

Subject 1660

June 1, 2018

SUMMARY OF TOPICS

The following changes in requirements to the Standard for Liquid-Tight Flexible Nonmetallic Conduit, UL 1660, are being proposed:

Publish an Updated New Edition which Includes References to the Mexican Electrical Installation Code, Reference Publications and ANCE References

STP BALLOTS AND ALL COMMENTS DUE: July 16, 2018

UL's goal is to have no interest category comprise more than one-third of the STP membership balance. To improve the current balance for STP 1660, UL is looking for participants in the Supply Chain, Commercial/Industrial User, General Interest, AHJ, Government, Testing and Standards, Consumer or International Delegation interest categories. Definitions for these interest categories are available on the Standards STP Internet site:

<http://ulstandards.ul.com/develop-standards/participation/interest-categories/>

If you are interested in applying for STP 1660 membership or are aware of potential candidates for this STP, please contact the STP Project Manager, Joshua.Johnson@ul.com.

For your convenience in review, proposed additions to existing requirements are shown underlined and proposed deletions are shown ~~lined-out~~.

Publish an Updated New Edition which Includes References to the Mexican Electrical Installation Code, Reference Publications and ANCE References

RATIONALE

Include the Reference to the Mexican Electrical Installation Code, Reference Publications and ANCE References

Proposal submitted by: the members of THC 23A MT 11

(See 1.1, 1.3, 3.2, 5.2.1, 5.2.3, 5.4.2, 5.12.2, 5.14.1.1, 5.14.6.1, 5.16.1, 6.1.3)

In the current round of proposals to amend this standard, it is transitioning from binational to trinational status. To accommodate the adoption of this standard in all of North America, the addition of normative references to the appropriate Mexican standards is necessary.

Aligning the Definitions of Liquid-Tight in Accordance to NEC 356.10(2)

Proposal submitted by: the members of THC 23A MT 11

(See 2.1)

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The current definition for LFNC is circular. It should include what is meant by liquid-tight. The proposal aligns with the definition of liquid-tight according to NEC 356.10(2).

Deletion of the Component Section

Proposal submitted by: the members of THC 23A MT 11

(See component section in attached document or current standard draft 3.1 for deleted text)

The THSC is not aware of any components used in the construction of LFNC.

Deletion of the Publication Year

Proposal submitted by: the members of THC 23A MT 11

Since 3.2.1 already states that references to any standards are to the latest editions unless otherwise specified, there is no need to assign dates to normative references wherever the latest edition is being referenced.

Specify the Impact Height

Proposal submitted by: Evangeline Cometa, CSA Group

(See 5.4.2)

The Cold Impact test specifies an impact of 12.2 (9ft-lb) and 5.4.2, a Tup B-9 kg mass (20 lb). Since we have identified the exact energy and weight of the impact mass, we might as well specify the exact height from which to release the weight so as to produce 12.2 J, instead of making the user calculate it which could lead to confusion. The impact height needs to be measured from the top of the specimen.

Restructure Moisture Penetration for Ease of Readability

Proposal submitted by: the members of THC 23A MT 11

(See 5.11)

This clause should be structured similarly to 5.12 for clarification.

Addition of Inside and Outside Dimensions, Wall Thickness of Flexible Lining or Jacket, Development of Minimum Deflection Load and Mandrel Diameters for 2-1/2, 3, 3-1/2 and 4 Trade Size Mandrels for Liquid-Tight Flexible Nonmetallic Conduit

Proposal submitted by: David Gerstetter, UL LLC

(See table 3, table 4, table 6 and table 8))

The standard covers LFNC in the 3/8 - 4 (12 - 103) trade sizes of Type LFNC-A (Layered), Type LFNC-B (Integral), and Type LFNC-C (Corrugated) constructions. According to the standard, inside and outside dimensions are identified as "to be developed". UL has completed its work and proposes outside dimension requirements for 2-1/2, 3, 3-1/2 and 4 trade sizes for Type LFNC-B conduits.

