.1.2 LFMC

Liquid-tight Flexible Metal Conduit (LFMC) is constructed following the *National Electrical Code*[®] (*NEC*) and complies with the safety requirements of Underwriters Laboratories (UL) UL 360 *Standard for Safety for Liquid-tight Flexible Metal Conduit*. The conduit is constructed with an interlocked zinc-coated corrosion-resistant steel, aluminum, brass, bronze, copper, or stainless steel in trade sizes 3/8, 1/2, 3/4, 1, 1-1/4, 1-1/2, 2, 2-1/2, 3, and 4. Steel conduit in trade sizes 3/8 – 1-1/4 includes a bonding strip or wire enclosed by the convolutions throughout its entire length. The need for a bonding strip or wire in conduits other than steel is determined through investigation. LFMC may also be fabricated with a metallic braiding material between the conduit core and outer jacket. Braiding material in aluminum conduit, if present, will always be aluminum. The minimum braid wire diameter is 0.005”.

UL 360 specifies the requirements for the core’s internal and external diameters, corrosion protection, electrical resistance, fault current carrying capability, flexibility, tension properties, and crush resistance, as well as pipe stiffness in the case of conduit intended for direct burial.

2.1.2 Jacket Material

2.1.2.1 LFNC

The material is liquid-tight, nonmetallic, and sunlight resistant (where applicable), suitable for use in wet, dry, or oily locations. The marked temperature designations indicate the maximum temperature for wet, dry, and oily locations. UL 1660 governs the minimum jacket thickness.

2.1.2.2 LFMC

The jacket material is liquid-tight, nonmetallic, and sunlight resistant, suitable for use in wet, dry, or oily locations. The marked temperature designations indicate the maximum temperature for wet, dry, and oily locations. UL 360 governs the minimum jacket thickness.

2.1.3 Fittings

Fittings for LFNC and LFMC are constructed in accordance with UL 514B *Conduit, Tubing and Cable Fittings*. See NEMA FB 2.20 for selection and installation guidelines for these fittings.

2.2 Grounding

2.2.1 LFNC

LFNC is installed in accordance with *NEC* Article 356, Liquidtight Flexible Nonmetallic Conduit. A separate grounding conductor or bonding jumper is installed with the circuit conductors, as required, in accordance with Article 250, Grounding and Bonding.

2.2.2 LFMC

LFMC trade sizes 3/8, 1/2, 3/4, 1, and 1-1/4 may be used for equipment grounding in lengths of 6 ft. or less when installed with listed fittings, and when installed in accordance with *NEC* Article 350, Liquid-tight Flexible Metal Conduit, and Article 250, Grounding and Bonding. LFMC trade sizes 3/8 through 4 may be installed in unlimited lengths provided the conduit meets the other requirements of Articles 350 and 250, and a separate grounding conductor is installed with the circuit conductors.

2.3 Marking

2.3.1 LFNC

LFNC is marked with the manufacturer name, trade name, or trademark, trade size, metric designator, temperature ratings, and, where applicable, direct burial and sunlight resistant. When LFNC-B is supplied as a prewired manufactured assembly, the type, size, and quantity of conductors are identified by means of a printed tag label as required in *NEC* Article 356.

2.3.2 LFMC

LFMC is marked with the manufacturer name or location, trade size, temperature ratings, direct burial rating (where applicable), flame rating, and current ratings (when used for equipment grounding according to Article 250). Also, conduit other than galvanized steel is marked as follows:

- 1) Aluminum – “LFMC-AL”
- 2) Brass – “LFMC-BR”
- 3) Bronze – “LFMC-BZ”
- 4) Copper – “LFMC-CU”
- 5) Stainless steel – “LFMC-SS”

2.4 Codes and Standards

2.4.1 National Electrical Code®

Type Liquidtight Flexible Metal Conduit, LFMC is designed, manufactured, and tested for use in accordance with the *NEC*, Article 350 and UL 360.

Type Liquid-tight Flexible Nonmetallic Conduit, LFNC is designed, manufactured, and tested for use in accordance with the *NEC*, Article 356 and UL 1660.

2.4.1.1 Uses Permitted

2.4.1.1.1 LFMC

NEC Section 350.10 specifies the permitted uses of LFMC as follows:

LFMC shall be permitted to be used in exposed and concealed locations as follows:

- a. Where conditions of installation, operation, or maintenance require flexibility or protection from liquids, vapors, or solids.

- b. As permitted by 501.10(B), 502.10, 503.10, and 504.20 and in other hazardous (classified) locations where specifically approved, and by 553.7(B).
- c. For direct burial where listed and marked for the purpose.
- d. Conductors or cables rated at a temperature higher than the listed temperature rating of LFMC conduit 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 per 110.14(C).

These permitted uses are not all-inclusive but only provide guidance on where LFMC may be used.

In addition to permitted uses covered in Section 350.10, LFMC is permitted for installation as follows:

- a. Outside Branch Circuits and Feeders;
- b. Services;
- c. Under raised floors of computer rooms;
- d. Lighting whips; and
- e. Motor leads.

2.4.1.1.2 LFNC

NEC Section 356.10 specifies the permitted uses of LFNC as follows:

LFNC shall be permitted to be used in exposed or concealed locations for the following purposes:

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

- 1) Where flexibility is required for installation, operation, or maintenance.
- 2) Where protection of the contained conductors is required from vapors, liquids, or solids.
- 3) For outdoor locations where listed and marked as suitable for the purpose.
- 4) For direct burial where listed and marked for the purpose.
- 5) Type LFNC-B shall be permitted to be installed in lengths longer than 1.8 m (6 ft.) where secured in accordance with 356.30.
- 6) Type LFNC-B as a listed manufactured prewired assembly, metric designator 16 through 27 (trade size ½ through 1) conduit.
- 7) For encasement in concrete where listed for direct burial and installed in compliance with 356.42.
- 8) Conductors or cables rated at a temperature rating of LFNC conduit shall be permitted to be installed in LFNC, provided the conductors or cables are not operated at a temperature higher than the listed temperature rating of the LFNC.

2.4.1.2 Uses Not Permitted

2.4.1.2.1 LFMC

As with permitted uses, those uses not permitted by the *NEC* are not all-inclusive. The code language is intended to provide guidance on where and how LFMC may be used.

NEC Section 350.12 specifies the uses of LFMC that are not permitted, which are as follows:

- 1) Where subject to physical damage.
- 2) Where any combination of ambient and conductor temperature produces an operating temperature in excess of that for which the material is approved.

2.4.1.2.2 LFNC

NEC Section 356.12 specifies the uses of LFNC that are not permitted, which are as follows:

- (1) Where subject to physical damage.
- (2) Where any combination of ambient and conductor temperatures is in excess of that for which the LFNC is approved.

- (3) In lengths longer than 1.8 m (6 ft.), except as permitted by 356.10(5) or where a longer length is approved as essential for a required degree of flexibility.
- (4) Where the operating voltage of the contained conductors is in excess of 1000 volts, nominal, except as permitted in 600.32(A).
- (5) In any hazardous (classified) location, except as permitted by other articles in this code.

2.4.1.3 Where Subject to Physical Damage

LFMC and LFNC must be protected from physical damage. This includes installing LFMC at heights and locations where it will not be exposed to damage. It also includes providing mechanical protection such as from nails and screws in accordance with section 300.4(D) by maintaining a 1-1/4 in (32 mm) distance from the edge of a framing member or by providing a metal plate where the distance cannot be maintained from the edge of a framing member or a furring strip.

2.4.2 RELATED NEC ARTICLES

The following *NEC* Articles also contain provisions for the use of LFMC and LFNC:

Wiring and Protection

ARTICLE 225 Outside Branch Circuits and Feeders
225.10 Wiring on Buildings

ARTICLE 230 Services
230.43 Wiring Methods for 1000 Volts, Nominal, or Less

ARTICLE 250 Grounding and Bonding (LFMC only)
250.118 Types of Equipment Grounding Conductors

Wiring Methods and Materials

ARTICLE 350 Liquid-tight Flexible Metal Conduit: Type LFMC

ARTICLE 356 Liquid-tight Flexible Nonmetallic Conduit: Type LFNC

ARTICLE 368 Busways
368.56 Branches from Busways

ARTICLE 374 Cellular Metal Floor Raceways
374.11 Connection to Cabinets and Extensions from Cells

ARTICLE 392 Cable Trays
392.10 Uses Permitted (A) Wiring Methods

Equipment for General Use

ARTICLE 430 Motors, Motor Circuits, and Controllers
XI. Over 1000 Volts, Nominal
430.223 Raceway Connection to Motors (LFMC only)
XIII. Grounding—All Voltages
430.245 Method of Grounding
(B) Separation of Junction Box from Motor

Special Occupancies

ARTICLE 501 Class I Locations
II. Wiring
501.10 Wiring Methods
(B) Class I, Division 2
(2) Flexible Connections
501.30 Grounding and Bonding, Class I, Divisions 1 and 2 (LFMC only)
(B) Types of Equipment Grounding Conductors

