UL 514B

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Fittings for Cable and Conduit

Underwriters Laboratories Inc. (UL)
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UL Standard for Safety for Fittings for Cable and Conduit, UL 514B

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Text that has been changed in any manner is marked with a vertical line in the margin. Changes in requirements are marked with a vertical line in the margin and are followed by an effective date note indicating the date of publication or the date on which the changed requirement becomes effective.

The revisions are substantially in accordance with UL's Bulletin(s) on this subject dated November 21, 2001.

The revisions dated February 7, 2002 include a reprinted title page (page1) for this Standard.

As indicated on the title page (page1), this UL Standard for Safety has been adopted by the Department of Defense.

The master for this Standard at UL's Northbrook Office is the official document insofar as it relates to a UL service and the compliance of a product with respect to the requirements for that product and service, or if there are questions regarding the accuracy of this Standard.

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The requirements in this Standard are now in effect, except for those paragraphs, sections, tables, figures, and/or other elements of the Standard having future effective dates as indicated in the note following the affected item. The prior text for requirements that have been revised and that have a future effective date are located after the Standard, and are preceded by a ″SUPERSEDED REQUIREMENTS″ notice.

New product submittals made prior to a specified future effective date will be judged under all of the requirements in this Standard including those requirements with a specified future effective date, unless the applicant specifically requests that the product be judged under the current requirements. However, if the applicant elects this option, it should be noted that compliance with all the requirements in this Standard will be required as a condition of continued Listing, Recognition and Follow-Up Services after the effective date, and understanding of this should be signified in writing.

This Standard consists of pages dated as shown in the following checklist:

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UL 514B

Standard for Fittings for Cable and Conduit

Prior to the First edition, the requirements for the products covered by this standard were included in the Standard for Outlet Boxes and Fittings, UL 514.

The Third and previous editions were titled Fittings for Conduit and Outlet Boxes.

First Edition – July, 1982
Second Edition – March, 1989
Third Edition – December, 1996

Fourth Edition

November 3, 1997

An effective date included as a note immediately following certain requirements is one established by Underwriters Laboratories Inc.

The Department of Defense (DoD) has adopted UL 514B on June 11, 1992 . The publication of revised pages or a new edition of this Standard will not invalidate the DoD adoption.

Revisions of this Standard will be made by issuing revised or additional pages bearing their date of issue. A UL Standard is current only if it incorporates the most recently adopted revisions, all of which are itemized on the transmittal notice that accompanies the latest set of revised requirements.

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FOREWORD

A. This Standard contains basic requirements for products covered by Underwriters Laboratories Inc. (UL) under its Follow-Up Service for this category within the limitations given below and in the Scope section of this Standard. These requirements are based upon sound engineering principles, research, records of tests and field experience, and an appreciation of the problems of manufacture, installation, and use derived from consultation with and information obtained from manufacturers, users, inspection authorities, and others having specialized experience. They are subject to revision as further experience and investigation may show is necessary or desirable.

B. The observance of the requirements of this Standard by a manufacturer is one of the conditions of the continued coverage of the manufacturer's product.

C. A product which complies with the text of this Standard will not necessarily be judged to comply with the Standard if, when examined and tested, it is found to have other features which impair the level of safety contemplated by these requirements.

D. A product that contains features, characteristics, components, materials, or systems new or different from those covered by the requirements in this standard, and that involves a risk of fire or of electric shock or injury to persons shall be evaluated using appropriate additional component and end-product requirements to maintain the level of safety as originally anticipated by the intent of this standard. A product whose features, characteristics, components, materials, or systems conflict with specific requirements or provisions of this standard does not comply with this standard. Revision of requirements shall be proposed and adopted in conformance with the methods employed for development, revision, and implementation of this standard.

E. UL, in performing its functions in accordance with its objectives, does not assume or undertake to discharge any responsibility of the manufacturer or any other party. The opinions and findings of UL represent its professional judgment given with due consideration to the necessary limitations of practical operation and state of the art at the time the Standard is processed. UL shall not be responsible to anyone for the use of or reliance upon this Standard by anyone. UL shall not incur any obligation or liability for damages, including consequential damages, arising out of or in connection with the use, interpretation of, or reliance upon this Standard.

F. Many tests required by the Standards of UL are inherently hazardous and adequate safeguards for personnel and property shall be employed in conducting such tests.

INTRODUCTION

1 Scope

1.1 These requirements cover fittings for use with conduit and outlet boxes to be employed in accordance with the National Electrical Code, NFPA 70.

1.2 The requirements in Sections 1 – 85 cover conduit locknuts, conduit bushings, conduit bodies, entrance elbows; fittings for electrical metallic tubing, flexible metal conduit, intermediate metal conduit, liquid-tight flexible conduit, rigid metal conduit, rigid nonmetallic conduit; service-entrance heads; threadless fittings; fittings for armored cable, metal clad cable, mineral-insulated cable, nonmetallic sheathed cable, service-entrance cable; and fittings for flexible cord, flexible nonmetallic tubing, insulating bushings, and nipples.

1.3 The requirements in Sections 86 – 103 cover fittings for rigid polyvinyl chloride (PVC) conduit. See Scope, Section 86, for additional details.

1.4 These requirements do not cover fittings for use in hazardous locations as defined in the National Electric Code, NFPA 70.

1.5 These requirements do not cover fittings intended for use with surface raceway systems.

1.6 These requirements do not cover conduit nipples, elbows and threaded couplings intended for use with intermediate metal conduit or rigid metal conduit, or elbows intended for use with intermediate metal conduit, rigid metal conduit, or electrical metallic tubing are not covered by these requirements.

1.7 Deleted February 7, 2002

2 Terminology

2.1 In the following text, a requirement that applies only to one or more types of fitting is so identified by a specific reference in that requirement to the type or types of fittings involved. Absence of such reference indicates that the requirement applies to all of these types of fittings unless the context indicates otherwise.

3 Undated References

3.1 Any undated reference to a code or standard appearing in the requirements of this standard shall be interpreted as referring to the latest edition of that code or standard.

4 Glossary

4.1 For the purpose of this standard the following definitions apply.

4.2 ANGLE FITTING – A fitting with or without a removable cover (or cap) intended to change the direction of the raceway.

4.3 BUSHING – A fitting provided to protect wires from abrasion and intended for use where conductors enter or leave the raceway system.

4.4 CONCRETE-TIGHT FITTING – A fitting that excludes concrete aggregate (portland-type cement and sand).

4.5 CONDUIT BODY – A means for providing access to the interior of the system through one or more removable covers at a junction of two or more sections or at a terminal point.

4.6 CONDUIT BODY, SHORT RADIUS – A capped elbow or service entrance elbow.

4.7 CONNECTOR – A fitting intended to terminate a cable, cord, or raceway to a box or similar device.

4.8 COUPLING – A fitting intended to connect two lengths of raceway or perform a similar function.

4.9 ELASTOMER – Rubber or any polymer other than a thermoplastic elastomer that has properties similar to those of rubber.

4.10 ELBOW – A fitting used to change the direction of a raceway system.

4.11 EXPANSION JOINT – A fitting intended to compensate for linear thermal expansion of a span of intermediate metal, rigid metal, or nonmetallic conduit.

4.12 FITTING – A means for securing conduit, cable, or electrical metallic tubing to an enclosure, box, or raceway system.

4.13 FLEXIBLE CORD FITTING – A cord grip without mesh support used to reduce strain at points of termination for flexible cord.

4.14 FLEXIBLE CORD FITTING, LIQUID-TIGHT – A cord grip without mesh support used to reduce strain at points of termination for flexible cord intended for liquid-tight and outdoor applications.

4.15 GRIP, PULLING – A mesh grip used to pull conductors or cable into a raceway.

4.16 GRIP, STRAIN RELIEF – A mesh grip used to reduce strain at points of termination for cable or flexible conduit.

4.17 GRIP, SUPPORT – A mesh grip used to hold the weight and restrain the arc-of-bend of a cable.

4.18 HUB – A fitting intended for use with threaded conduit for connection to an enclosure.

4.19 INSULATING BUSHING – A fitting, consisting of a polymeric insulator provided to protect wires from abrasion and intended for use where conductors enter or leave the raceway system. Included are metal bushings or fittings having a polymeric throat, throat liner, or insert.

4.20 LOCKNUT – An internally threaded fitting for use on intermediate metal or rigid metal conduit or fittings to prevent turning and to provide a secure joint.

4.21 NIPPLE – An externally threaded fitting intended primarily to serve as a short raceway between close-spaced enclosures.

4.22 REDUCING COUPLING – A fitting intended to join lengths of two different sizes of raceway.

4.23 SERVICE-ENTRANCE HEAD – An enclosed fitting intended for use at service entrances where open wiring is connected to a service-entrance cable or raceway system.

4.24 THREADLESS FITTING – A fitting intended for use with electrical metallic tubing, intermediate metal conduit, or rigid metal conduit.

5 Units of Measurement

5.1 If a value for measurement is followed by a value in other units in parentheses, the second value may be only approximate. The first stated value is the requirement. Where there is a trade size shown followed by a number in parentheses, the second number is the metric designator.

CONSTRUCTION

ALL FITTINGS

6 General

6.1 The requirements in Sections 7 – 12 apply to all fittings except those for use with rigid nonmetallic conduit. They are supplemented or modified in subsequent sections with requirements applying exclusively to threadless fittings, wet-location fittings, and concrete-tight fittings and the like.

6.2 A part of a fitting that may contact an insulated conductor shall be smooth and rounded.

6.3 A fitting that will accommodate more than one trade size of raceway shall comply with 6.2 with each size of raceway installed as intended.

6.4 Other than a coupling or locknut, a fitting that is internally threaded for attachment to intermediate metal conduit or rigid metal conduit shall be provided with a positive end stop for the conduit and a smooth, rounded throat to prevent abrasion of insulation on conductors entering the fitting from the conduit. The throat shall be continuous around the circumference.

6.5 A fitting for the connection of conduit shall have a smooth rounded inlet hole. Unless otherwise indicated, the throat diameter of the inlet hole shall be within the limits specified for a bushing in Table 30.1, and compliance shall be determined by applying the limit gauges illustrated in Figure 90.1 and having the dimensions specified in Table 90.5.

6.6 A fitting shall substantially close the opening with which it is used when the cable or raceway is clamped in place and shall not permit the passage of a 3/16-inch (4.8-mm) diameter probe.

6.7 All metal parts of a fitting that can become energized shall be grounded unless located so that they cannot be contacted.

7 Materials

7.1 A material intended for installation between a fitting or the cover of a fitting and an enclosure that is depended upon to exclude water or moisture shall be made of:

a) Material that complies with the requirements for use as gasket material in accordance with the Standard for Gaskets and Seals, UL 157,

b) An elastomer that complies with Elastomeric Materials Test, Section 44, or

c) Expanded (foam) closed-cell material that complies with Compression/Set Test, Section 43.

7.2 A polymeric fitting shall comply with Flammability Test, Section 36.

Exception No. 1: A fitting or insulating bushing of a material Classed V-0, V-1, V-2, or 5VA in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94, does not require flammability tests.

Exception No. 2: A polymeric component that is located so that it is unable to propagate flame from one area to another or bridge between a possible ignition source and a combustible material, does not require flammability tests.

7.2 revised October 21, 1998

7.3 A polymeric throat or throat liner installed in a metal fitting shall:

a) Comply with the requirements for fittings in Flammability Test, Section 36.

Exception: A polymeric throat or throat liner that has been evaluated at the minimum thickness in accordance with 7.4 and found to comply with the High-Current-Arc-Ignition Test in the Standard for Polymeric Materials – Short-Term Property Evaluations, UL 746A, when subjected to a minimum of 60 arcs, need not comply with Flammability Test, Section 36.

b) Comply with Insulating Bushings, Section 63.

7.4 The minimum thickness of a polymeric material is to be determined by measuring the thickness of the material at any point other than at the base of a groove used to assemble a polymeric throat to a bushing. The thickness at threads is to be measured from the crest of the thread through the material to the smooth wall surface.

7.5 An insulating bushing shall be assigned one of the temperature ratings specified in Table 63.1. See 81.1.

8 Protection Against Corrosion

8.1 A ferrous metal fitting shall be protected against corrosion with a zinc or cadmium coating not thinner than specified in Table 8.1.

Exception No. 1: A fitting of stainless steel and a bar hanger formed of steel bar stock need not be so protected.

Exception No. 2: A cut edge, a punched hole, and the threaded surface of a tapped hole, need not be so protected.

Exception No. 3: Other types of coatings may be employed provided they are investigated and found to be acceptable for the purpose.

