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NEMA FB 2.10-2007

Selection and Installation Guidelines for Fittings for Use with Non-Flexible Electrical Metal Conduit or Tubing (Rigid Metal Conduit, Intermediate Metal Conduit and Electrical Metallic Tubing)

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Foreword

These selection and installation guidelines offer practical information on correct product selection and industry recommended practices for the installation of fittings for nonflexible metallic conduit or tubing 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
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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, 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; assembly technique* must be considered. We know it is not practical to have a system without splices and 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 fittings. Considering the variety of materials: 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. Through the years, NEMA member companies who manufacturer conduit 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) to 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 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 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*. Specific use information related to listed fittings is available in the UL General Information for Electrical Equipment Directory, or online at www.ul.com.

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, interchangeability, and system compatibility. Besides outlining the essential functional characteristics of conduit and cable fittings, 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 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 one of the most significant changes in the UL 514B standard in recent times is:

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 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 NEC® Section 110.12, and 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.

Section 1
FITTINGS FOR USE WITH ELECTRICAL METALLIC TUBING (EMT)

Steel or aluminum Electrical Metallic Tubing (EMT) is for use in virtually all types of electrical systems as a raceway for branch circuits, feeders, and service entrance. EMT is permitted in both wet and dry locations and may be buried directly in earth or embedded in concrete. For a detailed description of the permitted uses of EMT, refer to *NFPA 70*, *National Electrical Code*® (NEC®), Article 358.

NEC® Section 250.118 permits Electrical Metallic Tubing to serve as the equipment grounding conductor, to ground metal boxes, enclosures, etc. of the electrical system to a single grounding point.

The requirements for listed Electrical Metallic Tubing are found in UL 797, *Electrical Metallic Tubing,* and ANSI C80.3, *Steel Electrical Metallic Tubing (EMT).*

1.1 FITTING SELECTION

The NEC®, in Section 300.15, requires that "fittings and connectors shall be used only with the specific wiring methods for which they were designed and listed."

EMT fittings are available in a variety of materials such as fabricated steel, cast malleable iron, cast aluminum, and cast zinc. Selection of the material type of a fitting is a matter of design considerations, or personal preference as all "listed" fittings conform to the same minimum performance criteria. ANSI/UL514B, *Fittings for Cable and Conduit,* contains the requirements for listed EMT fittings. Other industry standards pertaining to EMT fittings are ANSI/NEMA FB 1, and Federal Specification A-A-50553.

Two general categories describe the means by which fittings attach to EMT so as to assure a sound mechanical and electrical connection: Set screw type and Compression (gland) type. See Figure 1-1 for typical designs. Specialized Indenter Type Fittings are also available for use with EMT. Indenter type fittings rely on a specific indenting tool to indent both the fitting and the tubing. In addition to box connectors and couplings, other fittings designed for use with EMT include:

combination couplings: Are designed to make the transition in a raceway from EMT to another raceway type such as Rigid Conduit, Intermediate Metal Conduit (IMC), Flexible Metal Conduit (FMC), Liquidtight Flexible Metal Conduit, or another trade size of EMT,

pull elbows: Change the direction of the raceway by 90° or less and have a removable cover to facilitate wire pulling,

conduit bodies: Provide access to conductors in the raceway, allow for a change in direction of the raceway, and when listed for the purpose and marked with an internal volume, may accommodate splices or installation of certain wiring devices, and

expansion fittings: Compensate for stress on the raceway and supports that may result where substantial temperature changes are expected.

EMT connectors having throat liners of insulating material are also available. On some fitting designs, such throat liners provide the required primary means to protect the conductor's insulation during wire pulling. On most common fitting designs however, such insulating throat liners are optional. EMT connectors with insulating throats also provide the required protection against physical damage for 4 AWG and larger ungrounded conductors.