Adding the Figure 1 Key

Proposal submitted by: Alejandro Ramirez, ANCE

(See figure 1)

The figure does not define Dg or Dn

Clarification on Marking Requirements

Proposal submitted by: the members of THC 23A MT 11

(See 6.2.1)

This proposal clarifies the marking requirements.

The DWTT Guide information concerning fittings for LFNC-B says:

A metallic fitting that physically cannot be connected to any type of conduit other than liquid-tight flexible metallic or nonmetallic Type B conduit can have the marking on carton in which the fitting is packed. It is marked "Liquid-Tight Flexible Nonmetallic Conduit Type B Only," "LFNC-B" or "FNMC-B."

Upon review of UL 514B, there is no indication that states that all fittings for Liquid tight flexible metal conduit are acceptable for use with LFNC-B. One could not say that all LFMC fittings are approved for LFNC-B nor could one say that any LFMC fittings have ever been evaluated for use with LFNC-B. If however all LFMC fittings are not approved for LFNC-B, how can the user be instructed by the marking to use fittings for liquid-tight flexible metallic?

Editorial Correction

Proposal submitted by: Greg Steinman, Thomas & Betts Corp

Correct the units in section 5.6. "Pa" should be "kPa".

PROPOSAL

1 Scope

1.1 These requirements cover liquid-tight flexible nonmetallic conduit in the 3/8 – 4 (12 – 103) trade sizes of Type LFNC-A (Layered), Type LFNC-B (Integral), and Type LFNC-C (Corrugated) constructions. The conduit is intended for installation in accordance with the National Electrical Code (NEC) and the Canadian Electrical Code (CEC), Part 1, and the Mexican Electrical Code, NOM-001-SEDE. The values in parentheses are metric trade designators of conduit.

1.2 Conduit covered by this Standard is intended for use in wet, dry, or oily locations at a maximum of 60°C (140°F), unless otherwise marked. (See Clause 6.)

1.3 Fittings for liquid-tight flexible nonmetallic conduit are covered in UL 514B or, CSA C22.2 No. 18.3: or NMX-J-017-ANCE.

2 Definitions

2.1 For the purposes of this Standard the following definitions apply.

LIQUID-TIGHT FLEXIBLE NONMETALLIC CONDUIT – A conduit that is resistant to the ingress of vapors, machine oils and other liquids, and solids, liquid-tight, and can be bent by hand without other assistance, and is intended to flex throughout its life.

TYPE LFNC-A (Layered) – A liquid-tight conduit with a smooth seamless inner core and cover bonded together with one or more reinforcement layers between the core and cover.

TYPE LFNC-B (Integral) – A liquid-tight conduit with a smooth inner surface with integral reinforcement within the conduit wall.

TYPE LFNC-C (Corrugated) – A liquid-tight conduit with corrugated internal and external surfaces without integral reinforcement within the conduit wall.

3 General

3.1 Components

~~3.1.1 Except as indicated in Clause 3.1.2, a component of a product covered by this Standard shall comply with the requirements for that component. A component shall comply with both the Underwriters Laboratories Inc. and Canadian Standards Association standards for the component.~~

~~3.1.2 A component is not required to comply with a specific requirement that:~~

- ~~a) Involves a feature or characteristic not required in the application of the component in the product covered by this standard, or~~
- ~~b) Is superseded by a requirement in this standard.~~

~~3.1.3 A component shall be used in accordance with its rating established for the intended conditions of use.~~

~~3.1.4 Specific components are incomplete in construction features or restricted in performance capabilities. Such components are intended for use only under limited conditions, such as certain temperatures not exceeding specified limits, and shall be used only under those specific conditions.~~

3.2 Reference publications

3.2.1 Where reference is made to any Standards, such reference shall be considered to refer to the latest editions and revisions thereto available at the time of printing, unless otherwise specified.