Table 8.1
Thickness of coating

Table 8.1 revised October 21, 1998

Type of fitting and material	Thickness of coating, inch (mm)			
	Average[a]		Minimum	
A fitting part, lock-nut or clamp intended for assembly inside a box	0.00015	(0.0038)	0.0001	(0.0025)
Outside of a sheet-steel or a machined-steel coupling, connector, bushing, reducing washer, or conduit locknut (other than one intended for assembly inside a box)	0.0005	(0.0127)	0.0004	(0.0102)
Inside of a sheet-steel or machined-steel fitting	b		b	
Malleable or cast-iron fittings	b		b	
Screws	b		b	

[a] The average thickness is to be determined by averaging at least three measurements. Each measurement is to be taken on a different surface, if possible. If multiple measurements are taken on a single surface, they are to be spaced equally over that surface.

[b] The minimum thickness of the coating on these fittings and components is not specified. Evidence of corrosion protection provided is to be verified by visual inspection.

9 Wall Thickness

9.1 Other than as provided in 9.2 and 9.4, a fitting shall have a wall thickness not less than that specified in Table 9.1 when measured not less than 1/8 inch (3.2 mm) from the edge of the fitting. If a taper is provided to permit easy withdrawal of the part from the die, the thickness shall not be less than that required at the base of threads when measured 1/32 inch (0.8 mm) from the edge of the fitting.

9.2 Thickness at the base of threads is to be measured with a conical-nosed micrometer having points with a 1/64-inch (0.4-mm) flat surface at the ends, and with the sides of the cone forming an angle of 60 degrees with the planes of the flat surfaces.

9.3 The part of a die-cast fitting that is secured to flexible conduit by insertion inside the conduit shall not be less than 0.025 inch (0.64 mm) thick.

Table 9.1
Wall thickness of fittings

Table 9.1 revised October 21, 1998

Material of fittings	Minimum wall thickness of unthreaded parts,		Minimum thickness at base of threads,	
	inch	(mm)	inch	(mm)
Sheet steel or machine steel	0.0250[e]	(0.635)	0.0250[a]	(0.635)
			0.0200[b]	(0.508)
Sheet aluminum or machine aluminum	0.031	(0.79)	0.031	(0.79)
Die-cast aluminum, die-cast zinc, or malleable iron	1/16	(1.6)	1/32	(0.8)
Die-cast zinc – ribbed or otherwise reinforced	3/64	(1.2)	1/32	(0.8)
Sand-cast aluminum, steel, bronze, or cast iron	1/8	(3.2)	3/32[c]	(2.4)
			1/16[d]	(1.6)

[a] At the base of cut threads.

[b] At the base of rolled threads.

[c] At the base of internal threads and at the base of external threads in fittings of the 1 (27) and larger trade sizes.

[d] At the base of external threads in fittings of the 3/4 (21) and smaller trade sizes.

[e] A flexible-conduit or armored-cable connector less than 0.0250 inch (0.635 mm) but not less than 0.0160 inch (0.406 mm) thick is acceptable if it is manufactured from heat-treated steel with a Rockwell hardness on the C scale of 40–50.

9.4 Grounding ferrules of fittings for liquid-tight flexible metal conduit and gland rings of compression-type fittings having a minimum thickness less than that specified in 9.1, 9.3, or Table 9.1, are acceptable if the fittings comply with all other applicable tests in this Standard.

10 Internal Dimensions

10.1 The throat of a fitting that is internally threaded for attachment to intermediate metal conduit or rigid metal conduit, other than a coupling or a locknut (see 6.4), shall have a throat diameter as specified in Table 30.1 for a bushing. The limit gauges illustrated in Figure 90.1 and having the dimensions specified in Table 90.5 shall be used to determine whether the fitting complies.

10.2 A fitting, such as an offset nipple or elbow, through which wires are to pass shall have an internal cross-sectional area at all points not less than 80 percent of that of a bushing having a minimum throat diameter in accordance with Table 30.1. The shape and area of the fitting shall be such as to permit use of the largest number and size of conductors permitted for that trade size fitting.

10.3 For a fitting that will accommodate more than one trade size of raceway, the internal cross-sectional area shall comply with 10.2 with each size of raceway installed as intended.

10.4 A coupling intended to connect a metal sheathed cable to conduit or two different types of conduit shall have a smooth, rounded, centering stop having an effective diameter not less than the minimum throat diameter specified for the fitting for each cable or conduit. Neither cable or conduit shall be able to pass through the coupling.

10.4 effective February 1, 1999

11 Means of Assembly

11.1 A fitting utilizing a plate or yoke shall be secured by a screw or screws not smaller than No. 8 and having no more than 32 threads per inch.

11.2 A fitting shall be constructed so that it can be assembled to a cable or raceway as intended without damaging the cable or raceway.

11.3 A fitting shall be investigated for use with conduit or cable of each type, size, wall thickness, and material for which the manufacturer recommends its use.

11.4 A fitting intended for a specific condition of installation, for use with a specific conduit or cable construction, or for use with a specific wiring system shall be marked in accordance with 84.1.

11.5 A fitting that has a nonstandard thread shall be provided with a locknut.

Exception: This requirement does not apply to a fitting that is intended to be connected to a sheet-metal box without the use of a locknut.

11.6 A metal fitting intended to be installed in a knockout in a sheet-metal surface with or without the use of a locknut shall provide a reliable mechanical and electrical connection to the various thicknesses of metal to which it is likely to be installed.

11.7 The various thicknesses mentioned in 11.6 include 0.026 – 0.075 inches (0.66 – 1.91 mm) thick for steel, and 0.032 – 0.091 inch (0.81 – 2.31 mm) thick for aluminum.

11.8 The thread projection of a fitting, when measured from the shoulder stop to the end of the thread along the major axis of the fitting, shall not be less than that specified in Table 11.1. The construction shall be such that a 1-1/4 (35) or smaller trade-size fitting can be securely mounted in 0.026-inch (0.66-mm) thick metal.

Table 11.1
Minimum thread projection of fitting

Table 11.1 revised October 21, 1998

Trade size of fitting	(metric designator)	Minimum thread projection,	
		in	(mm)
3/8	(12)	0.299	(7.59)
1/2	(16)	0.323	(8.20)
3/4	(21)	0.338	(8.59)
1	(27)	0.391	(9.93)
1-1/4	(35)	0.391	(9.93)
1-1/2	(41)	0.391	(9.93)
2	(53)	0.408	(10.36)
2-1/2	(63)	0.654	(16.61)
3	(78)	0.654	(16.61)
3-1/2	(91)	0.717	(18.21)
4	(103)	0.717	(18.21)
5	(129)	0.779	(19.79)
6	(155)	0.841	(21.36)

12 Angle Fittings

12.1 A fitting intended to change the direction of a raceway system, and having a radius of bend less than that specified in Table 12.1 shall:

a) Have a removable cap or cover to facilitate the installation of wires; or

b) Comply with Wire Pull Test, Section 37.

Exception No. 1: This requirement does not apply to:

a) A liquid-tight flexible conduit fitting, or

b) A flexible cord fitting.

Exception No. 2: This requirement does not apply to an elbow, intended to be used as a connector, that

a) Changes the direction of the wires entering it not more than 90 degrees, and

b) Is secured to the raceway system by means other than turning.

12.2 An offset fitting intended to change the position of the axis of a raceway system shall have a removable cap or cover to facilitate the installation of wires if the offset is greater than 1 inch (25.4 mm) or if the axis of the offsetting section is at any angle greater than 35 degrees from the axis of the raceway.

Table 12.1
Radius of bend of angle fittings

Trade size of conduit	(metric designator)	Minimum radius to center of fitting,	
		in	(mm)
1/2	(16)	4	(102)
3/4	(21)	4-1/2	(114)
1	(27)	5-3/4	(146)
1-1/4	(35)	7-1/4	(184)
1-1/2	(41)	8-1/4	(210)
2	(53)	9-1/2	(241)
2-1/2	(63)	10-1/2	(267)
3	(78)	13	(330)
3-1/2	(91)	15	(381)
4	(103)	16	(406)
5	(129)	24	(610)
6	(155)	30	(762)

13 Wet-Location and Concrete-Tight Fittings

13.1 A fitting intended for use in a wet location shall comply with Wet-Locations Test, Section 39.

13.2 A concrete-tight fitting shall be tested in accordance with Concrete-Tightness Test, Section 40.

Exception No. 1: A fitting of the threaded or compression type need not be tested.

Exception No. 2: A fitting marked to indicate that it is to be taped against the entrance of concrete, in accordance with 84.1, need not be tested.

Exception No. 3: A fitting that complies with Wet-Locations Test, Section 39, need not be tested.

SPECIFIC FITTINGS

14 Studs

14.1 A fixture stud shall have available no fewer than five full threads and shall be made of malleable iron, steel, or other acceptable material.

15 Conduit Bodies

15.1 A conduit body intended for use with rigid polyvinyl chloride (PVC) conduit shall also comply with requirements in Section 89.

15.2 A conduit body shall have a cross-sectional area not less than that specified in Table 15.1, based on the largest size raceway that is intended to be connected to it.

Table 15.1
Cross-sectional area of conduit bodies

Trade size of raceway	(metric designator)	Cross section,		Trade size of raceway,	(metric designator)	Cross section,	
		in^2	(cm^2)			in^2	(cm^2)
1/2	(16)	0.605	(3.92)	3	(78)	14.785	(95.39)
3/4	(21)	1.067	(6.88)	3-1/2	(91)	19.774	(127.57)
1	(27)	1.729	(11.15)	4	(103)	25.461	(164.26)
1-1/4	(35)	2.991	(19.30)	5	(129)	40.012	(258.14)
2	(53)	6.711	(43.30)	6	(155)	57.781	(372.78)
2-1/2	(63)	9.576	(61.78)	–	–	–	–

15.3 A conduit body having provision for the connection of conduit or tubing larger than the 1/2 (16) trade size shall:

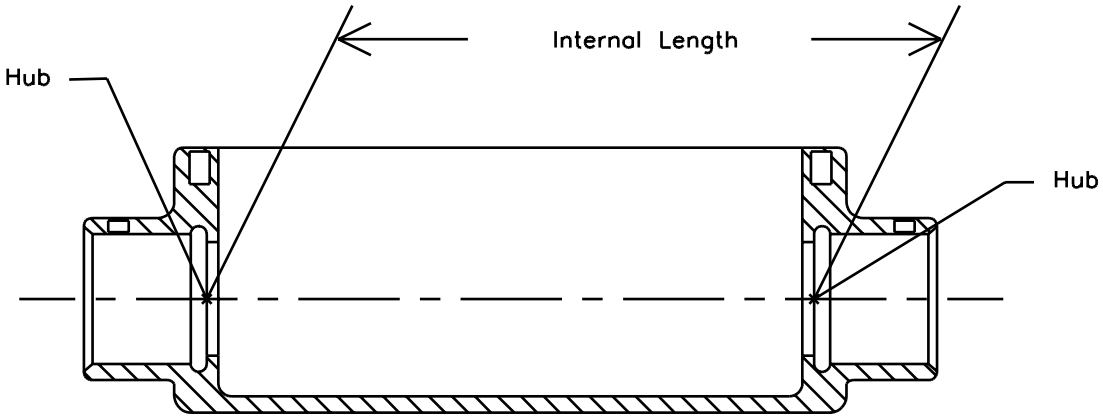
a) Have a removable cover, and

b) Comply with in 15.4 and 15.5.