ARTICLE 502 Class II Locations

II. Wiring

502.10 Wiring Methods

(2) Flexible Connections

502.30 Grounding and Bonding, Class II, Divisions 1 and 2

(B) Types of Equipment Grounding Conductors

ARTICLE 503 Class III Locations

II. Wiring

503.10 Wiring Methods

(3) Flexible Connections

ARTICLE 505 Class I, Zone 0, 1, and 2 Locations

505.15 Wiring Methods

(C) Class I, Zone 2

(2) Flexible Connections

505.25 Grounding and Bonding (LFMC only)

(B) Types of Equipment Grounding Conductors

ARTICLE 506 Zone 20, 21, and 22 Locations for Combustible Dusts or Ignitable Fibers/Flyings

506.15 Wiring Methods (A)(6)

506.25 Grounding and Bonding

(B) Types of Equipment Grounding Conductors (LFMC only)

ARTICLE 511 Commercial Garages, Repair and Storage

511.7 Wiring and Equipment Installed Above Class I Locations

(A) Wiring in Spaces Above Class I Locations

(1) Fixed Wiring Above Class I Locations

ARTICLE 551 Recreational Vehicles and Recreational Vehicle Parks

IV. Nominal 120-Volt or 120/240-Volt Systems

551.47 Wiring Methods

ARTICLE 551 Recreational Vehicles and Recreational Vehicle Parks

VI. Recreational Vehicle Parks

551.80 Underground Service, Feeder, Branch-Circuit, and Recreational Vehicle Site Feeder-Circuit Conductors

(B) Protection Against Physical Damage

ARTICLE 552 Park Trailers

IV. Nominal 120-Volt or 120/240-Volt Systems

552.48 Wiring Methods

(A) Wiring Systems

ARTICLE 553 Floating Buildings

II. Services and Feeders

553.7 Installation of Services and Feeders

(B) Wiring Methods

Special Equipment

ARTICLE 600 Electric Signs and Outline Lighting

II. Field-Installed Skeleton Tubing

600.31 Neon Secondary-Circuit Conductors, 1000 Volts or Less, Nominal

(A) Wiring Method

600.32 Neon Secondary Circuit Conductors, Over 1000 Volts, Nominal

(A) Wiring Methods

(1) Installation

- ARTICLE 604 Manufactured Wiring Systems
 - 604.6 Construction
 - (A) Cable or Conduit Types
 - (2) Conduits (LFMC only)
- ARTICLE 610 Cranes and Hoists
 - II. Wiring
 - 610.11 Wiring Method
 - (C) Flexible Connections to Motors and Similar Equipment
- ARTICLE 620 Elevators, Dumbwaiters, Escalators, Moving Walks, Platform Lifts, and Stairway Chair Lifts
 - III. Wiring
 - 620.21 Wiring Methods
- ARTICLE 645 Information Technology Equipment
 - 645.5 Supply Circuits and Interconnecting Cables
 - (E)(2) Under Raised Floors
- ARTICLE 680 Swimming Pools, Fountains, and Similar Installations
 - II. Permanently Installed Pools
 - 680.23 Underwater Luminaires (Lighting Fixtures)
 - (F) Branch-Circuit Wiring
 - (1) Wiring Methods
 - IV. Spas and Hot Tubs
 - 680.42 Outdoor Installations
 - (A) Flexible Connections
 - (1) Flexible Conduit
- ARTICLE 695 Fire Pumps
 - 695.6 Power Wiring
 - (D) Pump Wiring
 - 695.14 Control Wiring
 - (E) Electric Fire Pump Control Wiring Methods

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2.4.3 Underwriters Laboratories

2.4.3.1 UL Category Information and Certifications

For each certification product category, UL publishes Guide Information that contains useful information on the products that it lists, classifies, certifies, and recognizes. The certification category guide information is frequently used by installers and by inspection authorities to better understand how to specify and install products according to their certification.

This information is readily available on Product iQ™ (www.ul.com/apps/product-iq) (formerly known as the Online Certifications Directory). The easiest way to start is to enter a keyword or product type in the “Create a Search Now” field at the top of the page. While entering data into this field, relevant search terms will be suggested below. Once a search is performed, further options to refine the search will be available on the left side of the page. This website is helpful for locating the certification category guide information for products, the product certifications, and for understanding the details of how products are constructed and marked. Information on special or optional ratings and terminations is also available.

The following information on Type Liquid-tight Flexible Nonmetallic Conduit is reprinted from Product iQ™ with permission from UL © 2021 UL LLC. For the most current guide information, check the UL Product iQ™ website given above.

Liquid-tight Flexible Nonmetallic Conduit, DXOQ

USE AND INSTALLATION

This category covers liquid-tight flexible nonmetallic conduit, in trade sizes 3/8 in. to 4 (metric designators 12 to 103) inclusive, for installation in accordance with Article 356 of ANSI/NFPA 70, *National Electrical Code*® (NEC). This product may also be used for installation of conductors for electric signs and outline lighting following the NEC.

PRODUCT MARKINGS

Liquid-tight flexible nonmetallic conduit suitable for direct burial and in poured concrete is marked “Direct Burial”, “Burial”, “Dir Burial” or “Dir Bur.”

Liquid-tight flexible nonmetallic conduit suitable for use outdoors is marked “Outdoor.”

Liquid-tight flexible nonmetallic conduit is marked with the product name in conjunction with the Certification Mark and the type of construction: “A” for layered conduit, “B” for integral conduit and “C” for corrugated conduit, or with “LFNC-A” for layered conduit, “LFNC-B” for integral conduit, and “LFNC-C” for corrugated conduit.

Liquid-tight flexible nonmetallic conduit not marked with a temperature designation or marked “60 C” is for use at temperatures not in excess of 60°C (140°F).

Conduit for use in dry or oily locations at a temperature higher than 60°C (140°F) is marked “___ C dry, 60 C wet, 70 C oil res” (or “___ C dry, 60 C wet, 70 C oil resistant”) with “80 C” or “105 C” inserted as the dry-locations temperature.

Conduit marked “___ C dry, 60 C wet, 60 C oil res” (or “___ C dry, 60 C wet, 60 C oil resistant”) is for use at a temperature of 105°C (221°F) and lower temperatures in air, and at 60°C (140°F) and lower temperatures where exposed to water, oil or coolants, with “80”, “90” or “105” inserted as the dry-locations temperature.

PRODUCT IDENTITY

One of the following product identities appears on the product:

LFNC-A
LFNC-B
LFNC-C
Liquid-Tight Flexible Nonmetallic Conduit

RELATED PRODUCTS

Fittings for use with liquid-tight nonmetallic conduit are covered under Conduit Fittings (DWTT) and are suitable only for the type of conduit indicated by the marking on the fitting.

ADDITIONAL INFORMATION

For additional information, see Electrical Equipment for Use in Ordinary Locations (AALZ).

REQUIREMENTS

The basic Standard used to investigate products in this category is ANSI/UL 1660, "Liquid-Tight Flexible Nonmetallic Conduit."

UL MARK

The Certification Mark of UL on the product is the only method provided by UL to identify products manufactured under its Certification and Follow-Up Service. The Certification Mark for these products includes the UL symbol, the words "CERTIFIED" and "SAFETY," the geographic identifier(s), and a file number.

ALTERNATE UL MARK

The Listing Mark of UL on the product is the only method provided by UL to identify products manufactured under its Listing and Follow-Up Service. The Listing Mark for these products includes the UL symbol (as illustrated in the Introduction of this Directory) together with the word "LISTED," a control number, and one of the following product names as appropriate: "Liquid-Tight Flexible Nonmetallic Conduit," "LFNC-A," "LFNC-B" or "LFNC-C."

Liquid-tight Flexible Metal Conduit, DXHR

USE AND INSTALLATION

This category covers liquid-tight flexible metal conduit in trade sizes 3/8 to 4 (metric designators 12 to 103) inclusive, for installation in accordance with Article 350 of ANSI/NFPA 70, *NEC*. This product may also be used for installation of conductors in motor circuits and for electric signs and outline lighting following the *NEC*.

Liquid-tight flexible metal conduit is sunlight resistant and suitable for use outdoors.

Where terminated in fittings investigated for grounding and where installed with not more than 6 ft. (total length) in any ground-return path, liquid-tight flexible metal conduit in the 3/8 and 1/2 (12 and 16) trade sizes is suitable for grounding where used on circuits rated 20 A or less, and the 3/4, 1 and 1-1/4 (21, 27 and 35) trade sizes are suitable for grounding where used on circuits rated 60 A or less. See Conduit Fittings (DWTT) with respect to fittings suitable as a grounding means.

The following are not considered to be suitable as a grounding means:

1. The 1-1/2 (41) and larger trade sizes.
2. The 3/8 and 1/2 (12 and 16) trade sizes where used on circuits rated higher than 20 A or where the total length in the ground-return path is greater than 6 ft.
3. The 3/4, 1, and 1-1/4 (21, 27, and 35) trade sizes where used on circuits rated higher than 60 A or where the total length in the ground-return path is greater than 6 ft.

PRODUCT MARKINGS

Liquid-tight flexible metal conduit suitable for direct burial is marked "Direct Burial," "Burial," "Dir Burial" or "Dir Bur."

Liquid-tight flexible metal conduit not marked with a temperature designation or marked "60 C" is intended for use at temperatures not in excess of 60°C (140°F).

Conduit intended for use in dry or oily locations at a temperature higher than 60°C (140°F) is marked "____ C dry, 60 C wet, 70 C oil res" (or "____ C dry, 60 C wet, 70 C oil resistant") with "80" or "105" inserted as the dry-locations temperature.