Secretary of Energy

NOM-001-SEDE

Standard for Electrical Installations

Product Standardization and Certification Center (CNCP)

NMX-E-208-CNCP

Plastics industry – Determination of characteristics of plastic conduit under external loads using parallel plates - Test method

NMX-E-029-CNCP

Plastics industry - Impact resistance for conduit and fittings - Test method

ANCE Standards

NMX-J-017-ANCE

Fittings for Cables and Tubing – Specifications and Test Methods

NMX-J-178-ANCE

Wires and Cables – Ultimate Strength and Elongation of Insulation, Semiconducting Shields and Jackets of Electrical Conductors – Test Method

NMX-J-417-ANCE

Wires and Cables – Convection Laboratory Ovens for Evaluation of Electrical Insulation – Specifications and Test Methods

NMX-J-553-ANCE

Wires and Cables – Weather Resistance of Insulation or Jacket of Electrical Conductors – Test Method

NMX-J-565-3-ANCE

Safety Requirements – Flammability of Plastic Materials for Parts in Devices and Equipment – Test Methods

CSA Group Standards

Note: For products intended for use in Canada, general requirements are given in CAN/CSA-C22.2 No. 0

C22.1-12

Canadian Electrical Code (CEC), Part I

C22.2-No. 0-10

General Requirements – Canadian Electrical Code, Part II

CAN/CSA-C22.2 No. 0.17-00 (R2013)

Evaluation of Properties of Polymeric Materials

C22.2 No.18.3-12
Conduit, Tubing, and Cable Fittings

C22.2 No. 211.0-03 (R2013)
General Requirements and Methods of Testing for Nonmetallic Conduit

UL Standards

UL 94
Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

UL 514B
Conduit, Tubing, and Cable Fittings

ANSI/NFPA Standards

ANSI/NFPA 70-2014
National Electrical Code (NEC)

ASTM Standards

ASTM D412-06a (R2013)
Standard Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers – Tension

ASTM D 2412-11
Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading

ASTM D 2444-99 (R2010)
Standard Test Method for Determination of the Impact Resistance of Thermoplastic Pipe and Fittings by Means of a Tup (Falling Weight)

ASTM D 5025-12
Standard Specification for Laboratory Burner Used for Small-Scale Burning Tests on Plastic Materials

ASTM D 5207-09
Standard Practice for Confirmation of 20-mm (50-W) and 125-mm (500-W) Test Flames for Small-Scale Burning Tests on Plastic Materials

ASTM D 5423-93 (R2005)
Standard Specification for Forced-Convection Laboratory Ovens for Evaluation of Electrical Insulation

ASTM G 155-13
Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Nonmetallic Materials

3.3 Units of measurement

3.3.1 The values given in SI (metric) units shall be normative. Any other values given shall be for information purposes only.

4 Construction

4.1 General

4.1.1 Conduit shall be essentially circular in cross-section. The inside surface of conduit shall not have indentations (normal convolutions or corrugations shall not be considered indentations), projections, roughness, or other features that could damage or impede wires and cables being pulled into the conduit. The length of finished conduit is not specified. Spliced lengths of Type LFNC-B conduit shall be provided with a marking on the package. See Clause 6.2.1 g).

4.2 Materials

4.2.1 Conduit shall be made entirely of nonmetallic materials. Each material used in conduit shall be compatible with all of the other materials used in the conduit and with any conductors or cable intended to be pulled into the conduit.

4.3 Dimensions

4.3.1 Type LFNC-A conduit

4.3.1.1 The inside and outside diameters of finished Type LFNC-A conduit shall comply with Table 1.

4.3.1.2 Compliance of Type LFNC-A conduit with the minimum and maximum inside diameters shall be determined by means of the go and no-go limit gauges specified in Figure 1 and Table 1.

4.3.1.3 The average thickness and the minimum thickness at any point of the separate jacket of Type LFNC-A conduit shall not be less than indicated in Table 2. The thicknesses of Type LFNC-A conduit are not specified.

4.3.1.4 The average thickness of the separate jacket shall be determined from measurements on a specimen of the jacket that is at least 13 mm (1/2 in) wide, at least 125 mm (5 in) long, and prepared from the finished Type LFNC-A conduit by cutting the conduit through one wall longitudinally, followed by peeling or cutting and buffing the separate lining away and then removing the fibrous reinforcement. The longitudinal cut shall be clean and straight. The jacket shall be split, skived, or buffed to remove the irregularities left on its inside surface by the reinforcement. The specimen selected shall include the thinnest portion of the jacket as determined visually. Five readings shall be taken at different points along the length of the specimen. The average of these measurements shall be taken as the average thickness. The smallest of these measurements shall be taken as the minimum thickness at any point.