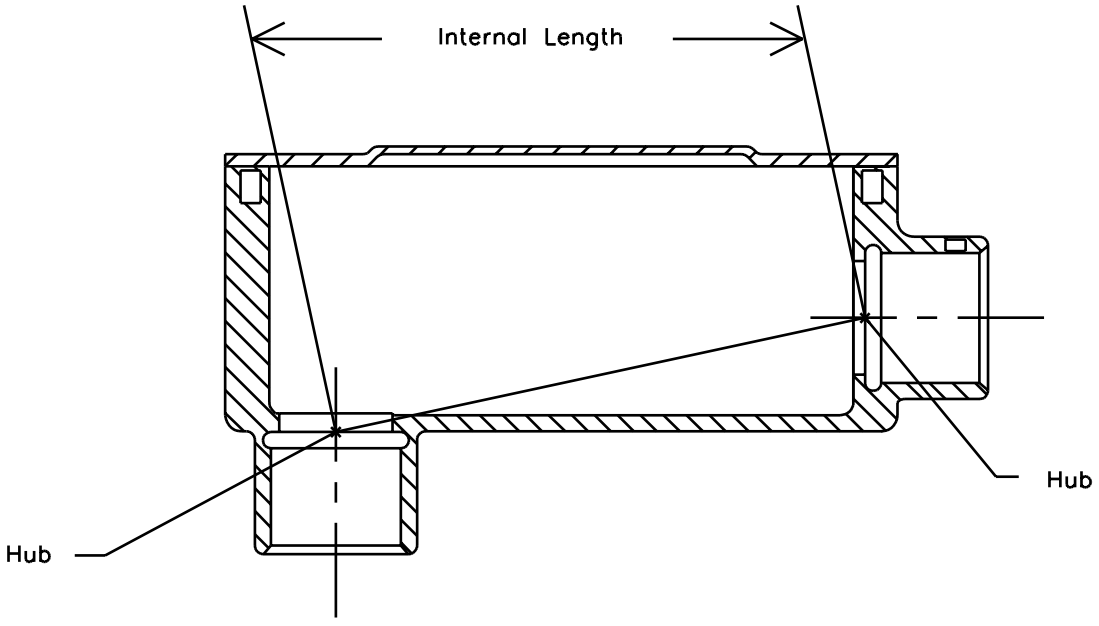
Exception No. 1: This requirement does not apply to a conduit body marked for use only with No. 6 AWG (13.3 mm^2) or smaller conductors.

Exception No. 2: This requirement does not apply to a conduit body having an internal length (measured as shown in Figure 15.1) that is equal to or greater than the dimensions specified in Table 15.2. See 70.1.

Figure 15.1
Conduit body internal length measurement



Straight Pull Conduit Body



Angle Pull Conduit Body

SM1198

Table 15.2
Minimum distance between conduit body hubs for three-conductor installation with no investigation

Wire size, AWG or kcmil (mm^2)	Minimum distance, in								Minimum distance, mm
	Conduit body hub trade size (metric designator)								
	1 (21)	1-1/4 (35)	1-1/2 (41)	2 (53)	2-1/2 (63)	3 (78)	3-1/2 (91)	4 (103)	
	4.50[a]	4.50[a]	4.50[a]	4.50[a]	4.50[a]	4.50[a]	4.50[a]	4.50[a]	114.30[a]
4	2.25[b]	2.25[b]	2.25[b]	2.25[b]	2.25[b]	2.25[b]	2.25[b]	2.25[b]	57.15[b]
(21.2)	4.00[c]	4.00[c]	4.00[c]	4.00[c]	4.00[c]	4.00[c]	4.00[c]	4.00[c]	101.60[c]
	–	4.98[a]	4.98[a]	4.98[a]	4.98[a]	4.98[a]	4.98[a]	4.98[a]	126.49[a]
3	–	2.55[b]	2.55[b]	2.55[b]	2.55[b]	2.55[b]	2.55[b]	2.55[b]	64.77[b]
(26.7)	–	4.25[c]	4.25[c]	4.25[c]	4.25[c]	4.25[c]	4.25[c]	4.25[c]	107.95[c]
	–	5.44[a]	5.44[a]	5.44[a]	5.44[a]	5.44[a]	5.44[a]	5.44[a]	138.18[a]
2	–	2.72[b]	2.72[b]	2.72[b]	2.72[b]	2.72[b]	2.72[b]	2.72[b]	69.09[b]
(33.6)	–	4.50[c]	4.50[c]	4.50[c]	4.50[c]	4.50[c]	4.50[c]	4.50[c]	114.30[c]
	–	–	5.82[a]	5.82[a]	5.82[a]	5.82[a]	5.82[a]	5.82[a]	147.83[a]
1	–	–	4.00[b]	4.00[b]	4.00[b]	4.00[b]	4.00[b]	4.00[b]	101.60[b]
(42.4)	–	–	4.80[c]	4.80[c]	4.80[c]	4.80[c]	4.80[c]	4.80[c]	121.92[c]
	–	–	6.06[a]	6.06[a]	6.06[a]	6.06[a]	6.06[a]	6.06[a]	153.92[a]
0	–	–	4.48[b]	4.48[b]	4.48[b]	4.48[b]	4.48[b]	4.48[b]	113.79[b]
(53.5)	–	–	5.00[c]	5.00[c]	5.00[c]	5.00[c]	5.00[c]	5.00[c]	127.00[c]
	–	–	–	7.53[a]	7.53[a]	7.53[a]	7.53[a]	7.53[a]	191.26[a]
00	–	–	–	5.00[b]	5.00[b]	5.00[b]	5.00[b]	5.00[b]	127.00[b]
(67.4)	–	–	–	5.88[c]	5.88[c]	5.88[c]	5.88[c]	5.88[c]	149.35[c]
	–	–	–	9.25[a]	9.25[a]	9.25[a]	9.25[a]	9.25[a]	234.95[a]
000	–	–	–	5.38[b]	5.38[b]	5.38[b]	5.38[b]	5.38[b]	136.65[b]
(85.0)	–	–	–	6.87[c]	6.87[c]	6.87[c]	6.87[c]	6.87[c]	174.50[c]
	–	–	–	9.68[a]	9.68[a]	9.68[a]	9.68[a]	9.68[a]	245.87[a]
0000	–	–	–	5.75[b]	5.75[b]	5.75[b]	5.75[b]	5.75[b]	146.05[b]
(107.2)	–	–	–	8.00[c]	8.00[c]	8.00[c]	8.00[c]	8.00[c]	203.20[c]
	–	–	–	–	10.20[a]	10.20[a]	10.20[a]	10.20[a]	259.08[a]
250	–	–	–	–	6.71[b]	6.71[b]	6.71[b]	6.71[b]	170.43[b]
(127.0)	–	–	–	–	8.40[c]	8.40[c]	8.40[c]	8.40[c]	213.36[c]
	–	–	–	–	12.64[a]	12.64[a]	12.64[a]	12.64[a]	321.06[a]
300	–	–	–	–	7.42[b]	7.42[b]	7.42[b]	7.42[b]	188.47[b]
(152.0)	–	–	–	–	8.72[c]	8.72[c]	8.72[c]	8.72[c]	221.49[c]
	–	–	–	–	–	14.87[a]	14.87[a]	14.87[a]	377.70[a]
350	–	–	–	–	–	7.94[b]	7.94[b]	7.94[b]	201.68[b]
(177.0)	–	–	–	–	–	8.94[c]	8.94[c]	8.94[c]	227.08[c]

Table 15.2 Continued on Next Page

Table 15.2 Continued

Wire size, AWG or kcmil (mm^2)	Minimum distance, in								Minimum distance, mm
	Conduit body hub trade size (metric designator)								
	1 (21)	1-1/4 (35)	1-1/2 (41)	2 (53)	2-1/2 (63)	3 (78)	3-1/2 (91)	4 (103)	
	–	–	–	–	–	–	–	–	–
400	–	–	–	–	–	–	–	–	–
(203.0)	–	–	–	–	–	10.30[c]	10.30[c]	10.30[c]	261.62[c]
	–	–	–	–	–	–	–	–	–
500	–	–	–	–	–	–	–	–	–
(253.0)	–	–	–	–	–	12.43[c]	12.43[c]	12.43[c]	12.43[c]

Note – Where values are not specified, an investigation shall be performed to determine acceptability of the intended installation.

[a] Applies to straight pull conduit body.

[b] Applies to conduit body with hub in side.

[c] Applies to conduit body with hub in back.

15.4 A conduit body that does not change the direction of wiring passing through it shall have a length not less than eight times the trade diameter of the largest tubing or conduit that may be connected to it. The length is to be measured inside the conduit body from the end stop of the conduit hub away from the center of the body to a like point on the conduit hub on the opposite wall, or for a conduit body having a single raceway entry, to the opposite wall.

Exception: A shorter conduit body shall be investigated for installation of a combination of conductors less than the maximum fill permitted in accordance with the National Electrical Code, ANSI/NFPA 70-1993. See 70.1.

15.5 A conduit body constructed to permit a change in the direction of the axis of a tubing or conduit system shall have a distance inside the body between each tubing or conduit entry and the entry hub on the opposite wall of the body intended to enclose a common conductor not less than that specified in (a) or between each tubing or conduit entry and the opposite wall not less than the sum of and (a) and (b):

a) Six times the trade diameter of the largest tubing or conduit for which the body is intended.

b) The sum of the diameters of all other tubing or conduit entries in the same wall of the body.

Exception No. 1: A conduit body having smaller dimensions shall be investigated for installation of a combination of conductors, including No. 4 AWG (21.2 mm^2) or larger, that is less than the maximum fill permitted in accordance with the National Electrical Code, ANSI/NFPA 70-1993. See 70.1.

Exception No. 2: A conduit body having a raceway entry in the wall opposite the removable cover shall have a distance from the cover to the opposite wall not less than that specified in Table 15.3.

Table 15.3
Space inside a conduit body

Maximum size of wire, AWG or kcmil (mm^2)		Minimum distance to cover,	
		in	(mm)
14 – 10	(2.1 – 5.3)	Not Specified	
8 – 6	(8.4 – 13.3)	1-1/2	(38.1)
4 – 3	(21.2 – 26.7)	2	(50.8)
2	(33.6)	2-1/2	(63.5)
1	(42.4)	3	(76.2)
0,2/0	(53.5,67.4)	3-1/2	(88.9)
3/0,4/0	(85.0,107.2)	4	(102)
250	(127)	4-1/2	(114)
300 – 350	(152 – 177)	5	(127)
400 – 500	(203 – 253)	6	(152)
600 – 700	(304 – 355)	8	(203)
750 – 900	(380 – 456)	8	(203)
1000 – 1250	(507 – 633)	10	(254)
1500 – 2000	(760 – 1013)	12	(305)

15.6 With reference to 15.5, the distance is to be measured from points located at each of the raceway entries where the axis of the raceway passes through the plane of the end stop of the conduit hub to the inside surface of the cover.

16 Short Radius Conduit Bodies

16.1 A capped elbow or service-entrance elbow for rigid metal or nonmetallic conduit, intermediate metal conduit, or electrical metallic tubing shall have an integral end stop that provides a smooth, rounded opening. The internal diameter of the end stop shall be within the limits specified in Table 30.1 for a bushing, as determined by the application of the limit gauges illustrated in Figure 90.1 and having the dimensions specified in Table 90.5.

16.1 effective February 1, 1999

17 Flexible Cord Fittings

17.1 The polymeric material of a flexible cord fitting shall have a relative thermal index of at least 60°C (140°F) as determined in accordance with the Standard for Polymeric Materials – Long Term Property Evaluations, UL 746B. A flexible cord fitting intended for use with flexible cord having a temperature rating higher than 60°C shall be molded of a material with a relative thermal index not less than that of the cord, and shall be marked in accordance with in 70.1.

18 Hubs

18.1 A fitting intended to be assembled in a conventional knockout or opening in a sheet metal enclosure to provide an internally threaded connection for threaded rigid or intermediate metal conduit shall comply with Hubs, Section 47.

19 Armored Cable Fittings

19.1 A fitting for armored cable shall be provided with a smooth, rounded end stop so that the armor will not pass through. The armored cable bushing shall be held in place and shall be visible after installation without disturbing the wiring.

19.2 A direct-bearing setscrew used in an armored cable fitting shall not be smaller than No. 10 and shall be of the tangential type.

Exception: A direct-bearing setscrew of the radial type with the axis of both the screw and the cable in the same plane is acceptable for use in an amored cable fitting if the angle between the axis of the screw and the axis of the cable is not more than 60 degrees and in the direction that will force the cable into the fitting.

19.3 An armored cable fitting of the 3/8 (12) trade size shall secure a No. 14 AWG (2.1 mm^2), 2-wire cable, unless marked in accordance with 73.1 to indicate its use with a cable of another size.

20 Armored Cable Bushings

20.1 An armored cable bushing shall be of a readily distinguishable bright color such as red, orange, or yellow. The polymeric material of the bushing shall have a relative thermal index of at least 50°C (122°F).