Conduit marked "80 C dry, 60 C wet, 60 C oil res" or "80 C dry, 60 C oil resistant" is intended for use at 80°C (176°F) and lower temperatures in air, and at 60°C (140°F) and lower temperatures where exposed to water, oil or coolants.

Conduit that has not been investigated for use where exposed to oil is marked "OIL-FREE ENVIRONMENTS ONLY."

PRODUCT IDENTITY

The following product identity appears on the product:

Liquid-Tight Flexible Metal Conduit

ADDITIONAL INFORMATION

For additional information, see Electrical Equipment for Use in Ordinary Locations (AALZ).

REQUIREMENTS

The basic Standard used to investigate products in this category is ANSI/UL 360, "Liquid-Tight Flexible Metal Conduit."



The Certification Mark of UL on the attached tag, reel, or on the smallest unit container in which the product is packaged, with or without the UL symbol on the product, is the only method provided by UL to identify products manufactured under its Certification and Follow-Up Service. The Certification Mark for these products includes the UL symbol, the words "CERTIFIED" and "SAFETY," the geographic identifier(s), and a file number.

ALTERNATE UL MARK

The Listing Mark of UL on the attached tag, the reel or the smallest unit container in which the product is packaged, with or without the UL symbol on the product, is the only method provided by UL to identify products manufactured under its Listing and Follow-Up Service. The Listing Mark for these products includes the UL symbol (as illustrated in the Introduction of this Directory) together with the word "LISTED," a control number, and the product name "Liquid-Tight Flexible Metal Conduit."

2.4.3.2 UL Fire Resistance Ratings

UL information regarding fire-resistance ratings (previously included in the UL Fire Resistance Directory) is available and generally covers the construction detail necessary for constructing fire-rated walls, floors, and ceilings. It also covers the certified materials and methods for sealing the wall, ceiling, or floor that has been penetrated by electrical cables, conduit, cable tray, or other equipment. Cable manufacturers' classifications for through-penetrating products are also covered. The methods and materials are certified by UL under the category of through-penetration firestop systems. This information should always be consulted for the proper method of sealing the opening. Any such opening that is not properly sealed in accordance with UL-certified through-penetration firestop systems will be subject to rejection by the inspecting authority.

To access this information:

1. Go to www.ul.com/apps/product-ig

2. Click on the blue "Access Product IQ" button
3. Log in or sign up for access
4. After log-in, you should see a screen with "Create a Search Now" near the top
5. Scroll down the page and click on "Building Materials, Systems, and Installation Codes" (green icon)
6. A list will open below with links for Firestop Systems and other related fire-resistance information
7. Once an option is selected and opened, a keyword search for the cable or conductor type can be made
8. The search can be further modified using the options on the left side of the page



Section 3 Installation Guidelines for Flexible Metal Conduit and Liquid-Tight Flexible Metal Conduit

3.1 Installation Considerations

3.1.1 General

Typical installations provide for ease of connection utilizing straight, compound bend, vertical loop, lateral offset, and other configurations. The *NEC* specifies that the minimum centerline bend radius ("R" as shown in **FIGURE 1**) not be less than that listed in Table 2 of Chapter 9 under the other bends column. *NEC* Sections 350.26 and 348.26 also require that there never be more than the equivalent of four 90-degree bends between pull points.

To reduce stress and the chance of fittings becoming loose from the conduit, it is recommended that a straight length (as shown in **FIGURE 1** and **FIGURE 2**) is measured from the fitting of 4 times the trade size diameter be established before creating a bend in the conduit. If possible, this distance should be secured with a restraint. This length should also be considered when creating a vertical loop or lateral offset.

3.1.2 Special Considerations for LFMC

Fittings for LFMC should always be mounted horizontally or from underneath termination boxes. This will allow all liquids to run away from the fittings. Fittings for LFMC should never be mounted on the top of boxes. This would allow liquids to flow through loose fittings into electrical boxes. To achieve maximum securement, fittings should be tightened to proper assembly torque values. Standard assembly torque values are located in tables 1 and 2 of section 3.3 for FMC and LFMC, respectively. The manufacturer's instructions should always be closely followed.

3.1.3 Overall Length of Conduit

The following are calculations for determining the required overall length of conduit installed in a traveling vertical loop with offset. If there is no travel or offset, T and F in **FIGURE 1** are equal to zero. It should be noted that these lengths do not include the length of fittings, as different types of fittings vary in length.

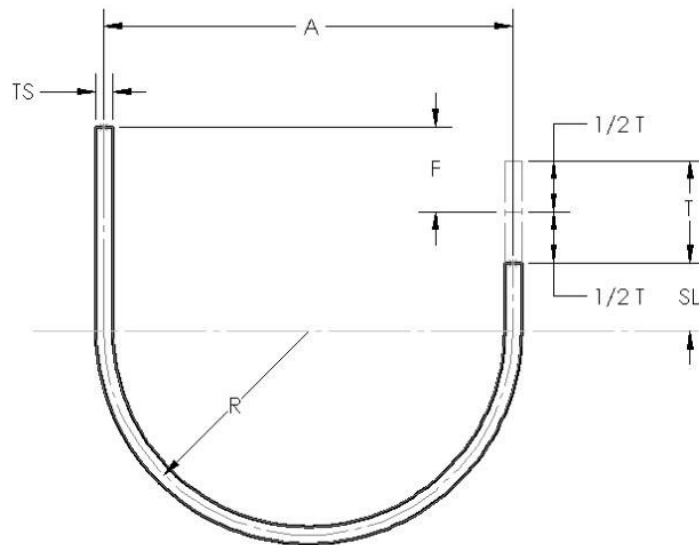
$$L = (8 \times TS) + (1.57 \times A) + T/2 + F$$

Where:

L = Overall length of conduit
TS = Trade size diameter
A = Horizontal distance between fittings*
T = Travel distance
F = Offset

Note: SL = Straight Length (4 x TS)

* Must be greater or equal to 2X the minimum bending radius from *NEC* Chapter 9, Table 2.



SL is suggested to be $4 \times TS$

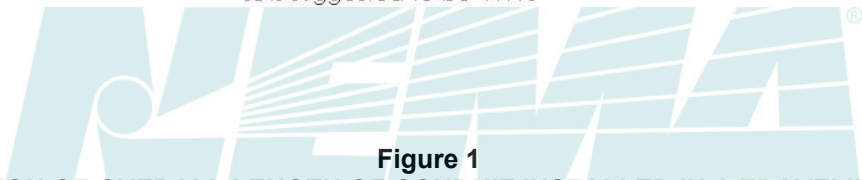


Figure 1

DETERMINATION OF OVERALL LENGTH OF CONDUIT INSTALLED IN A TRAVELING VERTICAL LOOP WITH OFFSET

National Electrical Manufacturers Association

Overall lengths for lateral offset installations of FMC and LFMC, as shown in Figure 2, are presented in tables 4 through 9.

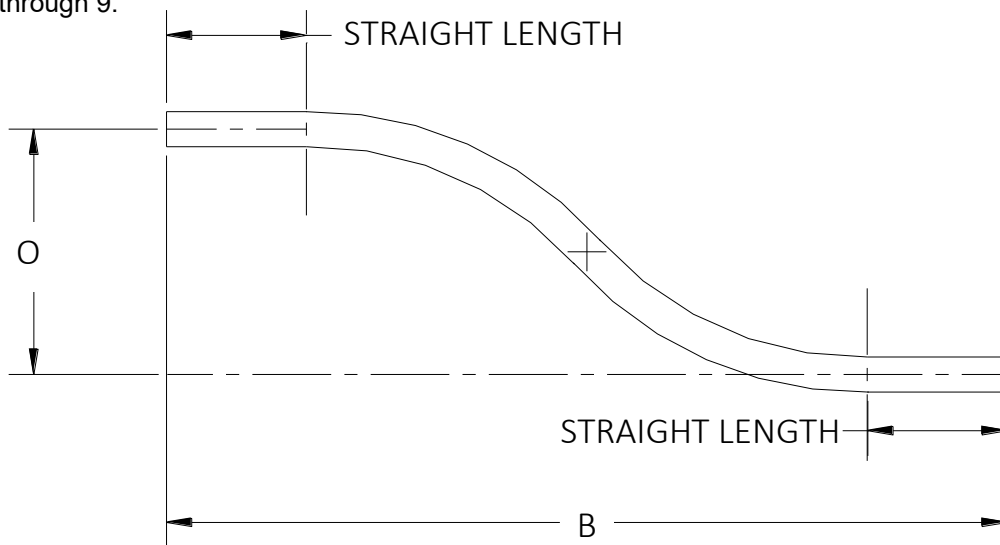


Figure 2 STRAIGHT LENGTH

3.2 SECURING AND SUPPORTING FMC AND LFMC

According to *NEC* Section 348.30 for FMC and Section 350.30 for LFMC, both conduits must be supported and secured at intervals of 4.5 ft. (1.4 m) or less (unless routed through a framing member) and within 12 in (300 mm) of every termination.

FMC and LFMC support requirements are waived when:

- a. The conduit is fished between access points through concealed spaces in finished buildings or structures, and supporting is impractical.
- b. Flexibility is necessary after installation.
- c. Used for luminaires (see *NEC* Sections 348.30 and 350.30).