4.3.2 Type LFNC-B conduit

4.3.2.1 The inside and outside diameters of finished Type LFNC-B conduit shall comply with Table 3.

4.3.2.2 Compliance of Type LFNC-B conduit with the minimum and maximum inside diameters shall be determined by means of the go and no-go limit gauges specified in Figure 1 and Table 3.

4.3.2.3 The minimum thickness at any point of the flexible lining or jacket of Type LFNC-B conduit shall not be less than indicated in Table 4 when measured on the finished conduit between the convolutions formed by the rigid reinforcement. The flexible jacket or lining shall be reinforced, but this thickness is not specified. The smallest of at least three measurements made around the circumference of the conduit shall be taken as the minimum thickness at any point.

4.3.3 Type LFNC-C conduit

4.3.3.1 The minimum inside diameter of finished Type LFNC-C conduit shall comply with Table 5. Other dimensions are not specified.

5 Tests

5.1 General

5.1.1 All conduit specimens shall be conditioned for not less than 24 hours at $23 \pm 2^\circ\text{C}$ ($73 \pm 4^\circ\text{F}$) and $50 \pm 5\%$ relative humidity before being tested under the same conditions, unless otherwise specified in this Standard.

5.2 Vertical flame test

5.2.1 A specimen of the finished conduit shall be subjected to five 15-s applications of flame, the period between applications being 15 s. The specimen shall not be acceptable if it:

- a) Continues to flame longer than 10 s, following the fifth application of the flame; or
- b) Shows more than 25% of the indicator flag burned away or charred during, between, or after the five applications of the flame. Soot that can be removed with a cloth or the fingers and brown scorching shall be ignored; or
- c) Emits flaming or glowing particles or flaming drops at any time that ignite the cotton on the burner, wedge, or floor of the enclosure. Flameless charring of the cotton shall be ignored.

The conduit need not be subjected to this test when it is made of a material that is classed 5VA or 5VB (small scale flame test rating), in accordance with UL 94, or CAN/CSA-C22.2 No. 0.17, or NMX-J-565-3-ANCE, and constructed of at least the same thickness as the material classed as 5VA or 5VB.

5.2.2 This test shall be performed on unaged specimens in a 3-sided metal enclosure in an exhaust hood or cabinet. The metal enclosure shall be 305 mm (12 in) wide, 355 mm (14 in) deep, 610 mm (25 in) high, and the top and front shall be open. A 457-mm (18 in) specimen cut from a length of finished conduit shall be secured with its longitudinal axis vertical in the center of the enclosure. A flat, horizontal layer of untreated surgical cotton 6 – 25 mm (1/4 – 1 in) thick shall cover the floor of the enclosure. The upper surface of the cotton shall be 229 – 241 mm (9 – 9-1/2 in) below point B, which is the point at which the tip of the blue inner cone of the test flame touches the specimen (shown in Figure 2).

5.2.3 A burner conforming to ASTM D5025 or NMX-J-565-3-ANCE having a bore of 9.5 ± 0.3 mm and a length of 100 ± 10 mm from the top of the air-inlet openings to the top of the mixing tube, or an equivalent which meets the calibration of ASTM D5207 or NMX-J-565-3-ANCE shall be used. While the barrel is vertical and the burner is well away from the specimen, the overall height of the flame shall be adjusted to approximately 100 – 125 mm (4 – 5 in). The blue inner cone shall be 38 mm (1-1/2 in) high and the temperature at its tip shall be 816°C (1500°F) or higher as measured using a chromel-alumel (nickel-chromium and nickel-manganese-aluminum) thermocouple. Without disturbing the adjustments for the height of the flame, the valve supplying gas to the burner flame and the separate valve supplying gas to any pilot flame shall be closed.