20.2 An armored cable bushing shall have dimensions as specified in Table 20.1.

Table 20.1
Armored cable bushing dimensions

Bushing size No.	Wall thickness,		Tolerance (+/-),	
	in	(mm)	in	(mm)
0	0.025	(0.64)	0.010	(0.25)
1	0.029	(0.74)	0.011	(0.28)
2	0.033	(0.84)	0.012	(0.30)
3	0.034	(0.86)	0.012	(0.30)
4	0.034	(0.86)	0.012	(0.30)
5	0.038	(0.97)	0.013	(0.33)
6	0.043	(1.09)	0.014	(0.36)
7	0.050	(1.27)	0.015	(0.38)
8	0.070	(1.78)	0.015	(0.38)

20.3 The bushing size for a given range of armored cable is shown in Table 20.2.

Table 20.2
Bushing size for a range of amored cable

Bushing size, No.	Diameter, in (mm)			
	Minimum		Maximum	
0	0.210	(5.33)	0.350	(8.89)
1	0.306	(7.78)	0.460	(11.68)
2	0.430	(10.92)	0.590	(14.99)
3	0.560	(14.22)	0.740	(18.80)
4	0.710	(18.03)	0.960	(24.38)
5	0.900	(22.86)	1.200	(30.48)
6	1.120	(28.45)	1.510	(38.35)
7	1.420	(36.07)	1.860	(47.24)
8	1.730	(43.94)	2.330	(59.18)

21 Flexible Metal Conduit Fittings

21.1 A flexible metal conduit fitting shall be provided with a smooth, rounded end stop so that the conduit will not pass through.

21.2 The end stop of a flexible metal conduit fitting, other than an angle fitting, shall completely encircle the end of the conduit when installed in the fitting, and the throat of the fitting shall be smooth and rounded.

21.3 The maximum and minimum inside diameter of the end stop of a flexible metal conduit fitting shall be within the limits specified in Table 21.1.

Exception: These dimensional requirements do not apply to the shoulder of a fitting that is secured to flexible metal conduit by insertion inside the conduit.

Table 21.1
Internal diameter of end stop of flexible-metal-conduit fitting

Table 21.1 revised October 21, 1998

Trade size of conduit	(metric designator)	Maximum internal diameter,		Minimum internal diameter,	
		in	(mm)	in	(mm)
5/16	(11)	0.313	(7.95)	0.266	(6.76)
3/8	(12)	0.375	(9.35)	0.319	(8.10)
1/2	(16)	0.625	(15.88)	0.531	(13.49)
3/4	(21)	0.813	(20.65)	0.691	(17.55)
1	(27)	1.000	(25.40)	0.850	(21.59)
1-1/4	(35)	1.250	(31.75)	1.063	(27.00)
1-1/2	(41)	1.500	(38.10)	1.275	(32.39)
2	(53)	2.000	(50.80)	1.700	(43.18)
2-1/2	(63)	2.500	(63.50)	2.125	(53.98)
3	(78)	3.000	(76.20)	2.550	(64.77)
3-1/2	(91)	3.500	(88.90)	2.975	(75.57)
4	(103)	4.000	(101.60)	3.400	(86.36)

21.4 A direct-bearing setscrew used in a flexible metal conduit fitting shall not be smaller than No. 10 and shall be of the tangential type.

Exception: A direct-bearing setscrew of the radial type with the axis of both the screw and the conduit in the same plane is acceptable for use in a flexible metal conduit fitting if the angle between the axis of the screw and the axis of the conduit is not more than 60 degrees and in the direction that will force the conduit into the fitting.

22 Metal-Clad Cable Fittings

22.1 A fitting for metal-clad cable shall be provided with a smooth, rounded end stop so that the metal sheath of the cable will not pass through and the wires will not be damaged in passing over the end stop.

23 Nonmetallic-Sheathed Cable Fittings

23.1 A nonmetallic-sheathed cable fitting of the 3/8 (12) or larger trade size shall secure cable in a range between No. 14 AWG (2.1 mm^2), two-wire cable with an uninsulated grounding wire, and the largest oval or round multiconductor cable that is to be accommodated by the fitting, unless marked to indicate its use with a specific range of cable sizes. See Nonmetallic-Sheathed Cable Fittings, Section 52, and 74.1 and 74.2.

23.1 revised October 21, 1998

23.2 The polymeric material of a fitting for nonmetallic sheathed cable shall have a relative thermal index of at least 90°C (194°F) for electrical properties, 90°C for mechanical without impact properties, and 50°C (122°F) for mechanical with impact properties as determined in accordance with the Standard for Polymeric Materials – Long Term Property Evaluations, UL 746B.

Exception: Material having a relative thermal index – based upon historical record – described in UL 746B need not be investigated to determine the relative thermal index.

23.3 Polymeric parts, such as a gland or bushing, of a metal or polymeric fitting shall have the relative thermal index specified in 23.2.

24 Service-Entrance Cable Fittings

24.1 The external threads of a service-entrance cable fitting for wet location use shall have a taper of 3/4 inch per foot (1 mm per 16 mm).

24.2 A service-entrance cable fitting shall be tested in accordance with Service-Entrance Cable Fittings, Section 53.

25 Flexible Metallic Tubing Fittings

25.1 A fitting for flexible metallic tubing shall be provided with a smooth, rounded end stop so that the tubing will not pass through.

25.2 The end stop of a flexible metallic tubing fitting shall completely encircle the end of the tubing when installed.

25.3 The maximum and minimum inside diameters of the end stop of a flexible metallic tubing fitting shall be within the limits specified in Table 25.1.

Exception: These dimensional requirements do not apply to the shoulder of a fitting that is secured by insertion inside the tubing.

Table 25.1
Internal diameter of end stop of flexible metallic tubing fittings

Table 25.1 revised October 21, 1998

Trade size of tubing	(metric designator)	Maximum internal diameter,		Minimum internal diameter,	
		in	(mm)	in	(mm)
3/8	(12)	0.400	(10.16)	0.319	(8.10)
1/2	(16)	0.625	(15.88)	0.531	(13.49)
3/4	(21)	0.813	(20.65)	0.691	(17.55)

25.4 The maximum external diameter of a flexible metallic tubing fitting that fits inside a raceway (screw -in type) shall not exceed the diameter specified in Table 25.2.

Table 25.2
External diameter of flexible metallic tubing fittings

Table 25.2 revised October 21, 1998

Trade size of tubing	(metric designator)	Maximum external diameter of barrel,	
		in	(mm)
3/8	(12)	0.485	(12.30)
1/2	(16)	0.634	(16.10)
3/4	(21)	0.825	(20.96)

26 Liquid-Tight Flexible Metal Conduit Fittings

26.1 A fitting for liquid-tight flexible metal conduit shall be provided with a smooth, rounded end stop that will completely encircle the end of the conduit. The minimum and maximum inside diameter of the end stop shall be within the limits specified in Table 26.1.

26.2 The smooth end stop shall be provided by the body of the fitting or by a separate part applied over the cut end of the conduit.

Table 26.1
Diameter of end stop of liquid-tight flexible conduit fittings

Table 26.1 revised October 21, 1998

Trade size of fitting	(metric designator)	Throat diameter of end stop, in (mm)			
		Minimum		Maximum	
3/8	(12)	0.411	(10.44)	0.484	(12.29)
1/2	(16)	0.529	(13.44)	0.622	(15.80)
3/4	(21)	0.697	(17.70)	0.820	(20.83)
1	(27)	0.885	(22.48)	1.041	(26.44)
1-1/4	(35)	1.173	(29.79)	1.380	(35.05)
1-1/2	(41)	1.339	(34.01)	1.575	(40.01)
2	(53)	1.717	(43.61)	2.020	(51.31)
2-1/2	(63)	2.108	(53.54)	2.480	(62.99)
3	(78)	2.609	(66.27)	3.070	(77.98)
3-1/2	(91)	2.975	(75.57)	3.500	(88.90)
4	(103)	3.400	(86.36)	4.000	(101.60)

26.3 Any part of a fitting inserted into the conduit to assist in providing a smooth throat, a bond between fitting and conduit, or an assembly to the conduit shall not reduce the diameter below the minimum value specified in Table 26.1.

27 Liquid-Tight Flexible Nonmetallic Conduit Fittings

27.1 A fitting for liquid-tight flexible nonmetallic conduit shall comply with Liquid-Tight Flexible Metal Conduit Fittings, Section 26, and Liquid-Tight Flexible Nonmetallic Conduit Fittings, Section 57.

Exception: An end stop need not completely encircle the end of the conduit.

28 Threadless Fittings

28.1 Other than noted in 28.2, a threadless connector shall have a smooth, rounded end stop with a throat diameter within the limits specified for a bushing in Table 30.1. Compliance shall be determined by application of limit gauges illustrated in Figure 90.1 and having the dimensions specified in Table 90.5.

28.2 A threadless connector for electrical metallic tubing in the 2-1/2, 3, 3-1/2, and 4 (63, 78, 91, and 103) trade sizes shall have a smooth, rounded end stop with an internal diameter within the limits specified in Table 28.1. See 79.1.

28.3 Other than noted in 28.4, a threadless coupling shall be provided with a centering stop having an effective diameter not less than the minimum throat diameter specified in Table 30.1 for the smallest trade size of raceway intended to be accommodated.

28.4 A threadless coupling for electrical metallic tubing in the 2-1/2, 3, 3-1/2, and 4 (63, 78, 91, and 103) trade sizes shall have an effective center stop diameter not less than the maximum throat diameter at end stop specified in Table 28.1.

Table 28.1
Diameter of end stop

Trade size of fitting	(metric designator)	Throat diameter at end stop, in (mm)				Minimum throat diameter under threaded section,	
		Minimum		Maximum		in[a]	(mm)
2-1/2	(63)	2.594	(65.89)	2.731	(69.37)	2.222	(56.44)
3	(78)	3.189	(81.00)	3.356	(85.24)	2.761	(70.13)
3-1/2	(91)	3.642	(92.51)	3.834	(97.38)	3.193	(81.10)
4	(103)	4.117	(104.57)	4.334	(110.08)	3.623	(92.02)

[a] A reduced diameter under the threaded section is not to result in a sudden reduction in the inside diameter of the raceway.

29 Mineral-Insulated Cable Fittings

29.1 A fitting for mineral-insulated cable shall be provided with means for separation of the cable conductors.

29.2 Flexible insulating tubing shall be provided with each fitting. At least 6 inches (152 mm) of tubing shall be provided for each cable conductor.

Exception: A single piece of tubing of sufficient length is acceptable in lieu of a separate piece for each conductor.

29.3 The inside diameter of the tubing mentioned in 29.2 shall be such that the tubing can be slipped easily over the bared conductors of the cable of the largest AWG size for which the fitting is intended. The wall thickness of the tubing shall not be less than 0.020 inch (0.51 mm).

29.4 Insulating materials of different composition used with the same fitting shall be compatible. See 61.8.1.

29.4 revised October 21, 1998

29.5 Other than noted in 29.6, a fitting shall be provided with a means, as a part of the fitting, for sealing the end of the cable against the entrance of moisture or it shall be acceptable for use with a separate sealing fitting.

29.6 A fitting intended for use in dry locations only and marked in accordance with 80.1 is not required to comply with 61.7.1. See 29.7.

29.6 revised October 21, 1998

29.7 A fitting not marked in accordance with in 80.1 shall comply with 61.7.1.

29.7 revised October 21, 1998

30 Locknuts, Bushings, and Nipples

30.1 A conduit locknut for intermediate metal conduit or rigid metal conduit shall be provided with notches or the equivalent to facilitate tightening and shall have dimensions as specified in Table 30.1.

Exception: A locknut thinner than specified shall comply with 62.3.

30.1 revised October 21, 1998

Table 30.1
Thickness and diameters of locknuts and bushings

Table 30.1 revised October 21, 1998

Trade size of fitting	(metric designator)	Minimum thickness of conduit locknut,		Maximum diameter of locknut or bushing,		Throat diameter of bushing, in (mm)			
		in	(mm)	in	(mm)	Minimum		Maximum	
3/8	(12)	0.125	(3.18)	0.970	(24.64)	0.444	(11.28)	0.493	(12.52)
1/2	(16)	0.125	(3.18)	1.140	(28.96)	0.560	(14.22)	0.622	(15.80)
3/4	(21)	0.140	(3.56)	1.420	(36.07)	0.742	(18.85)	0.824	(20.93)
1	(27)	0.170	(4.32)	1.770	(44.96)	0.944	(23.98)	1.049	(26.64)
1-1/4	(35)	0.170	(4.32)	2.281	(57.94)	1.242	(31.55)	1.380	(35.05)
1-1/2	(41)	0.170	(4.32)	2.598	(65.99)	1.449	(36.80)	1.610	(40.89)
2	(53)	0.187	(4.75)	3.175	(80.65)	1.860	(47.24)	2.067	(52.50)
2-1/2	(63)	0.375	(9.53)	3.562	(90.47)	2.222	(56.44)	2.469	(62.71)
3	(78)	0.375	(9.53)	4.250	(107.95)	2.761	(70.13)	3.068	(77.92)
3-1/2	(91)	0.438	(11.13)	4.803	(122.00)	3.193	(81.10)	3.548	(90.12)
4	(103)	0.438	(11.13)	5.402	(137.21)	3.623	(92.02)	4.026	(102.26)
5	(129)	0.500	(12.70)	6.674	(169.52)	4.542	(115.37)	5.047	(128.19)
6	(155)	0.562	(14.27)	7.934	(201.52)	5.458	(138.63)	6.065	(154.05)

30.2 A fitting locknut shall not have a maximum diameter exceeding that specified in Table 30.1.

30.3 A conduit locknut shall be threaded throughout its entire thickness.

Exception: A conduit locknut having an incomplete or nonstandard thread shall comply with 62.4.