3.2.1 Supported

The *NEC* Article 348 for FMC and Article 350 for LFMC requires the conduit to be supported and secured at intervals not to exceed 1.4 m (4-1/2 ft.) and within 300 mm (12 in) of each box (note exceptions in these articles). Support in this manner ensures that a minimum strain will be placed on the conduit-to-fitting and fitting-to-box connection during assembly and throughout the lifetime of the installation. FMC and LFMC shall be supported at least at the frequency required by the *NEC* using raceway supports intended for the purpose and mounted by hardware acceptable to the authority having jurisdiction.

A variety of straps, clamps, and hangers that are specifically intended to secure FMC and LFMC and similar raceways are available. These supports shall be installed only on the conduit of the trade size indicated on the support or its smallest unit shipping container. The variability of mounting surfaces, expected loads, and application environments will determine the appropriate support options and mounting hardware. Design specifications usually calculate requirements based on maximum spacing intervals given in the *NEC*. The use of closer support intervals than are required in the *NEC* is an acceptable option for heavier supports and mounting hardware in some applications.

3.2.2 Unsupported

The *NEC* allows FMC and LFMC, in 348.30 and 350.30 respectively, to be installed unsupported according to the following exceptions:

- a. When the conduit is fished between access points through concealed spaces in finished buildings or structures and supporting is impractical.
- b. At terminals where flexibility is necessary after installation in lengths not exceeding (3 ft.) 900 mm for LFMC and lengths not exceeding the following for FMC:
 1. 3 ft. (900 mm) for trade sizes 1/2 through 1-1/4 (metric designators 16 through 35).
 2. 4 ft. (1200 mm) for trade sizes 1-1/2 through 2 (metric designators 41 through 53).
 3. 5 ft. (1500 mm) for trade size 2-1/2 (metric designator 63) and larger.
- c. Lengths not exceeding 6 ft. (1.8 m) from a luminaire (fixture) terminal connection for tap connections to luminaires (light fixtures) as permitted in 410.117(C).
- d. Lengths not exceeding 6 ft. (1.8 m) from the last point where the raceway is securely fastened for connections within an accessible ceiling to luminaire(s) [lighting fixture(s)] or other equipment. Listed LFMC fittings are permitted as a means of support.

Note: LFMC fittings shall be permitted as a means of support in regards to the above exceptions.

3.3 Terminating Flexible Metal Conduit

3.3.1 Fitting Selection

Selecting the correct fitting requires the installer to know:

- a. The trade size or metric designator.
- b. The type of FMC: Standard wall (FMC), reduced wall (RWFMC), or extra-reduced wall (XRWFMC).
- c. The type of metal: either steel or aluminum.

3.3.2 Conduit Preparation and Assembly

The most efficient assembly of a flexible metal conduit and fitting system can be achieved, and optimum performance is ensured, by adherence to a few simple conduit preparations and assembly techniques.

- a. Square the cut end of the metal conduit.
- b. Insert conduit so that it is flush with the fitting's end stop.
- c. Ensure seating of a clamp on conduit before tightening the securement screw.
- d. Do not apply excessive torque to the fitting's securement screw(s).

For conduit preparation, always follow the conduit manufacturer's instructions. In addition, NEMA recommends thorough adherence to the recommendations described in NEMA FB 2.20 *Selection and Installation Guidelines for Fittings for Use with Flexible Electrical Conduit and Cable*. This document can be downloaded at no charge from the NEMA website.

The mechanical and electrical performance of a fitting for Flexible Metal Conduit is dependent on an adequate, secure, and clean bearing surface for the fitting's securement screw or clamp. Most experienced electricians recognize that flexible metal conduit is different on each end. Since the interlocked armor is wound in one direction, the convolutions on one end sometimes have a tendency to open when a fitting is tightened while the other end tends to remain more closed. Flexible Metal Conduit fittings are designed to assemble to either end of the conduit.

3.3.3 Cutting Conduit

There are three methods used to cut sections of Flexible Metal Conduit, including rotary armor cutters, hacksaws, and wire cutters such as diagonal cutters. Rotary cutters are designed specifically for safely cutting Flexible Metal Conduit and Armored Cable. A few turns of the handle make a cut through the convolution. Where a hacksaw is used, a sharp hacksaw blade having at least 32 teeth per inch is recommended to cut one of the convolutions at approximately a 60-degree angle. The use of a wire cutter requires either breaking the armor or unwinding it. Breaking the armor involves bending the conduit at the point where the cut is desired and twisting the armor slightly so the cutting pliers can be inserted between the convolutions where it is cut. The armor must be twisted back into the convolutions before it is inserted into the connector.

Liquid-tight Flexible Metal Conduit requires a square cut, which may be done with a sharp hacksaw with a blade equipped with at least 32 teeth per inch. A band saw may also be used with a 1/2" wide x .025" thick blade having 24 teeth per inch (no set) and a blade speed of approximately 350 ft. per minute.

3.3.4 Inserting Conduit

Product Standards call for Flexible Metal Conduit fittings to have a smooth end stop that completely encircles the end of the conduit. For fittings that are secure to the conduit's outside, be certain that the conduit is completely inserted in the fitting and is flush against the end stop. This ensures that the conduit is secure, the sharp cut end of the conduit is bushed by the fitting, and the end of the conduit will not open under pressure when torquing the securement screw. When assembling a fitting that threads inside the conduit, be certain to fully thread the fitting until the conduit is flush against the external end stop of the fitting.

The diameter of the opening in the end stop of a listed fitting of the type which secures to the outside of the conduit is restricted based on the trade size of the conduit for which it is listed. This requirement ensures effective bushing of the sharp end of the conduit and prevents it from being pulled through when the wires are pulled.

Combination fittings listed for trade size 3/8 (12) flexible metal conduit as well as armored cable or metal-clad cable may have a smaller end stop diameter than a similar fitting specifically listed for armored cable and/or metal-clad cable. This can cause difficulty in feeding the conductors of larger sizes of armored cable within the fitting's acceptable range. Selection of the proper fitting to match the trade size of the conduit or cable cannot be overemphasized.

3.3.5 Seating a Securement Clamp

Where a fitting employs a clamp as the means to secure the conduit, proper seating of the clamp to the conduit is to be ensured. Using the following method, the fitting's clamp will seat between the convolutions of the conduit:

Hand tighten the fitting screw(s). Then slightly rotate the conduit in the fitting. Where two screws are provided, they are to be alternately tightened until both are secure. Visually inspect the assembly prior to applying the final torque to the screws to be certain the end of the conduit remains flush with the fitting's end stop (see **FIGURE 8**).

3.3.6 Tightening Torque

The designed performance of an FMC fitting is dependent on applying adequate torque to the fitting's securement means, screw or clamp. By nature of its design, the interlock construction of flexible metal conduit may be susceptible to collapse from excessive torque on the fitting's securement means. Performance typically will not be enhanced and may be reduced when excessive torque is applied. The experienced electrician often has come to rely on the "measured by feel" approach when securing these fittings. Performance tests in the product Standards prescribe testing under specific assembly torque (e.g., average hand tightening of a No. 10 screw with a screwdriver is represented by 35 lbs.-in. (3.96 N-m) torque). Some fitting designs include a raised screw boss; see **FIGURE 3**. It is usually not necessary or intended that the screw be tightened to the point that its head be in contact with the boss. The screws on certain fitting designs, particularly larger trade sizes, may offer more than one tightening option including screwdriver (slot, Phillips, or Robertson-square drive) and bolt head (hex or square) for wrench application. Greater mechanical advantage and torque can generally be achieved with a wrench. When screwdriver and wrench application options are offered, the torque should be limited to that which can be applied by the screwdriver. See **FIGURE 4** for examples of FMC fittings having direct-bearing screws.

NEMA advocates the use of torque indicating tools for the assembly of FMC fittings. Care should be taken during fitting assembly not to puncture or deform the conduit, which may result in the presence of sharp edges in the wireway when wires are pulled. Table 1 provides a complete reference of Standard assembly torques for FMC fittings. If a manufacturer prescribes a tightening torque other than that in the Standard as a condition for listing, that specified torque must be marked on installation instructions or the smallest unit shipping container in which the fitting is provided.

Table 1
Standard Assembly Torque Values for Type FMC Fittings
(Torque applied to test assemblies of listed fittings¹)

Trade Size	Torque: lb-in. (N-m)				
	6	8	10	12	1/4+
Screws ²	12 (1.38)	20 (2.26)	35 (3.96)	35 (3.96)	35 (3.96)
Bolt Head Screws ³	–	–	–	160 (18.1)	160 (18.1)
Compression Gland Nut	–	–	–	–	–
Locknuts	–	–	–	–	–

¹ Test assemblies evaluated with alternative torque must be marked to indicate the manufacturer's recommended torque.

² Screwdriver applied (e.g., slotted, Phillips, Robertson-square drive head, or combinations). Also includes bolt head screws having provision for tightening with a screwdriver.

³ Usually square or hexagonal, without provision for tightening with a screwdriver.

3.3.7 Attachment to Unthreaded Entries

Where Flexible Metal Conduit is used, electricians usually fasten the boxes into position on the framing members before attaching the raceway assembly. Conduit and fittings manufacturers caution installers to be sure to allow for sufficient length of conduit to enable complete seating of the conduit against the fitting's end stop so as to minimize undue stress on the conduit's interlocked convolutions and the conduit-to-fitting connection during attachment to a box. *NEC* Section 300.18 requires that a raceway be completely installed and supported before conductors are pulled into it.

