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Selection and Installation Guidelines for Fittings for Use with Flexible Electrical Conduit and Cable

National Electrical Manufacturers Association

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Foreword

The selection and installation guidelines provided herein offer practical information on correct product selection and industry recommend practices for the installation of fittings for flexible conduit or cable in accordance with the National Electrical Code®.

These guidelines have been developed by the NEMA Conduit Fittings Section, which periodically reviews 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:

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At the time of approval, the Conduit Fittings Section of the National Electrical Manufacturers Association had the following members:

Adalet—Cleveland, OH
AFC Cable Systems—New Bedford, MA
Arlington Industries, Inc.—Scranton, PA
Bridgeport Fittings, Inc.—Bridgeport, CT
Carlon, Lamson & Sessions—Cleveland, OH
Cooper B-Line—Highland, IL
Cooper Crouse-Hinds—Syracuse, NY
EGS Electrical Group—Rosemont, IL
Erico, Inc.—Solon, OH
Hubbell Incorporated, Kellems Division—Stonington, CT
Killark Electric Manufacturing Company—St. Louis, MO
Minerallac/Cully—Addison, IL
Pass & Seymour/Legrand—Syracuse, NY
Plastic Trends, Inc.—Shelby Township, MI
Producto Electric Corporation—Orangeburg, NY
Progressive Machine Die, Inc.—Walton Hills, OH
RACO, Hubbell Incorporated—South Bend, IN
Steel City—Memphis, TN
Steel Electric Products Company, Inc.—Brooklyn, NY
Thomas & Betts Corporation—Memphis, TN

Introduction

It is a common perception that in any continuous system, the joints (splices, taps, couplings, and connections) are the weakest link. In fact, specifically by design, this is not usually the case. In order to achieve this design performance, variables such as *selection, preparation*, and *assembly technique* must be considered. We know it is not practical to have a system without splices, joints, and terminations, and so we strive to build in safety where these occur.

The expectations and demands on our electrical raceway systems have evolved throughout the twentieth century. Metallic conduit raceway systems (conduit, fittings, and enclosures) originally intended just to provide mechanical protection for circuit conductors are now often relied upon to carry potentially dangerous fault currents. Flexible metallic and nonmetallic conduit and metallic and composite cable systems have been introduced to meet ever-changing market needs. Emerging manufacturing technology and economic pressures have resulted in noticeable changes to some system components. Because of this evolution, sole reliance on the historical mechanical evaluation criteria of the system's components is of increasing concern to those charged with approving an installation. These concerns are very often evidenced through product standards development and installation code processes.

Along with evolving manufacturing technology, improved and new materials and processes are used in the manufacture of conduit and cable fittings. Considering the variety of materials, such as steel, iron, aluminum, zinc, and engineered plastics, the industry has come a long way in providing numerous options to solve an infinite number of applications. Over the years, NEMA member companies that manufacturer conduit and cable fittings have met the needs of the market with new and innovative product designs that continue to live up to higher standards demanded by the market.

These guidelines are written by the NEMA Conduit Fittings Section (5-FB). They provide installers and inspectors with an industry perspective of what has changed and what has not, how product standards have evolved with technology and product changes, and some of our industry's concerns and challenges as we move into the 21st century. The member companies of the NEMA Conduit Fittings Section promote the selection and installation of listed conduit and cable fittings, listed conduit and cable, and associated supports. Listing of electrical system components qualifies them to minimum performance requirements and provides for ongoing conformity surveillance. Listed conduit and cable fittings can be recognized by the trademark of the qualified electrical testing laboratory on the part or its smallest unit container.

It is our objective to develop a closer liaison with the installers of our products and the professional electrical inspector. Through this liaison, we intend to provide uniform education and understanding as to the intended use and application of our products and to develop an alliance founded in trust that will enable us together to address and resolve the concerns and challenges we each face.

NOTE—All references to the *National Electrical Code*® are to the 2005 Edition.

Product Standards and Installation Codes

Conduit and cable fittings for use in “ordinary” locations (locations not classified as hazardous) in the U.S. are typically designed and manufactured to meet the requirements of National Electrical Manufacturers Association Standards Publication ANSI/NEMA FB 1, *Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies*. “Listed” fittings are typically evaluated to Underwriters Laboratories Standard ANSI/UL 514B, *Conduit, Tubing and Cable Fittings.*

Conduit and cable fittings designed and manufactured to ANSI/NEMA FB 1 have fundamental design elements in common. NEMA conduit fittings manufacturers have agreed that these basic design and construction features are fundamental to safety, performance, inter-changeability, and system compatibility. Besides outlining the essential functional characteristics of conduit and cable fittings, ANSI/NEMA FB 1, as a voluntary consensus design standard, tends to be very specific in suggesting types of materials, acceptable wall thickness, corrosion protection, and other minimum criteria for metallic components and physical properties requirements for nonmetallic components.