30.4 A bushing or insulating bushing for intermediate metal conduit or rigid metal conduit shall have a smooth, rounded surface at the throat. The throat diameter shall be within the limits specified in Table 30.1 as determined by the application of the limit gauges illustrated in Figure 90.1 and having the dimensions specified in Table 90.5.

30.5 A bushing or insulating bushing shall be provided with ribs or the equivalent to facilitate easy tightening.

30.6 The polymeric material of an insulating bushing rated:

a) 90°C (194°F) shall have a relative thermal index of at least 90°C.

b) 105°C (221°F) shall have a relative thermal index of at least 105°C.

c) 150°C (302°F) shall have a relative thermal index of at least 150°C.

d) 200°C (392°F) shall have a relative thermal index of at least 200°C.

30.7 A nipple shall not have a tightening means that has a maximum diameter exceeding that specified in the third column of Table 30.1.

30.7 effective February 1, 1999

31 Service-Entrance Heads

31.1 A service-entrance head for rigid metal conduit, intermediate metal conduit, or electrical metallic tubing shall have an integral end stop for the conduit or tubing. The end stop shall have a smooth, rounded opening. Other than noted in 31.3, the opening shall have an internal diameter equivalent to that provided by the throat of a standard conduit bushing. The internal diameter of the end stop shall be within the limits specified for a bushing in Table 30.1. Compliance shall be determined by the application of the limit gauges illustrated in Figure 90.1 and having the dimensions specified in Table 90.5. A service-entrance head for rigid nonmetallic conduit shall comply with Section 89.

31.1 revised October 21, 1998

31.2 A metal service-entrance head shall comply with Service-Entrance Heads, Section 64. A nonmetallic service-entrance head shall comply with Tests for Nonmetallic Service-Entrance Heads, Section 101.

31.3 A service-entrance head for use with conduit of a size larger than that corresponding in size to the other parts of the head shall have an end stop with an internal diameter no greater than the maximum size throat diameter specified in Table 30.1. No minimum internal diameter of the end stop is specified for such a head.

31.4 A removable part on a service-entrance head intended for use on rigid metal conduit, intermediate metal conduit, or electrical metallic tubing that is intended to be discarded after the head is assembled to the conduit or tubing shall be secured so that separation from the head during shipping or handling and improper use does not occur.

31.5 A service-entrance head shall have provision for the separate entry of each conductor through a bushed hole. Not more than three of the holes shall be open and not more than one hole shall be uninsulated. The polymeric material of the bushing shall have a relative thermal index of at least 50°C (122°F).

31.6 A service-entrance head for service-entrance cable shall protect the open end of the jacket or braid from the entrance of rain and shall have means for mounting and for clamping of the cable.

32 Pulling, Strain Relief, and Support Grips

32.1 A grip shall be made of a mesh material (wire, strand, or polymeric filament). The material of a polymeric grip shall have a relative thermal index rating of at least 50°C (122°F) or higher based on the temperature of the environment in which it is intended to be used. See 83.1.

Revised 32.1 effective February 1, 1999

32.2 A strain relief grip attached to a fitting shall be able to be assembled in accordance with Method of Assembly, Section 35.

32.2 effective February 1, 1999

33 Reducing Washers

33.1 Reducing washers shall consist of two pieces made of metal having a combined thickness of not less than 0.0625 inch (1.590 mm) for steel and 0.091 inch (2.31 mm) for aluminum. The dimensions shall be as specified in Table 33.1.

33.1 effective February 1, 1999

Table 33.1
Reducing washer dimensions

Table 33.1 effective February 1, 1999

Trade size	(metric designator)	Outer diameter, in (mm)				Diameter of projection, in (mm)				Diameter of conduit opening, in (mm)			
		Minimum		Maximum		Minimum		Maximum		Minimum		Maximum	
1/2	(16)	–	–	–	–	–	–	–	–	0.860	(21.84)	0.906	(23.01)
3/4	(21)	1.232	(31.29)	1.488	(37.79)	1.050	(26.67)	1.090	(27.68)	1.094	(27.78)	1.141	(28.98)
1	(27)	1.507	(38.28)	1.882	(47.80)	1.305	(33.15)	1.355	(34.41)	1.359	(34.51)	1.406	(35.71)
1-1/4	(35)	1.873	(41.57)	2.354	(59.79)	1.659	(42.14)	1.715	(43.56)	1.719	(43.66)	1.766	(44.86)
1-1/2	(41)	2.139	(54.33)	2.630	(66.80)	1.893	(48.08)	1.953	(49.61)	1.958	(49.73)	2.016	(51.21)
2	(53)	2.632	(66.85)	3.260	(82.80)	2.368	(60.15)	2.428	(61.67)	2.433	(61.80)	2.500	(63.50)
2-1/2	(63)	3.137	(79.68)	3.732	(94.79)	2.863	(72.72)	2.933	(74.50)	2.938	(74.63)	3.000	(76.20)
3	(78)	3.752	(95.30)	4.441	(112.80)	3.498	(88.85)	3.578	(90.88)	3.583	(91.00)	3.625	(92.08)
3-1/2	(91)	4.392	(111.56)	5.000	(127.00)	3.920	(99.57)	4.000	(101.60)	4.063	(103.20)	4.156	(105.56)
4	(103)	4.924	(125.07)	5.500	(139.70)	4.420	(112.26)	4.500	(114.30)	–	–	–	–

PERFORMANCE

ALL FITTINGS

34 General

34.1 Unless otherwise stated, the requirements in Sections 35 – 44 apply to all products that are covered by this standard. They are supplemented or modified in subsequent sections by requirements applying to specific products. Where a test is described, but criteria are not given, the requirements are stated in subsequent sections for specific products. For all tests requiring assembly to metal representing a box, sheet metal having a thickness of 0.0625 – 0.0645 inch (1.590 – 1.640 mm) shall be used. In addition, all products in the 3/8 to 1-1/4 (13 to 35) trade sizes shall comply with the Method of Assembly, Section 35, and Resistance Test, Section 41, assembled to sheet metal having a thickness of 0.026 – 0.028 inch (0.66 – 0.71 mm).

34.2 If the performance of a fitting is dependent upon the thickness of the material to which it is mounted, the fitting shall comply with all applicable tests after the fitting has been assembled to metal with the thicknesses specified in 11.7.

34.3 Unless otherwise stated, a minimum of six samples of each trade size of fitting are to be subjected to each test. When a line of at least four trade sizes of a particular design is being investigated, a minimum of three samples of each trade size are to be tested.

35 Method of Assembly

35.1 Unless otherwise noted, the samples of fittings for all tests are to be assembled in the intended manner and as described in 35.2 – 35.5. When assembled in accordance with 35.2 – 35.5, a fitting shall not crack or break and the fitting or screw threads shall not be stripped.

35.2 If a fitting other than noted in 60.1 and 60.2 has an end or centering stop, the conduit, tubing, or cable is to be pushed against the stop before the fitting is tightened.

35.3 Other than indicated in 35.4 and 35.5, the tightening torque to be applied to a compression fitting or the like is to be as specified in Table 35.1. A locknut is to be hand-tightened and then further tightened 1/4 turn with a hammer and a standard screwdriver or by an equivalent method.

35.4 A screw or bolthead screws other than a No. 8 or No. 6, that can be tightened with a screwdriver is to be tightened with a torque of 35 lbf-in (3.96 N•m). A No. 8 screw is to be tightened with a torque of 20 lbf-in (2.26 N•m) and a No. 6 screw is to be tightened with a torque of 12 lbf-in (1.36 N•m). A unslotted bolthead screw, direct bearing or securing a clamp is to be wrench-tightened with a torque of 160 lbf-in (18.1 N•m).

35.5 A fitting that is provided with specific instructions is to be assembled and installed in accordance with the method specified by the manufacturer.

Table 35.1
Tightening torque

Table 35.1 revised October 21, 1998

Trade size of fitting	(metric designator)	Tightening torque,	
		lbf-in	(N•m)
1/4[a]	(10)	175	(19.8)
3/8	(12)	200[b]	(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)

[a] Applies to flexible cord fittings only.

[b] A 3/8 (12) trade-size fitting for use with liquid-tight flexible metal conduit is to be tightened with a torque of 235 lbf-in (26.6 N•m).

36 Flammability Test

36.1 Fittings

36.1.1 When plaque specimens or finished product samples are tested as described in 36.1.2 – 36.1.8:

a) The plaque material shall not flame for more than 30 seconds after any of the first four applications or more than 1 minute after the fifth application of the test flame.

b) The finished product material shall not:

1) Openly flame for more than one minute after the final application of the test flame or

2) Be consumed.

c) There shall not be any opening in the material that will permit a 1/4 inch (6.4 mm) diameter rod to pass through after the material has returned to ambient temperature. The rod shall be applied without force.

d) There shall not be visible flame on the surface of the plaque or samples opposite the surface to which the test flame has been applied.

e) There shall not be glowing or burning particles during the test.

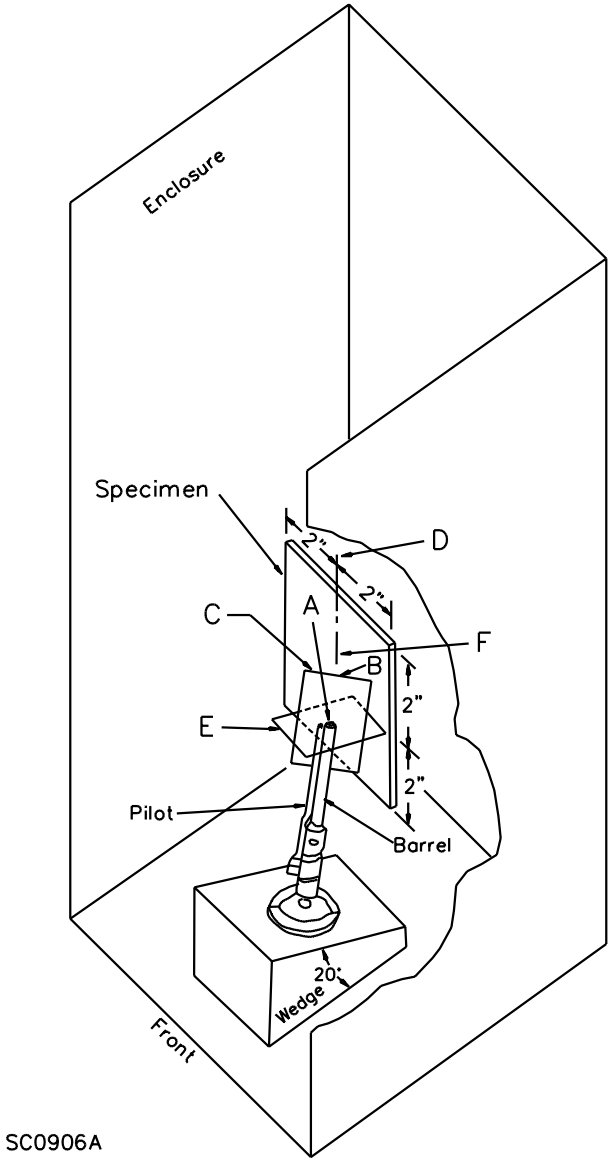
36.1.2 Six plaque specimens or finished product samples are to be tested. Three are to be tested as-received, and three are to be tested after being conditioned for 168 hours at a temperature of 90 ±1 °C (194 ±2 °F) in an air-circulating oven.

36.1.3 The test is to be conducted in a three-sided enclosure that is 12 inches (305 mm) wide, 14 inches (356 mm) deep, and 24 inches (610 mm) high. The top and front of the enclosure are to be open. The room or hood in which the enclosure is located for the test is to be ventilated, but drafts are not to affect the test flame.