Flexible Metal Conduit fittings supplied with locknuts for attachment to a box or enclosure may be assembled first to the conduit or the box; attachment first to the conduit is preferred. A secure attachment can be made when the locknut is hand tightened and then further tightened 1/4 turn using an appropriate tool. When securing the locknut, avoid excessive pressure when gripping the body of the fitting. When tightening the locknut, the conduit and the body of the fitting are not to be rotated. Assemble fittings supplied without locknuts to the conduit and the box according to the manufacturer's installation instructions.

Note: Locknuts are not to be relied upon to penetrate nonconductive coatings on enclosures. Such coatings are to be removed in the locknut area prior to raceway assembly to ensure that a continuous ground path is achieved.

3.3.8 Attachment to Threaded Entries

FMC fittings having external threads may be installed into the threaded entries provided in certain boxes, enclosures, and conduit bodies. This does not include external threads of fittings intended for insertion inside of conduit; see **FIGURE 6**. The external threads of FMC fittings conforming to ANSI/NEMA FB 1 have straight threads (NPS). Threaded openings where these may be installed will have tapered (NPT) or straight (NPS) threads, varying depth, and varying number of threads. Care must be taken to ensure that a minimum of 3-1/2 threads of the fitting is fully engaged with the threads of the conduit entry when the wrench tightened.

3.4 Terminating Liquid-Tight Flexible Metal Conduit

3.4.1 Fitting Selection

Selecting the correct fitting requires the installer to know:

- a. The trade size or metric designator
- b. The environment in which the conduit is to be installed (e.g., wet locations)

3.4.2 Conduit Preparation and Assembly

The most efficient assembly of a Liquid-tight Flexible Metal Conduit and fitting system can be achieved, and optimum performance is ensured by adherence to a few simple conduit preparations and assembly techniques:

- a. Square the end of the conduit
- b. Fully insert the conduit flush with the fitting's end stop
- c. Ensure jacketing over conduit is not cut or ripped in any location

For conduit preparation, always follow the conduit manufacturer's instructions. In addition, NEMA recommends thorough adherence to the recommendations described in NEMA FB 2.20 *Selection and Installation Guidelines for Fittings for Use with Flexible Electrical Conduit and Cable*. This document can be downloaded at no charge from the NEMA website.

Start the assembly of the fitting to the liquid-tight conduit by cutting the end of the conduit squarely using a hacksaw or similar tool. Liquid-tight conduit manufacturers sometime offer cutting jigs specifically for this purpose. A hacksaw blade should have 24–32 teeth per inch. A power band saw, when used, should be set at a speed no greater than 400 ft./min. The squared end of the conduit must be fully inserted onto the ferrule

component of the fitting, see **FIGURE 7**. If the conduit is not cut squarely, complete seating of the conduit to the end of the ferrule cannot be ensured. It is also important that the ferrule is inserted (screwed) all the way into the conduit to ensure proper seating of the sealing ring.

The remaining fitting components then must be securely assembled to the conduit. A compression gland nut, when supplied as part of a fitting, will typically achieve maximum securement when tightened to the assembly torque specified in Table 2 with an appropriate tool or in accordance with the manufacturer's instructions.

Assembly methods for LFMC fittings vary. Follow the manufacturer's directions closely.

To ensure the integrity of the liquid-tight system, the full length of the conduit should be examined for cuts or tears at the time of installation.

Table 2
Standard Assembly Torque Values for Type LFMC Fittings

Trade size of fitting	Metric designator	Tightening Torque	
		lbf-in	N-m
1/4	10	175	19.8
3/8	12	235	26.6
1/2	16	300	33.9
3/4	21	500	56.5
1	27	700	79.1
1-1/4	35	1000	113
1-1/2	41	1200	136
2	53	1600	181
2-1/2	63	1600	181
3	78	1600	181
3-1/2	91	1600	181
4	103	1600	181

National Electrical Manufacturers Association

3.4.2.1 Attachment to Unthreaded Entries

For installations where Liquid-tight Flexible Metal Conduit is used, the electrician usually fastens the box or enclosure into position before attaching the conduit assembly. When the fitting and conduit assembly is to be attached to an unthreaded opening in a box or enclosure using a locknut, first attach the threaded body of the fittings to the box or enclosure and secure the locknut hand-tight. Then assemble the ferrule and gland nut onto the end of the conduit. After securely tightening the gland nut to the threaded body of the fittings, finish tightening the locknut.

A secure attachment to a box or enclosure can be made when the locknut is hand tightened and then further tightened 1/4 turn using an appropriate tool. When securing the locknut, avoid applying excessive pressure when gripping the body of the fitting. The conduit and fitting body are not to be rotated when tightening the locknut.

Note: Locknuts are not to be relied upon to penetrate nonconductive coatings on enclosures. Such coatings must be removed in the locknut area prior to raceway assembly to ensure a continuous ground path.

3.4.2.2 Attachment to Threaded Entries

LFMC fittings may be installed into the threaded entries provided in certain boxes, enclosures, and conduit bodies. Threaded openings will have tapered (NPT) or straight (NPS) threads, varying depth, and varying number of threads. Care should be taken to ensure that the threaded entry will accommodate a minimum of 3-1/2 engaged threads of the connector.

When assembling the fitting into a threaded enclosure, the body of the fitting is typically disassembled from the gland nut then threaded and wrench tightened into the enclosure entry. Teflon tape or lubricants should only be used on the threaded joint surfaces when specifically stated in the manufacturer's instructions or labeling. Doing so may result in a high impedance connection, which may interfere with the electrical ground continuity of the joint. After proper assembly of the fitting body to the enclosure, the remaining components of the assembly should then be joined to the conduit and then to the fitting's body, according to the manufacturer's instructions.

Conduit and fittings manufacturers caution installers to be sure to allow for sufficient length of conduit to enable complete seating of the conduit into the fitting's ferrule and so as not to put undue stress on the conduit-to-fitting connection during attachment to the box or enclosure.

3.5 Verification of Installation

Once the conduit is fully installed, all fittings and locknuts should be re-examined for tightness. A continuity test should be performed over the entire length of the raceway as a final means of inspection of all joints.

A visual check should be made to determine if adjustments are needed. This is necessary to determine if there is any loosening of system components, which may sometimes occur during construction involving other trades. The following steps should be taken:

- a. Conduit shall be properly terminated at boxes.
- b. Conduit shall be properly secured and supported.
- c. Conduit shall not show evidence of damage or physical abuse.



Section 4 Installation Guidelines for Liquid-Tight Flexible Nonmetallic Conduit (LFNC)

4.1 Installation Considerations

4.1.1 General

Liquid-tight Flexible Nonmetallic Conduit (LFNC) is permitted for use in both exposed and concealed work for electrical systems that require flexibility and protection for conductors from vapors, liquids, or solids. Liquid-tight Flexible Nonmetallic Conduit is permitted for use outdoors exposed, in concrete or masonry, and for direct burial in the earth when listed and marked for the purpose. For a detailed description of the uses permitted and not permitted, refer to Article 356 of the *NEC*.

4.1.2 Types

Liquid-tight flexible nonmetallic conduit comes in three types:

Type LFNC-A: smooth, seamless inner core and cover bonded together and having one or more reinforcement layers between the core and cover.

Type LFNC-B: smooth inner surface with integral reinforcement within the conduit wall.

Type LFNC-C: corrugated internal and external surfaces without integral reinforcement within the conduit.

The requirements for listed Liquid-tight Flexible Nonmetallic Conduit can be found in UL 1660 *Liquid-tight Flexible Nonmetallic Conduit*.

4.2 Securing and Supporting LFNC

4.2.1 Supported

NEC Article 356 allows Type LFNC-B Liquid-tight Flexible Nonmetallic Conduit to be used in lengths longer than 1.8 m (6 ft.). When used in lengths longer than 1.8 m (6 ft.), Type LFNC-B is required to be secured at intervals not to exceed 900 mm (3 ft.) and within 300 mm (12 in.) of each box (note exceptions in Article 356). Support in this manner ensures a minimum strain will be placed on the conduit-to-fitting and fitting-to-box connection during assembly and throughout the lifetime of the installation. Liquid-tight Flexible Nonmetallic Conduit shall be supported using products intended for the purpose and mounted by hardware acceptable to the authority having jurisdiction.

A variety of straps, clamps, and hangers are available, which are specifically intended to secure Liquid-tight Flexible Nonmetallic Conduit and similar raceways. These supports shall be installed only on conduit of the trade size indicated on the support or its smallest unit shipping container. The variability of mounting surfaces, expected loads, and application environments will determine the appropriate support options and mounting hardware. Design specifications usually calculate requirements based on maximum spacing intervals given in the *NEC*. The use of closer support intervals than are required in the *NEC* is an acceptable option for heavier supports and mounting hardware in some applications.

4.2.2 Unsupported

NEC Section 356.30 allows LFNC to be installed unsupported under the following conditions:

- a. At terminals where flexibility is necessary after installation in lengths not exceeding (3 ft.).
- b. Lengths not exceeding 6 ft. (1.8 m) from a luminaire (fixture) terminal connection for tap connections to luminaires (light fixtures) as permitted in 410.117(C).