An evaluation by a qualified electrical testing laboratory verifies that “listed” fittings contain essential design characteristics such as conduit end stops, conduit centering stops (for couplings), smooth-rounded wire entries, minimum corrosion protective coatings, and essential dimensions (e.g. throat diameters) that are within specified tolerances. A listed conduit or cable fitting can be identified by the distinctive trademark of the testing laboratory on the fitting itself and/or on the smallest unit container. Performance tests include mechanical sequences (e.g. assembly, bend tests, pull tests) and electrical tests (e.g. milli-volt drop before and after bend test in mechanical sequence, fault current test, electrical continuity test) designed to represent “real life” for these fittings both during installation and in service throughout the useful life of the system.

As one might imagine, these standards are dynamic and have changed over time to address the needs and expectations of the installer and the electrical inspector.

Among the changes in UL 514B in recent times, two very significant changes are as follows:

1. A fitting shall be investigated for use with conduit or cable of each type, size, wall thickness, and material, as recommended by the manufacturer; and

2. For a fitting that has been found acceptable for specific conditions of installation, for use with a specific conduit or cable construction, or for use with certain wiring systems, the condition of installation or the intended use shall be indicated by marking on the smallest-unit carton in which the product is packaged.

These standard revisions recognized that something had changed. They meet with the intent of *NEC*® Section 110.3(B) by providing the installer with necessary information. Given that all “listed” fittings have met the appropriate design and performance requirements, **selection** of the right fitting for the application is the single most important factor leading to a safe, effective, and permanent installation. The way things used to be, “I’ve always used that fitting for this application," may not be the right way today! We have to get back to the fundamentals.

Beyond **selection** of the right fitting for the application, almost every other variable comes down to good **workmanship**, something every craftsman takes pride in and that is fundamentally required by the *NEC*® Section 110.12, and to **personal preference** in selecting optional features and benefits that distinguish alternative brands.

Several other significant revisions have been made to product standards in the recent past. We will cover the most important of these in the sections to follow. As you can begin to see, the conduit and cable fittings industry continues to meet each challenge as an integral component in our complex electrical distribution system.

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Section 1
FITTINGS FOR USE WITH ARMORED CABLE (TYPE AC)

Armored cable (Type AC) is permitted for use in both exposed and concealed work for virtually all types of electrical systems and for branch circuits and feeders, where not subject to physical damage. AC cable is permitted for use only in dry locations or embedded in plaster finish on brick or other masonry. For a detailed description of the permitted uses of AC cable, refer to Article 320 of the *NEC*®.

NEC® Section 250.118 allows the armor of AC cable to serve as the equipment grounding conductor to ground metal boxes, enclosures, etc. of the electrical system to a single grounding point. The armor and aluminum bond wire in the armored cable combine with grounding type fittings to work together to assure a continuous path to ground.

The requirements for listed Armored Cable are found in ANSI/UL 4, *Armored Cable.*

1.1 FITTING SELECTION

Section 300.15 of the *NEC*® requires that "Fittings and connectors shall be used only with the specific wiring methods for which they are designed and listed." Often, fittings listed for use with Armored Cable are also listed for use with Flexible Metal Conduit (Type FMC) and/or Metal Clad Cable (Type MC). The manufacturer's instructions, labels, and literature should be consulted to determine specific wiring methods for which the fitting is intended and "listed." Refer to the "Required Marking" section for guidance in identifying "listed" uses of such fittings.

Trade references for armored cable most often pertain to the number and trade size of the conductors (e.g. 14/2 indicates two 14 AWG conductors). Fittings for use with armored cable may also make reference to traditional trade sizes (e.g. 1/2(16), 3/4(21)). These typically refer to the knockout size in a box or enclosure into which the fitting is to be mounted. (See Table 1-1)

Recently, metric designators were introduced that correspond to these traditional trade sizes. Table 1-1 provides a cross-reference of traditional trade sizes to these metric designators. Armored cable fittings are available in a variety of materials including fabricated steel, cast malleable iron, cast aluminum, and cast zinc. Selection of the material type of a fitting is a matter of design consideration, or personal preference as all "listed" fittings conform to the same minimum performance criteria. ANSI/UL 514B, *Conduit, Tubing and Cable Fittings,* contains the requirements for listed Armored Cable fittings. Other industry standards pertaining to AC fittings are ANSI/NEMA FB 1, and Federal Specification A-A-50552.

Table 1-1
TRADE SIZES AND METRIC DESIGNATORS

Trade Size	Metric Designator
3/8	12
1/2	16
3/4	21
1	27
1-1/4	35
1-1/2	41
2	53
2-1/2	63
3	78
3-1/2	91
4	103