36.1.4 If plaque specimens are tested, the plaques are to be molded composition, in 4-inch (102-mm) square sheet form, having a thickness equal to the minimum thickness used for a part. Each plaque or finished sample is to be secured with its vertical axis in the center of the enclosure and with both axes parallel to the back of the enclosure. See Figure 36.1.

Figure 36.1
Flammability test apparatus and specimen dimensions

Figure 36.1 revised October 21, 1998



NOTES –

1. Units for the values specified are: 4 inches (102 mm); 2 inches (50.8 mm); 1-1/2 inches (38.1 mm)

2. C is the vertical plane parallel to the sides of the enclosure and containing the vertical axis of the specimen and the longitudinal axis of the barrel.

3. D is the vertical axis of the specimen in the center of the enclosure and parallel to the back of the enclosure.

4. E is the plane of the tip of the barrel.

5. F is the longitudinal axis of the barrel.

36.1.5 A Tirrill gas burner to which a gas pilot light is attached is to supply the test flame. The barrel of the burner is to extend 4 inches (102 mm) above the air inlets and its inside diameter is to be 3/8 inch (9.5 mm). While the barrel is vertical, the overall height of the flame is to be adjusted to 5 inches (127 mm). The blue inner cone is to be 1-1/2 inches (38 mm) high. Without disturbing the adjustments for the height of the flame, the valves supplying gas to the burner and pilot flames are to be closed.

36.1.6 A wedge to which the base of the burner can be secured is to be provided for tilting the barrel 20 degrees from the vertical while the longitudinal axis of the barrel remains in a vertical plane. The burner is to be secured to the wedge and the assembly is to be placed in an adjustable jig that is attached to the floor of the enclosure. The jig is to be adjusted laterally (see Figure 36.1) to place the longitudinal axis of the barrel in the same vertical plane as the vertical axis of the specimen. The plane is to be parallel to the sides of the enclosure.

36.1.7 The jig is also to be adjusted toward the rear or front of the enclosure (see Figure 36.1) to position point A 1-1/2 inches (38.1 mm) from point B at which the extended longitudinal axis of the barrel meets the front surface of the specimen. Point A is the intersection of the longitudinal axis of the barrel with the plane of the tip of the barrel. Point B is the point at which the tip of the inner blue cone will touch the plaque or finished sample. The plaque or finished sample is to be adjusted vertically to place point B at the center of the plaque or finished sample.

36.1.8 The valve supplying gas to the pilot is to be opened and the pilot flame lit. The valve supplying gas to the burner is to be opened to apply the flame to the specimen automatically. This valve is to be held open for 15 seconds and then closed for 15 seconds. This procedure is to be repeated four times for a total of five applications of flame to the plaque or finished sample.

36.2 Bushings

36.2.1 A bushing or an insulating bushing made of polymeric material shall comply with 36.1.1(b), (d), and (e).

Exception No. 1: A bushing or an insulating bushing that is made of a material that has been investigated and found to comply with the vertical burning test requirements in the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94, for material designated as V-0, V-1, V-2, or 5VA does not require tests.

Exception No. 2: Comsumption of a polymeric throat liner in a 1/2 or 3/4 (16 or 21) trade size conduit fitting or bushing complies with requirement.

36.2.1 revised October 21, 1998

36.2.2 A sample of an insulating bushing mentioned in 36.2.1 is to be mounted on a 1-foot (0.30-m) length of conduit and suspended at an angle of 45 degrees to the axis of the test flame described in 36.1.5. The sample is to be subjected to five 15-second applications of the test flame with 15 seconds between successive applications of the flame. The tip of the inner blue cone of the flame is to be applied to the upper edge of the inner diameter of the insulating bushing.

37 Wire Pull Test

37.1 Conductors are to be pulled through an angle fitting, conduit body, or short radius conduit body as described in 37.2 – 37.5. After the pull, the insulation of the conductors shall:

a) Not show visible damage, and

b) Comply with 37.6 and 37.7.

37.2 Three 6-foot (1.8-m) conductors are to be pulled, as a group, through the fitting. The conductors are to be:

a) Type THHN for a fitting for use with 1/2 or 3/4 (16 or 21) trade size conduit or tubing, and

b) Type XHHW for a fitting for use with 1 to 3 (27 to 78) trade size conduit or tubing. Use of wire pulling compound is acceptable if the product or smallest unit shipping carton is marked in accordance with 69.6.

37.2 effective February 1, 1999

37.3 The AWG size of conductor used is to be as specified in the National Electrical Code, ANSI/NFPA 70-1993 for the trade size of conduit or tubing with which the fitting is intended to be used.

37.4 An angle fitting is to be secured with a locknut as intended to an outlet box or a steel plate equivalent. An 18-inch (457-mm) section of the appropriate conduit or tubing that the fitting is intended to be used with is to be secured to the fitting. The wires are to be pulled through the conduit or tubing and the fitting. The use of blunt tools to guide the wires is acceptable.

37.5 The internal length of each configuration of a particular conduit body type is to be measured as shown in Figure 15.1. An 18-inch (457-mm) section of conduit is to be secured to each of two conduit openings. The conductors are to be pulled through the bottom or side conduit and out through the conduit body cover opening. Additionally, the conductors are to be rigidly secured to the open end of the first conduit to prevent the conductors from exiting back through the first conduit during the pull through the second conduit. Before pulling through the second conduit, a training loop is to be formed. The conductors are then to be pulled through the second conduit. When the starting end of the conductor bundle begins to exit the second conduit, the training loop is to be removed. The conductors are then to be pulled one conductor at a time to remove the remaining length of the conductor. When recommended by the manufacturer, the use of a wire pulling compound during this test is acceptable.

37.6 After being pulled, the insulation on the wires shall withstand for 5 minutes without electrical breakdown the application of a 60-hertz, essentially sinusoidal potential of 2500 volts.

37.7 Compliance with 37.6 is to be determined by applying the test potential between the conductor and:

a) Aluminum foil that is wrapped around, and in contact with, the insulation, or

b) A volume of water containing the wire, fitting, and conduit section.

38 Metallic Coating Thickness Test

38.1 Other than specified in 38.2, the Metallic Coating Thickness Test described in 38.3 – 38.10 shall be used to determine the thickness of a zinc or cadmium coating. The test is only to be conducted when a required coating thickness is specified.

38.2 If agreeable to those concerned, a nondestructive test method is acceptable to determine the thickness of a zinc or cadmium coating. Whenever referee measurements are necessary, the test described in 38.3 – 38.10 is to be used.

38.3 The solution to be used for the test is to be made from distilled water and is to contain 200 grams per liter of reagent grade chromic acid, CrO_3; and 50 grams per liter of reagent grade concentrated sulphuric acid, H_2SO_4. The latter is equivalent to 27 milliliters per liter of reagent grade concentrated sulphuric acid, specific gravity 1.84, containing 96 percent of H_2SO_4.

38.4 The test solution is to be contained in a glass vessel such as a separatory funnel with the outlet equipped with a stopcock and a capillary tube having an inside bore of 0.025 inch (0.64 mm) and a length of 5.5 inches (140 mm). The lower end of the capillary tube is to be tapered to form a tip, the drops from which are about 0.05 milliliter each. To preserve an effectively constant level, a small glass tube is to be inserted in the top of the funnel through a rubber stopper and its position is to be adjusted so that, when the stopcock is open, the rate of dropping is 100 ±5 drops per minute. An additional stopcock shall be used in place of the glass tube to control the rate of dropping.

38.5 The sample and the test solution are to be kept in the test room long enough to acquire the temperature of the room, which is to be noted and recorded. The test is to be conducted at a room temperature of 21.1 – 32.2°C (70 – 90°F).

38.6 Each sample is to be thoroughly cleaned before testing. All grease, lacquer, paint, and other nonmetallic coatings are to be removed completely by means of solvents. Samples are then to be thoroughly rinsed in water and dried with clean cheesecloth. Care is to be exercised to avoid contact of the cleaned surface with the hands or any foreign material.

38.7 The sample to be tested is to be supported 0.7 – 1.0 inch (18 – 25 mm) below the orifice, so that the drops of solution strike the point to be tested and run off quickly. The surface to be tested is to be inclined about 45 degrees from horizontal.

38.8 After cleaning, the sample to be tested is to be put in place under the orifice. The stopcock is to be opened and the time in seconds is to be measured with a stop watch until the dropping solution dissolves the protective metallic coating exposing the base metal. The end point is the first appearance of the base metal recognizable by the change in color at that point.

38.9 Each sample of a test lot is to be subjected to the test at three or more points, excluding cut, stenciled, and threaded surfaces, on the inside surface and at an equal number of points on the outside surface, at places where the metallic coating is the thinnest.

38.10 To calculate the thickness in inches (mm) of the coating being tested, select from Table 38.1 the thickness factor corresponding to the temperature at which the test was conducted, multiply by 0.00001 inch (0.0003 mm), and then multiply by the time in seconds required to expose the base metal as determined in accordance with in 38.8.

Table 38.1
Thickness of coatings

Temperature, degrees F (C)	Thickness factors	
	Cadmium platings	Zinc platings
70 (21.1)	1.331	0.980
71 (21.7)	1.340	0.990
72 (22.2)	1.352	1.000
73 (22.8)	1.362	1.010
74 (23.3)	1.372	1.015
75 (23.9)	1.383	1.025
76 (24.4)	1.395	1.033
77 (25.0)	1.405	1.042
78 (25.6)	1.416	1.050
79 (26.1)	1.427	1.060
80 (26.7)	1.438	1.070
81 (27.2)	1.450	1.080
82 (27.8)	1.460	1.085
83 (28.3)	1.470	1.095
84 (28.9)	1.480	1.100
85 (29.4)	1.490	1.110
86 (30.0)	1.501	1.120
87 (30.6)	1.513	1.130
88 (31.1)	1.524	1.141
89 (31.7)	1.534	1.150
90 (32.2)	1.546	1.160

39 Wet-Locations Test

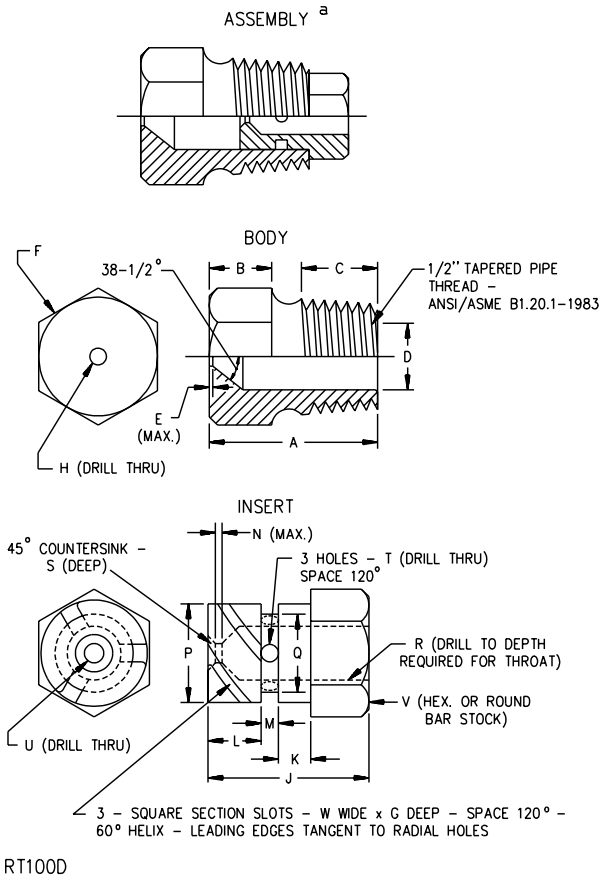
39.1 A fitting intended for use in a wet location shall not allow more than 0.1 mL (0.1g) of water into the fitting when tested as described in 39.3 and 39.4. See 84.1 and Table 84.1.

39.2 Prior to assembly, dry absorbent paper is to be placed in a container that can be sealed and resealed. The paper and the sealed container are to be weighed. The paper is then to be removed from the container and placed in the interior of the fitting at the point where the fitting interfaces with the electrical enclosure and also where it interfaces with the cable, conduit, or tubing. A threaded end cap shall be used in place of the enclosure for a fitting that is intended for securement to a threaded hub only and marked in accordance with 69.7.

39.3 The product is to be assembled in the intended manner. The assembly is to be vented to atmosphere to equalize the pressure during the test. The assembly is to be mounted under the apparatus described in 39.4 and illustrated in Figure 39.1. The water spray is to be applied for 1 hour.