- c. Lengths not exceeding 6 ft. (1.8 m) from the last point where the raceway is securely fastened for connections within an accessible ceiling to luminaire(s) [lighting fixture(s)] or other equipment.

4.3 Terminating LFNC

4.3.1 Fitting Selection

NEC Section 300.15 requires that "Fittings and connectors shall be used only with the specific wiring methods for which they are designed and listed." Section 356.6 and 356.42 state:

"Only fittings listed for use with LFNC shall be used. Angle connectors shall not be used for concealed raceway installations. Straight LFNC fittings are permitted for direct burial or encasement in concrete."

Often, fittings that are listed for use with Liquid-tight Flexible Nonmetallic Conduit Type B are also listed for use with Liquid-tight Flexible Metallic Conduit. A description of these fittings is given in Section 4 of NEMA FB 2.20 *Fittings for Use with Liquid-tight Flexible Metal Conduit*. The manufacturer's instructions, labels, and literature should be consulted to determine the specific wiring methods for which the fittings are intended and listed. Refer to Section 4.2, required marking for guidance in identifying the listed uses of such fittings.

Liquid-tight Flexible Nonmetallic Conduit fittings are available in various designs. These fittings all serve to prevent the ingress of liquids into the raceway and enclosure system. They also provide mechanical protection for the conductors entering an enclosure. Fittings are available in both straight and angle (45 and 90 degrees) designs. See **FIGURE 6** for typical designs.

Fittings supplied with locknuts are for the purpose of sealing at an enclosure knockout or fitting joint. A sealing ring or other device may be supplied or recommended as a provision of the fitting's Liquid-tight listing. These fittings may also provide a Liquid-tight joint when installed into a threaded entry of an enclosure. When utilized in this way, the sealing device and locknuts are not used.

Liquid-tight Flexible Nonmetallic Conduit fittings supplied without locknuts are generally intended only for use in threaded entries of enclosures. Fittings without locknuts may also be installed in unthreaded entries when an appropriate size listed locknut is used as part of the assembly. A sealing ring or other device may also be necessary for such Liquid-tight applications. Again, the manufacturer's instructions, labels, and literature should be consulted to determine the specific applications for which the fitting is intended and listed.

Metallic fittings for use with Liquid-tight Flexible Nonmetallic Conduit are also offered with an optional insulating throat. The fitting's throat is not required to be insulated, but some installers prefer the increased conductor protection provided by this design option. Insulating throats also provide the required protection against physical damage for 4 AWG and larger ungrounded conductors, in accordance with NEC Section 300.4(G).

Liquid-tight Flexible Nonmetallic Conduit and fittings may also be suitable for use in certain adverse environments along with appropriate enclosures. The specific requirements for Type Rated enclosures and fittings to be used in these applications are found in NEMA 250 *Enclosures for Electrical Equipment (1000 Volts Maximum)* and UL 50E *Enclosures for Electrical Equipment, Environmental Considerations*.

LFNC fittings are referred to by the trade size of the Liquid-tight Flexible Nonmetallic Conduit for which they are designed, typically 3/8 (12) through 4 (103). Metric designators have been established that correspond to these traditional trade sizes. FB 2.20 Table 1-1 provides a cross-reference of traditional trade sizes to these metric designators.

4.3.2 Environmental Considerations

Fittings for use in wet locations must be suitable for the purpose. Listed liquid-tight fittings have been found suitable for use in wet locations as described in the *NEC*. However, important additional considerations are necessary for making the right conduit and fitting selection.

Importantly, fittings marked wet locations are not inherently liquid-tight. Listed wet locations fittings are tested under conditions simulating typical wet locations such as exposure to pouring rain, thus the wet locations marking, while liquid-tight fittings are also intended for use in more severe wet industrial environments, which may contain machine oils and coolants. The test conditions for listed liquid-tight fittings include an oil and water spray to simulate these harsh environments.

In its definition of wet locations, the *NEC* includes, "Locations subject to saturation with water or other liquids, such as vehicle washing areas, and locations exposed to weather and unprotected." These are acceptable locations for liquid-tight fittings. However, the definition for wet locations also includes "Installations underground or in concrete slabs or masonry in direct contact with the earth." A fitting intended for these applications is marked wet locations in addition to liquid-tight.

Liquid-tight or wet location fitting designs may require a separate sealing ring to be installed outside a box or enclosure to ensure a sealed interface between the body of the fitting and the box. See Section 4.3, required marking.

Listed liquid-tight fittings are not intended for occasional, temporary, or prolonged submersion in any liquid. Fittings subjected to occasional submersion in liquid in normal use must have a NEMA 6 or 6P Type rating according to NEMA 250.

4.3.3 Required Marking on Fittings

Required marking on listed Liquid-tight Flexible Nonmetallic Conduit fittings, or their smallest unit shipping container provides the installer and the electrical inspector with basic information as to the specific wiring methods for which the fitting has been found acceptable. Table 3 provides a summary of those markings for fittings listed for use with Liquid-tight Flexible Nonmetallic Conduit.

Table 3
Markings for Fittings For Use With Liquid-Tight Flexible Nonmetallic Conduit

Application	Marking	Intended Use
Liquid-tight applications	Liquid-tight	—
Wet locations	*Wet locations	—
Wet locations (where required)	*between box and fitting	Listed for use in wet locations only when the specified gasket or sealing ring is installed between the fitting and the box

*Specific identification of the component to be used

An LFNC fitting:

- a. for Type A conduit will be marked **"LFNC-A ONLY."**
- b. for metallic and nonmetallic fittings for Type B conduit will be marked **"LFNC-B."**
- c. for LFNC-C **"Use with _ fittings only,"** where the blank space is filled with the manufacturer's name or trademark.

A Liquid-tight Flexible Nonmetallic Conduit fitting or the smallest unit shipping carton in which it is packaged may also be marked with an environmental Type number, for example, "Type 3, 3S, 4, 4X..." indicating the external conditions and degrees of ingress protection for which it is acceptable. See NEMA 250 *Enclosures for Electrical Equipment (1000 Volts Maximum)* and UL 50E *Enclosures for Electrical*

Equipment, Environmental Considerations, for details and requirements for these and other type ratings. A fitting that complies with the requirements for more than one Type rating may have multiple designations.

A Liquid-tight Flexible Nonmetallic Conduit fitting, or the smallest unit shipping carton in which it is packaged, may also be marked WET LOCATIONS, indicating liquid-tight fittings that have also been evaluated for direct burial applications, including in concrete or masonry, as defined by the *NEC*.

A Liquid-tight Flexible Nonmetallic Conduit fitting supplied without a locknut is marked:

For securement to a threaded hub only

Exception: A fitting supplied without a locknut but used within either a threaded or unthreaded opening may have the alternative marking:

For use only with listed locknuts or securement to a threaded hub

4.3.4 Grounding

All three types of Liquid-tight Flexible Nonmetallic Conduits require that an equipment grounding conductor be installed. Metal fittings listed for use with both Type B Liquid-tight Flexible Nonmetallic Conduit and Liquid-tight Flexible Metal Conduit may be listed as grounding type. This listing applies only to application on Liquid-tight Flexible Metal Conduit.

4.3.5 Conduit Preparation and Fitting Assembly Technique

Performance test methods for LFNC fittings are designed to recognize the variability inherent in field applications. The most efficient assembly of a Liquid-tight Flexible Nonmetallic Conduit and fitting system can be achieved, and optimum performance is ensured, by adherence to simple conduit preparation and assembly techniques:

- a. Square the end of the conduit
- b. Fully insert the conduit flush with the fitting's end stop
- c. Ensure jacketing over conduit is not cut or ripped in any location

For conduit preparation, always follow the conduit manufacturer's instructions.

Start the assembly of the fitting to the liquid-tight conduit by cutting the end of the conduit squarely using a hacksaw or similar tool. Liquid-tight conduit manufacturers sometimes offer cutting jigs specifically for this purpose. A hacksaw blade should have 24–32 teeth per inch. A power band saw, when used, should be set at a speed no greater than 400 feet/minute. The squared end of the conduit must be fully inserted onto the ferrule component of the fitting, see **FIGURE 6**. If the conduit is not cut squarely, complete seating of the conduit to the ferrule cannot be ensured. It is also important that the ferrule is inserted (screwed) all the way into the conduit to ensure proper seating of the sealing ring.

The fitting then must be securely assembled to the conduit. A compression gland nut, when supplied as part of a fitting, will typically achieve maximum securement when tightened to the torque specified in Table 3 with an appropriate tool or in accordance with manufacturer instructions.

To ensure the integrity of the liquid-tight system, the full length of the conduit should be examined for cuts or tears at the time of installation.

Table 4
Assembly Torque Values for LFNC Fittings

Trade size	Metric designator	Tightening Torque	
		lbf. in.	N·m
1/4	10	175	19.8
3/8	12	200	22.6
1/2	16	300	33.9
3/4	21	500	56.5
1	27	700	79.1
1-1/4	35	1000	113
1-1/2	41	1200	136
2	53	1600	181
2-1/2	63	1600	181
3	78	1600	181
3-1/2	91	1600	181
4	103	1600	181

4.3.6 Attachment to Boxes or Enclosures and Support

Assembly methods for LFNC fittings might vary. Follow the manufacturer's directions closely.