5.2.4 A wedge (dimensions are specified in Figure 3) to which the base of the burner can be secured shall be provided for tilting the barrel 20° from the vertical while the longitudinal axis of the barrel remains in a vertical plane. The burner shall be secured to the wedge and the assembly shall be placed in an adjustable support jig. A layer of untreated surgical cotton 6 – 25 mm (1/4 – 1 in) thick shall be placed on the wedge and around the base of the burner. The jig shall be adjusted toward one side or the other of the enclosure to place the longitudinal axis of the barrel in the vertical plane that contains the longitudinal axis of the specimen. The plane shall be parallel to the sides of the enclosure. The jig shall also be adjusted toward the rear or front of the enclosure to position point A, which is the intersection of the longitudinal axis of the barrel with the plane of the tip of the barrel, 38 mm (1-1/2 in) from point B at which the extended longitudinal axis of the barrel meets the outer surface of the specimen. Point B is the point at which the tip of the blue inner cone touches the center of the front of the specimen.

5.2.5 In the absence of a gas pilot light on the burner, the support for the burner and wedge shall be arranged to enable the burner to be quickly removed from and precisely returned to the position described in Clause 5.2.4 without disturbing the layer of cotton on the floor of the enclosure or the cotton on the wedge and around the base of the burner.

5.2.6 A strip of unreinforced 94-g/m² or 60-lb kraft paper that is 0.13 mm (1/2 in) wide, approximately 5 mils or 0.1 mm thick, and is gummed on one side shall be used to make an indicator flag. The gumming shall be moistened just to facilitate adhesion. With the gum toward the specimen, the strip shall be wrapped around the specimen once with its lower edge 254 mm (10 in) above B, the point at which the blue inner cone touches the specimen. The ends of the strip shall be pasted together evenly and trimmed to provide a flag that projects 19 mm (3/4 in) from the specimen toward the rear of the enclosure, with the flag parallel to the sides of the enclosure (see Figure 2). The lower clamp or other support for the specimen shall be adjusted vertically to keep it from being any closer than 76 mm (3 in) to point B.

5.2.7 If the burner has a gas pilot light, the valve supplying gas to the pilot shall be opened and the pilot lit. If the burner does not have a gas pilot light, the burner shall be supported as indicated in Clause 5.2.6 in a position away from the specimen and then lit. This operation and the remainder of the test shall be conducted under a forced-draft exhaust hood or cabinet operating to remove smoke and fumes, but not having drafts that affect the flame.

5.2.8 If the burner has a gas pilot light, the valve supplying gas to the burner shall be opened to apply the flame to the specimen automatically. This valve shall be held open for 15 s, closed for 15 s, opened for 15 s, and so forth for a total of five 15-s applications of the gas flame to the specimen, with 15 s between applications. If the burner does not have a gas pilot light, the burner shall be moved into position to apply the gas flame to the specimen, kept there for 15 s, removed for 15 s, and so forth for a total of five 15-s applications of the gas flame to the specimen, with 15 s between applications. The gas flame shall be reapplied to the specimen 15 s after the previous application, regardless of whether flaming of the specimen ceases of its own accord within 15 s of the previous application.

5.2.9 The gas used shall be either technical grade methane gas (min. 98 percent pure) supplied using a regulator and meter for uniform gas flow or natural gas having a heat content of approximately 37 ± 1 MJ/m³ (993 ± 27 Btu/ft³).

5.3 Flame test in cable trays – FT4 (OPTIONAL)

5.3.1 Conduit which is intended to be marked FT4 shall comply with the Vertical Flame Test (FT4) Conduit or Tubing on Cable Tray in accordance with CSA C22.2 No. 211.0.

Note: The FT4 flame test is a National Building Code of Canada requirement in designated applications in noncombustible construction buildings.

5.4 Cold impact

5.4.1 Ten 150-mm (6-in) specimens of conduit shall be conditioned at a temperature of minus $18 \pm 1^\circ\text{C}$ ($0 \pm 2^\circ\text{F}$) for a period of 4 hours. They shall then be subjected to an impact of 12.2 J (9 ft-lb). The conduit shall not have cracks or separation of convolutions in more than two out of ten specimens when examined under normal or corrected-to-normal vision. Damage to the conduit shall be determined without excessive bending, stretching, or pulling of the conduit.