Figure 39.1
Rain-test spray-head piping

Figure 39.1 revised October 21, 1998



Item	inch	mm	Item	inch	mm
A	1-7/32	31.0	N	1/32	0.80
B	7/16	11.0	P	.575	14.61
C	9/16	14.0		.576	14.53
D	.578	14.68	Q	.453	11.51
	.580	14.73		.454	11.53
E	1/64	0.40	R	1/4	6.35
F	c	c	S	1/32	0.80
G	.06	1.52	T	(No. 35)[b]	2.80
H	(No. 9)[b]	5.0	U	(No. 40)[b]	2.50
J	23/32	18.3	V	5/8	16.0
K	5/32	3.97	W	0.06	1.52
L	1/4	6.35			
M	3/32	2.38			

[a] Nylon Rain – Test spray Heads are available from Underwriters Laboratories

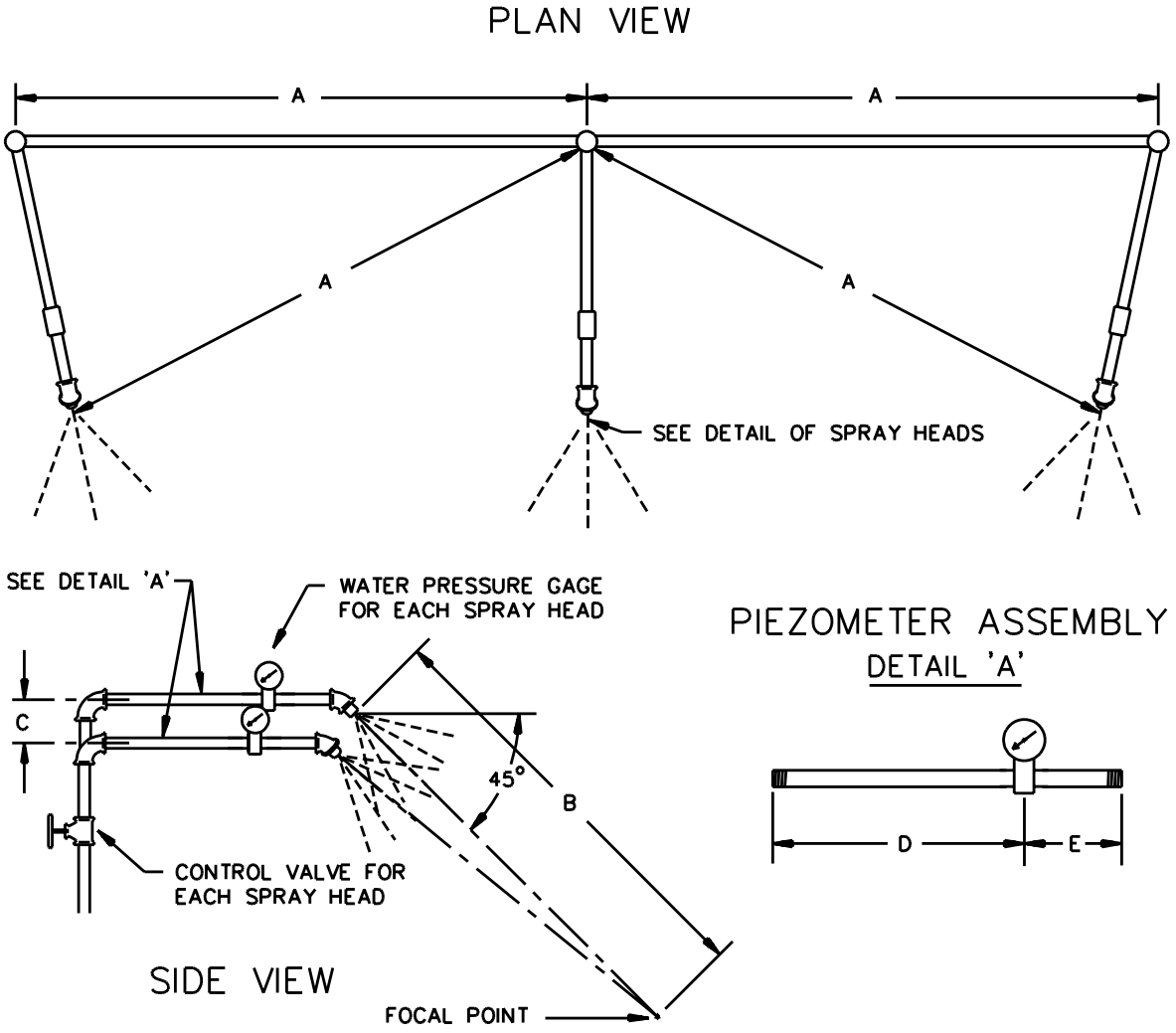
[b] ANSI B94.11M Drill Size

[c] Optional – To serve as a wrench grip.

39.4 The water spray apparatus is to consist of three spray heads constructed in accordance with the details illustrated in Figure 39.2 and mounted in a water supply pipe rack as illustrated in Figure 39.1. The water pressure is to be maintained at each spray head at approximately 5 psi (34.47 kPa). The distance between the center nozzle and the product is to be approximately 5 feet (1.52 m). The product is to be brought into the focal area of the three spray heads in such a position and under such conditions that water will be most likely to enter when the fitting is in its normal mounting position.

Figure 39.2
Rain-test spray head

Figure 39.2 revised October 21, 1998



RT101C

Item	inch	mm
A	28	710
B	55	1400
C	2-1/4	55
D	9	230
E	3	75

39.5 Immediately following the water spray, the outside of the test assembly is to be wiped dry. The test assembly is then to be disassembled. The absorbent paper is removed and placed in the container. The container is then to be resealed and weighed. The difference between the weight of the paper before and after the test is to be used to determine the quantity of water.

40 Concrete-Tightness Test

40.1 A concrete-tight fitting is to be tested as described in 40.2 – 40.5. There shall not be entrance of concrete aggregate (portland-type cement and sand) into the fitting, outlet box, conduit, or tubing used in the test assembly.

40.2 A concrete-tight fitting is to be assembled in the intended manner to a concrete-tight outlet box and a short length of the conduit or tubing that it is intended to be used with. A concrete-tight coupling is to be assembled in the intended manner to two short lengths of the conduit or tubing that it is intended to be used with. The conduit or tubing is to be pushed against an end or centering stop of a fitting before the fitting is tightened in accordance Method of Assembly, Section 35. A slotted or unslotted bolthead screw is to be tightened with a torque of 160 lbf-in (18.1 N•m). The ends of the conduit are to be sealed. The fitting assembly is to be secured to the bottom of the formwork used to contain the concrete. A coupling assembly is to be supported between one and two inches (25.4 and 50.8 mm) above the bottom of the formwork. The formwork is to be filled with concrete prepared in accordance with 40.3. The concrete is to be vibrated immediately after it is poured using a vibrator in accordance with 40.4. The assembly is to be tested in accordance with 40.5. Twenty-four hours after the concrete has been poured, it is to be broken loose from the assembly, and the interior of the fitting, outlet box, and conduit or tubing is to be examined.

40.2 effective February 1, 1999

40.3 Portland-type cement is to be used in the preparation of the concrete for the test required by 40.1. The sand is to be of the type known to the construction industry as mason sand. The cement to sand ratio is to be 1:2 by volume, and there is to be a 1/16-inch (1.6-mm) deep film of water on the surface of the mixture after it has stood for 1 minute in the mixing vat.

40.4 The concrete is to be vibrated with an internal type vibrator that operates between 13,500 and 15,000 vibrations per minute in free air. The vibrator head is to have:

a) A circumference not less than 3.75 inches (95 mm) and not greater than 5.5 inches (140 mm) and

b) A length not less than 14 inches (356 mm) and not greater than 16 inches (406 mm).

40.5 The assembly is to be covered with a minimum of 2 feet (0.61 m) of concrete. The vibrator head is to be placed into the concrete so that:

a) Its major axis is vertical, and

b) Its free end is within 1 inch (25.4 mm) of the bottom of the formwork and within 1 inch (25.4 mm) of the assembly.

The head is then to be withdrawn at a rate not less than 1 inch (25.4 mm) per second and not more than 2 inches (50.8 mm) per second. This procedure is to be repeated until all of the concrete has been vibrated as indicated by an overlap of vibration patterns over the entire surface. The vibrator is not to come in contact with the assembly or the formwork. The total vibration time is to be 10 seconds per cubic foot of concrete used.

41 Resistance Test

41.1 The resistance between the points specified in 41.2 shall not be more than that specified for the fitting as determined by causing a direct current of 30 amperes to flow through the fittings and connections between the fitting and the conduit, tubing, cable, box, or enclosure to which the fitting is assembled. The voltage drop between the points mentioned in 41.2 is to be measured. For a connector, a threaded coupling or plate used to simulate a box is acceptable.

41.2 For a coupling, the voltage drop is to be measured between two points, one on each section of the conduit, tubing, or cable. For a connector, the voltage drop is to be measured between a point on the conduit, tubing, or cable, and a point on the box, enclosure, or threaded coupling used to simulate the box. The point on the box, enclosure, or threaded coupling is to be 1/16 inch (1.6 mm) from the fitting. The point on the conduit, tubing, or cable is to be 1/16 inch from the fitting or the contact point between the fitting and the conduit, tubing, or cable.

42 Current Test

42.1 A fitting shall carry the specified current for the time indicated in Table 42.1. The fitting shall not crack or break, and there shall be continuity between the enclosure, fitting, and raceway following the test. Arcing and burning of a throat insulator is acceptable.

Exception: A fitting considered to be a nongrounding type need not be subjected to this test.

Table 42.1
Test currents and times

Table 42.1 revised October 21, 1998

Trade size	(metric designator)	Test time, seconds	Current, amperes	Minimum size of copper leads used to connect sample assembly to current source,	
				AWG	(mm^2)
3/8	(12)	4	470	12	(3.3)
1/2	(16)	4	1180	8	(8.4)
3/4, 1	(21, 27)	6	1530	6	(13.3)
1-1/4, 1-1/2	(35, 41)	6	2450	4	(21.2)
2	(53)	6	3900	2	(33.6)
2-1/2	(63)	6	4900	1	(42.4)
3, 3-1/2, 4	(78, 91, 103)	9	5050	1/0	(53.5)
5, 6	(129, 155)	9	8030	3/0	(85.0)

Note – Trade size for metal-clad cable fittings refers to the associated knockout.

42.2 Three samples of each fitting are to be tested. Each fitting is to be assembled to a minimum 6-inch (152-mm) length of raceway of the intended size and an unpainted, plated or unplated, steel enclosure (as shown in Figure 42.1) or steel plate simulating an enclosure (as shown in Figure 42.2). A fitting for metal-clad cable is to be tested with smooth-sheath or continuous-corrugated cable. The thickness of the enclosure or plate is to be as specified in 42.4 and 42.5.