4.3.6.1 Attachment to Unthreaded Entries

Electricians usually fasten the box or enclosure into position before attaching the conduit assembly. When a multi-part fitting and conduit assembly is to be attached to an unthreaded opening in a box or enclosure using a locknut, first attach the threaded body of the fitting to the box or enclosure and secure the locknut hand-tight. Then assemble the ferrule and gland nut to the end of the conduit. After the gland nut is securely tightened to the threaded body of the fitting, finish tightening the locknut.

For one-piece fitting designs (see **FIGURE 6**), the fitting is to be completely assembled to the conduit prior to attachment to the box or enclosure.

A secure attachment to a box or enclosure can be made when the locknut is hand tightened and then further tightened 1/4 turn using an appropriate tool. When securing the locknut, avoid applying excessive pressure when gripping the body of the fitting. Assemble fittings supplied without locknuts to the conduit and the box according to the manufacturer's installation instructions.

4.3.6.2 Attachment to Threaded Entries

LFNC fittings may be installed into the threaded entries provided in certain boxes, enclosures, and conduit bodies. Threaded openings will have tapered (NPT) or straight (NPS) threads, varying depth, and varying number of threads. Care should be taken to ensure that the threaded entry will accommodate a minimum of 3½ engaged threads of the connector.

When assembling a fitting employing a compression gland into a threaded opening in an enclosure, the body of the fitting is typically disassembled from the gland nut then threaded and wrench tightened into the enclosure entry. After proper assembly of the fitting body to the enclosure, the remaining components of the assembly should then be joined to the conduit and then to the fitting's body according to the manufacturer's instructions.

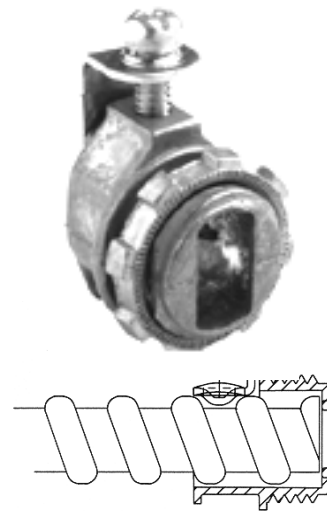
Conduit and fittings manufacturers caution installers to be sure to allow for sufficient length of conduit to enable complete seating of the conduit into the fitting's ferrule and so as not to put undue stress on the conduit-to-fitting connection during attachment to the box or enclosure.

4.4 Verification of Installation

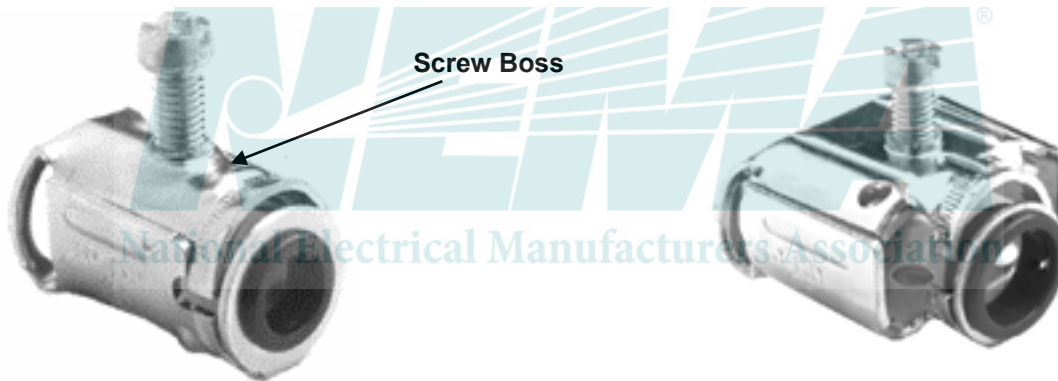
Loosening of raceway components is sometimes encountered during the construction process. Once the raceway is fully installed and supported, all fittings and locknuts should be re-examined for tightness.



FMC Squeeze Connector



FMC Single Screw Clamp Connector



FMC Connector (without locknut)

FMC Duplex Connector (without locknut)



Twin Screw 90° Angle Connector

Figure 3
Typical Designs of FMC Fittings, Clamp Type

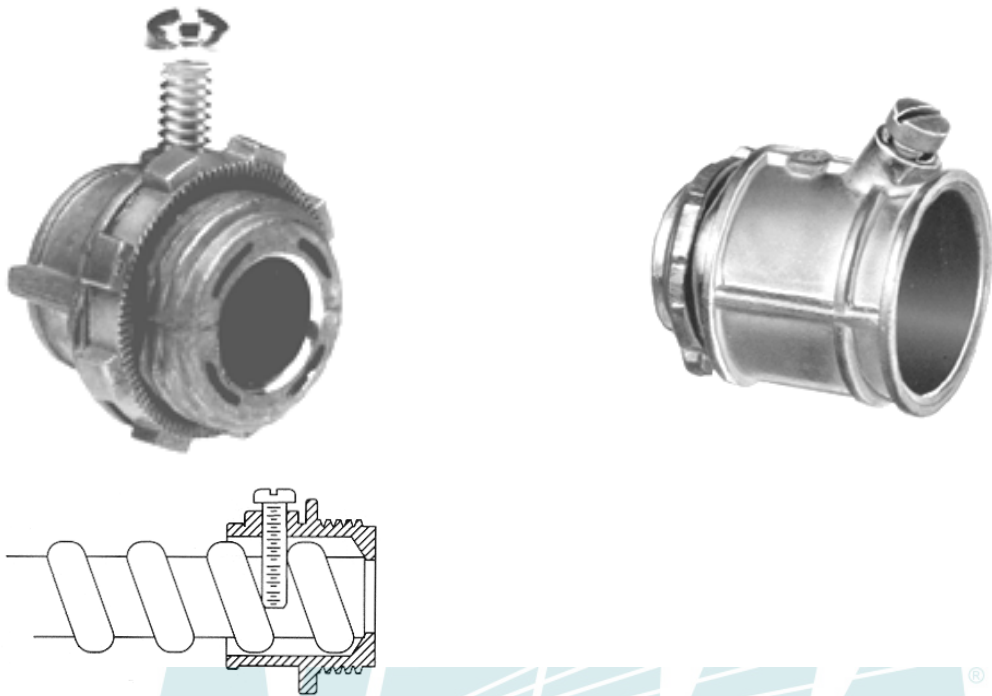


Figure 4
Typical Designs OF FMC Fittings, Direct-Bearing Screw Type

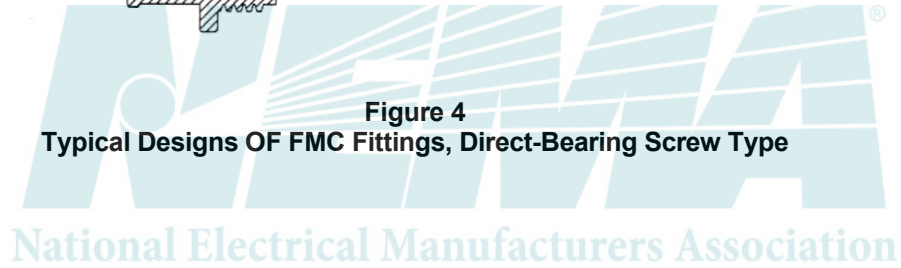


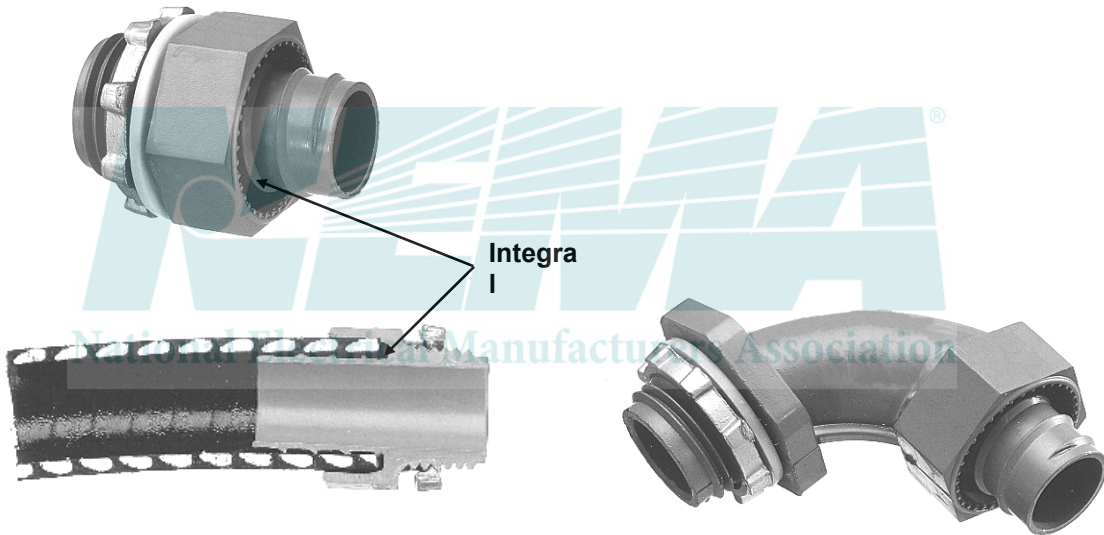
Figure 5
Typical Designs of FMC Fittings, Screw-In Type