5.4.2 The impact test in Clause 5.4.1 shall be performed using Tup B, having a 9-kg (20-lb) mass dropped from a height of 13.8 cm (5.4 in), in accordance with the method specified in ASTM D2444 or NMX-E-029-CNCP. The test shall be conducted inside the cold chamber or within 15 s after removal from the cold chamber.

5.5 Resistance to deflection

5.5.1 The load required to deflect any specimen of the conduit to 50 percent of its original overall diameter shall be at least as great as the value indicated in Table 6. The center section of five specimens of finished conduit, a minimum of 380 mm (15 in) long, shall be deflected between two flat, square steel plates having rounded edges and measuring 150 mm (6 in) on each side, moving toward one another at the rate of 12.5 ± 2.5 mm/min ($1/2 \pm 1/8$ in/min) until the overall diameter of the conduit is reduced to half of its original value.

5.6 Tension

5.6.1 Finished conduit shall be capable of withstanding an axial tension of 890 N (200 lbf) for the 3/8 (12) trade size and 1334 N (300 lbf) for 1/2 (16) trade size or larger for 60 s without opening up at any point when tested as indicated in Clauses 5.6.2 – 5.6.6. There shall be no splits, cracks, tears, or other openings in the outside or inside surfaces of the conduit. Damage to the conduit shall be determined without excessive bending, stretching, or pulling of the conduit.

5.6.2 The apparatus shall consist of a pair of clamps or grips and a weight or a tensile testing machine for exerting the force specified in Clause 5.6.1. If a weight is used, a block and tackle or a differential pulley shall be provided to lift the specimen, clamps, and weight (see Figure 4).

5.6.3 For a test using a weight and either a block and tackle or a differential pulley, the clamps shall be made of hard wood. The two pieces comprising each clamp shall be fastened together by two bolts, enabling the conduit to be clamped tightly between the jaws without being crushed (see Figure 5).

5.6.4 For a test using a weight and either a block and tackle or a differential pulley, a 1.1-m (44-in) specimen of the conduit shall be fastened in the clamps so that its ends project about 50 mm (2 in) beyond the edges of each clamp. The result is a specimen that is 0.9 m (36 in) long between the clamps, which are then to be tightened to keep the specimen from slipping.

5.6.5 For a test using a testing machine, a 457-mm (18-in) specimen shall be gripped in the jaws of the machine. If necessary to keep the jaws from crushing the specimen, round metal plugs shall be inserted into the ends of the specimen. The jaws shall then be separated at a rate of 50 ± 5 mm/min (2.0 ± 0.2 in/min) until the specimen is under tension by the force specified in Clause 5.6.1. This level of tension shall be maintained for 60 s and shall then be released at the same rate at which it was applied. For any adjustment necessary for maintaining the tension during the 60 s, the jaws shall be separated at the rate of 12.5 ± 3.0 mm/min ($1/2 \pm 1/8$ in/min).

5.6.6 For a test using a weight and either a block and tackle or a differential pulley, the specimen shall be suspended by the upper clamp with a loop of rope passing over the hook of the block and tackle or differential pulley assembly, and a weight exerting the force as specified in Clause 5.6.1 shall be attached to the lower clamp. The specimen shall hang vertically for its full length and at right angles to the faces of the clamps. The specimen, clamps, and weight shall then be raised gently so that tension is applied to the specimen as evenly as possible. The total weight shall be applied within 30 s so that the weight clears the floor and hangs freely in the air. The weight shall be kept from rotating. The weight shall be supported by the specimen for 60 s, and shall then be lowered to the floor, and the weight and clamps shall be removed.

5.7 Secureness forces

5.7.1 Three 380-mm (15-in) specimens of finished conduit shall withstand the pull described in Clause 5.7.2 without damage to the conduit.

5.7.2 Each conduit specimen shall be assembled to a separate fitting that is intended for the conduit and shall then be tested by a weight as shown in Table 7 between each fitting and the conduit for 5 min. The conduit shall not show any damage. Elongation or stretching of the conduit that is not permanent shall not be considered damaged.