Straight LFNC Connector



45° LFNC Connector



**Straight LFNC Connector
One Piece Screw-On Style**

**90° LFNC Connector
One Piece Screw-On Style**

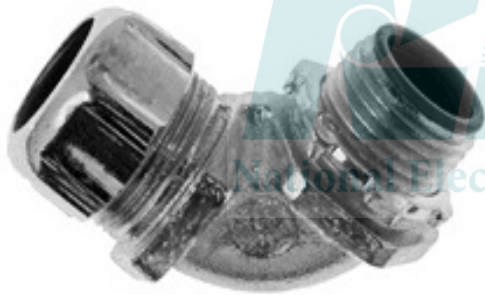
**Figure 6
Typical Designs of Liquid-Tight Flexible Nonmetallic Conduit Fittings**



Straight LFM Connector



45° LFM Connector



90° LFM Connector



90° LFM Connector with Integral Grounding Lug

Figure 7
Typical Designs Of Liquidtight Flexible Metal Conduit Fittings

Table 5
Overall Conduit Length for Given Offset And Lateral Distance
Trade Size 1/2

Lateral Distance "B" (inches)	"R" Offset Distance (inches)									
	1.0	1.5	2	2.5	3.0	4.0	5.0	6.0	8.0	10.0
5	5.6	—	—	—	—	—	—	—	—	—
6	6.3	6.7	—	—	—	—	—	—	—	—
7	7.2	7.5	7.8	8.2	—	—	—	—	—	—
8	8.2	8.4	8.6	9.0	9.4	—	—	—	—	—
9	9.1	9.3	9.5	9.8	10.1	10.9	—	—	—	—
10	10.1	10.2	10.4	10.7	11.0	11.6	12.5	—	—	—
11	11.1	11.2	11.4	11.6	11.8	12.4	13.2	14.0	—	—
12	12.1	12.2	12.3	12.5	12.7	13.3	13.9	14.7	16.6	—
13	13.1	13.2	13.3	13.5	13.6	14.1	14.7	15.5	17.2	—
14	14.1	14.1	14.3	14.4	14.6	15.0	15.6	16.2	17.8	19.7
15	15.1	15.1	15.2	15.4	15.5	15.9	16.5	17.1	18.5	20.3
20	20.0	20.1	20.2	20.3	20.4	20.7	21.0	21.5	22.5	23.9
25	25.0	25.1	25.1	25.2	25.3	25.5	25.8	26.1	27.0	28.0
30	30.0	30.0	30.1	30.2	30.2	30.4	30.6	30.9	31.6	32.5

Table 6
OVERALL CONDUIT LENGTH FOR GIVEN OFFSET AND LATERAL DISTANCE
TRADE SIZE 3/4

Lateral Distance "B" (inches)	"R" Offset Distance (inches)									
	1.0	1.5	2	2.5	3.0	4.0	5.0	6.0	8.0	10.0
7	7.6	—	—	—	—	—	—	—	—	—
8	8.3	8.7	—	—	—	—	—	—	—	—
9	9.2	9.5	9.8	—	—	—	—	—	—	—
10	10.2	10.4	10.6	11.0	—	—	—	—	—	—
11	11.1	11.3	11.5	11.8	—	—	—	—	—	—
12	12.1	12.2	12.4	12.7	13.0	—	—	—	—	—
13	13.1	13.2	13.4	13.6	13.8	14.4	—	—	—	—
14	14.1	14.2	14.3	14.5	14.7	15.3	—	—	—	—
15	15.1	15.2	15.3	15.5	15.6	16.1	16.7	—	—	—
20	20.0	20.1	20.2	20.3	20.4	20.7	21.2	21.7	22.9	24.4
25	25.0	25.1	25.1	25.2	25.3	25.6	25.9	26.2	27.2	28.3
30	30.0	30.1	30.1	30.2	30.2	30.4	30.7	31.0	31.7	32.7

Table 7
Overall Conduit Length for Given Offset And Lateral Distance
Trade Size 1

Lateral Distance "B" (inches)	"R" Offset Distance (inches)									
	1.0	1.5	2	2.5	3.0	4.0	5.0	6.0	8.0	10.0
9	9.6	—	—	—	—	—	—	—	—	—
10	10.3	10.7	—	—	—	—	—	—	—	—
11	11.2	11.5	11.8	—	—	—	—	—	—	—
12	12.2	12.4	12.6	13.0	—	—	—	—	—	—
13	13.1	13.3	13.5	13.8	14.1	—	—	—	—	—
14	14.1	14.2	14.4	14.7	15.0	15.6	—	—	—	—
15	15.1	15.2	15.4	15.6	15.8	16.4	17.2	—	—	—
20	20.1	20.1	20.2	20.3	20.5	20.9	21.3	21.9	23.3	24.9
25	25.0	25.1	25.2	25.2	25.3	25.6	26.0	26.4	27.4	28.7
30	30.0	30.1	30.1	30.2	30.3	30.5	30.7	31.1	31.9	32.9

Table 8
Overall Conduit Length for Given Offset And Lateral Distance
Trade Size 1-1/4

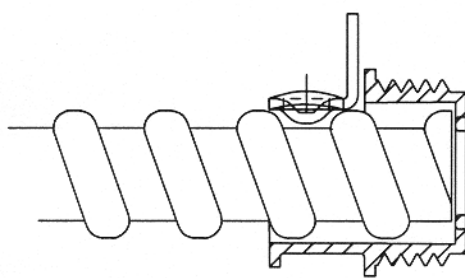
Lateral Distance "B" (inches)	"R" Offset Distance (inches)									
	1.0	1.5	2	2.5	3.0	4.0	5.0	6.0	8.0	10.0
11	11.6	—	—	—	—	—	—	—	—	—
12	12.3	12.7	—	—	—	—	—	—	—	—
13	13.2	13.5	13.8	—	—	—	—	—	—	—
14	14.2	14.4	14.6	—	—	—	—	—	—	—
15	15.1	15.3	15.5	15.8	—	—	—	—	—	—
16	16.1	16.2	16.4	16.7	—	—	—	—	—	—
17	17.1	17.2	17.4	17.6	17.8	—	—	—	—	—
18	18.1	18.2	18.3	18.5	18.7	19.3	—	—	—	—
19	19.1	19.2	19.3	19.5	19.6	20.1	20.7	—	—	—
20	20.1	20.1	20.3	20.4	20.6	21.0	21.6	22.2	—	—
25	25.0	25.1	25.2	25.3	25.4	25.7	26.1	26.5	27.7	29.1
30	30.0	30.1	30.1	30.2	30.3	30.5	30.8	31.2	32.1	33.2

Table 9
Overall Length of Conduit For Given Offset And Lateral Distance
Trade Size 1-1/2

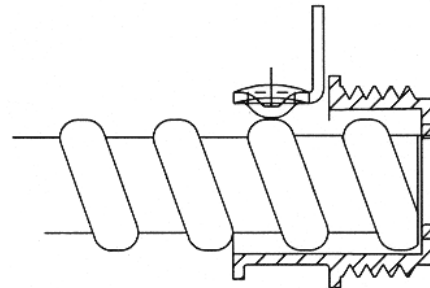
Lateral Distance "B" (inches)	"R" Offset Distance (inches)									
	1.0	1.5	2	2.5	3.0	4.0	5.0	6.0	8.0	10.0
13	13.6	—	—	—	—	—	—	—	—	—
14	14.3	—	—	—	—	—	—	—	—	—
15	15.2	15.5	—	—	—	—	—	—	—	—
16	16.2	16.4	16.6	—	—	—	—	—	—	—
17	17.1	17.3	17.5	17.8	—	—	—	—	—	—
18	18.1	18.2	18.4	18.7	19.0	—	—	—	—	—
19	19.1	19.2	19.4	19.6	19.8	—	—	—	—	—
20	20.1	20.2	20.3	20.5	20.7	21.3	—	—	—	—
25	25.0	25.1	25.2	25.3	25.5	25.8	26.2	26.8	—	—
30	30.0	30.1	30.1	30.2	30.3	30.6	30.9	31.3	32.3	33.5

Table 10
Overall Length of Conduit For Given Offset And Lateral Distance
Trade Size 2

Lateral Distance "B" (inches)	"R" Offset Distance (inches)									
	1.0	1.5	2	2.5	3.0	4.0	5.0	6.0	8.0	10.0
17	17.6	—	—	—	—	—	—	—	—	—
18	18.3	18.7	—	—	—	—	—	—	—	—
19	19.2	19.5	19.8	20.2	—	—	—	—	—	—
20	20.2	20.4	20.6	21.0	21.4	—	—	—	—	—
22	22.1	22.2	22.4	22.7	23.0	23.6	—	—	—	—
24	24.1	24.2	24.3	24.5	24.7	25.3	25.9	—	—	—
26	26.1	26.1	26.3	26.4	26.6	27.0	27.6	28.2	—	—
28	28.1	28.1	28.2	28.3	28.5	28.9	29.3	29.9	31.3	—
30	30.0	30.1	30.2	30.3	30.4	30.7	31.2	31.7	32.9	34.4



Correct Seating



Incorrect Seating

Figure 8
Flexible Metal Conduit Securement Clamp

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