Figure 42.1
Current test using an enclosure

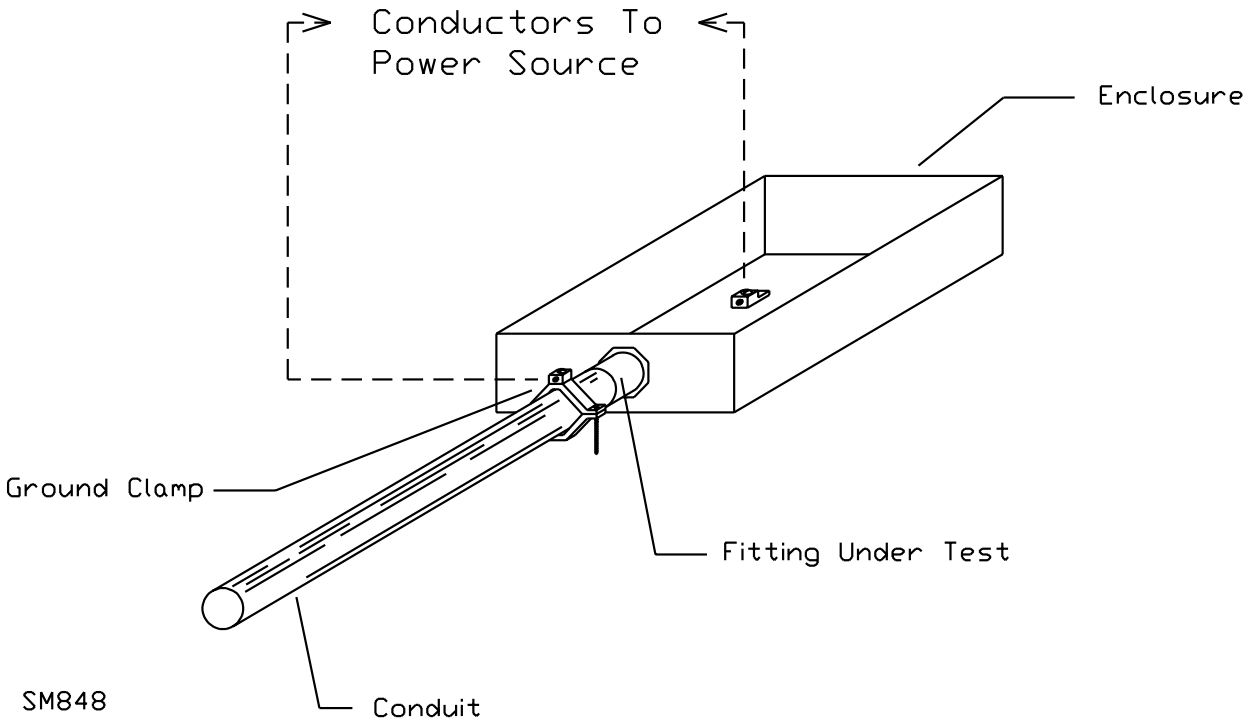
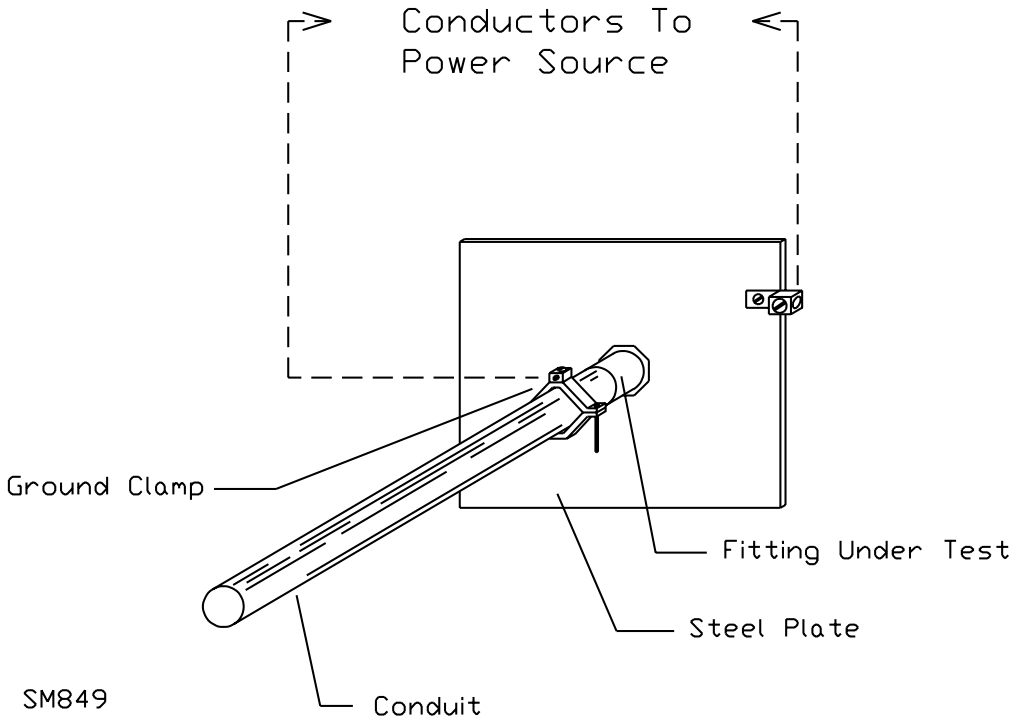


Figure 42.2
Current test using a steel plate



42.3 A locknut is to be hand-tightened and then further tightened 1/4 turn with a hammer and a standard screw driver or by an equivalent method. A copper wire lead, not less than 2 feet (610 mm) long, is to be connected:

a) To the enclosure by a pressure wire connector, and

b) To the raceway, 1/32 inch (0.8 mm) from the fitting, by a ground clamp of the appropriate size.

Pressure wire connectors are to be tightened using the torque specified in the Standard for Wire Connectors and Soldering Lugs, UL 486A. The test current is to be passed through the wire and assembly.

42.4 For 3/8 – 1-1/4 (13 – 35) trade sizes, a fitting is to be tested with:

a) A steel enclosure or plate of thickness 0.053 – 0.055 inch (1.35 – 1.40 mm) as specified in Table 42.1, and

b) A steel enclosure or plate of thickness 0.026 – 0.028 inch (0.66 – 0.71 mm) at 470 amperes for 4 seconds.

Exception: For 3/8 – 1-1/4 (13 – 35) trade sizes, a fitting shall be tested with only a steel enclosure or plate of 0.026 – 0.028 inch (0.66 – 0.71 mm) thickness provided it is tested according to Table 42.1.

42.5 For 1-1/2 – 6 (41 – 155) trade sizes, a fitting is to be tested with a steel enclosure or plate of 0.053 – 0.055 inch (1.35 – 1.40 mm) thickness per Table 42.1.

42.6 After having carried the test current, continuity shall exist between the parts of the test assembly when measured between a point on the raceway and a point on the enclosure 1/4 inch (6.4 mm) from the fitting. An indicating device, such as an ohmmeter or battery-and-buzzer combination, is to be used to determine whether continuity exists.

43 Compression/Set Test

43.1 Specimens of an expanded (foam) closed-cell material (see 7.1 (c)) shall be tested as described in 43.2. The thickness of a specimen after conditioning shall not be less than five-sixths of its original (before conditioning) thickness.

43.2 Three specimens, each 1.14 ±0.02 inch (29.0 ±0.5 mm) in diameter and 0.50 ±0.02 inch (12.7 ±0.5 mm) thick are to be prepared, using as many thicknesses of the material as necessary. Each specimen is to be conditioned for 24 hours at a temperature of 23 ±2°C (73 ±4°F) while compressed by one-third its original thickness between flat steel plates. At the end of this period, the specimens are to be removed from between the compression plates. After an additional 24 hours, the thickness is to be measured at the center of each specimen.

44 Elastomeric Materials Test

44.1 An elastomer other than a thermoplastic elastomer shall not crack or show a change in hardness of more than ten numbers after the conditionin described in 44.2.

44.2 The hardness of the unaged material is to be determined as the average of five readings using a gauge such as the Rex hardness gauge or the Shore durometer. The samples are to be conditioned for 70 hours in an air-circulating oven at 100 ±1°C (212 ±2°F). After conditioning, the component is to be allowed to rest at room temperature but not less than 4 hours and the hardness is then to be determined again as the average of five readings. The difference between the original hardness reading and the reading taken after the conditioning is the change in hardness.

SPECIFIC FITTINGS

45 Studs

45.1 A stud shall comply with 45.3 – 45.7. A new sample is to be used for each test.

45.2 A separate stud or one provided with a bar hanger is to be assembled to a standard octagonal outlet box for each test described in 45.3 – 45.7.

45.3 A stud and its attachment to a box, cover, bar hanger, or other device shall withstand for 5 minutes a direct pull of 200 pounds (890 N) without pulling apart or breaking.

45.4 A stud and its attachment to a box, cover, bar hanger, or device shall withstand for 1 minute, without visible damage, the application of a load as specified in Table 45.1. The load is to be applied at the end of a 20-inch (508-mm) rigid fixture stem attached to the stud, with the stud assembly mounted in the intended manner on the under side of a platform that is at an angle of 30 degrees with the horizontal and that can be rotated about the axis of the fixture stud. The platform is to be rotated for six complete revolutions during the test.

Table 45.1
Load

Size of stud,		Load,	
in	**(mm)**	**lb**	**(kg)**
1/8	(3.2)	20	(9.07)
1/4	(6.4) and larger	30	(13.61)

45.5 The load applied at the end of the stem is to be reduced an appropriate amount to allow for the bending moment due to the weight of the stem.

45.6 A stud and its attachment to a box, cover, bar hanger, or other device shall withstand for 1 minute, without visible damage or relative movement, the application of a torque having the value specified in Table 45.2.

45.7 With reference to 45.6, the stud is to be rigidly supported in the intended manner, and the torque is to be applied at the end of a lever arm attached to the stud or to an extension member which is in turn attached to the stud. The torque is to be applied in the direction tending to tighten the screw connections. The lever arm is to be measured from the axis of the stud to the point of application of the torque, and the lower arm is to be perpendicular to the axis of the stud.

Table 45.2
Torque

Size of stud,		Torque,	
in	(mm)	lbf-in	(N•m)
1/8	(3.2)	200	(22.6)
1/4	(6.4) and larger	400	(45.2)

46 Flexible Cord Fittings

46.1 General

46.1.1 A flexible cord fitting other than a liquid-tight fittings, shall comply with test sequence A of Table 46.1, excluding the Oil Spray Test. A liquid-tight flexible cord fitting shall comply with test sequences A and B of Table 46.1.

46.1.2 Two samples of each trade size of a flexible cord fitting are to be subjected to each test sequence specified by 46.1.1. With respect to trade size of fittings, if the gland ends of two trade sizes are identical, only one trade size of each fitting needs to be tested. See 46.1.3.

Exception: The Ultraviolet-Light and Water Conditioning Test from sequence B is not required for:

a) A fitting that, when assembled to cord as required by 46.1.3, has no exposed nonmetallic parts;

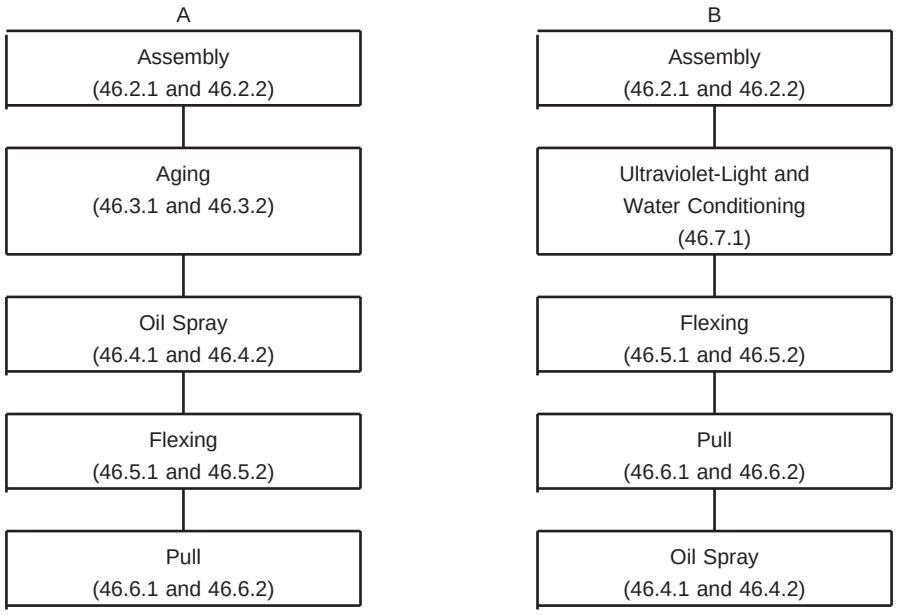
b) A fitting made from a material that is rated for exposure to ultraviolet light and water; or

c) A metallic fitting that encloses at least 95 percent of the surface area of a nonmetallic gland. In determining surface area of a gland, that portion of the gland that bears directly against the cord in an assembled sample is not to be considered part of the surface area.

46.1.3 One of the two samples of each trade size specified in 46.1.2 is to be tested with a gland that will accommodate the smallest diameter cord within the range of sizes specified for use with the fitting. The other sample is to be tested with a gland that will accommodate the largest diameter cord within the range.

46.1.4 Two samples of the elastomeric gland for each type of a flexible cord fitting shall comply with Elastomeric Materials Test, Section 44, and two samples are to be conditioned as described in 46.7.2 and 46.7.3 and then shall comply with Section 44.

Table 46.1
Test sequences for flexible cord fittings



Note – Numbers in parentheses are the paragraph numbers of the requirements.

46.2 Assembly Test

46.2.1 Samples of a fitting are to be assembled to flexible cord using the torque specified in Table 35.1. Each fitting is to be assembled to cord so that between 1-1/2 inches (38 mm) and 2 inches (51 mm) of cord projects beyond the throat of the fitting. See 35.5.

46.2.2 The flexible cord used in a sample assembly shall be at least 18 inches (457 mm) long, and shall have the smallest or largest, as specified in these requirements, overall diameter specified by the manufacturer for the gland under test. A ±0.020-inch (±0.51-mm) tolerance for a cord not more than 3/4 inch (19.1 mm) in diameter, and a ±0.030-inch (±0.76-mm) tolerance for a cord more than 3/4 inch in diameter is acceptable. The cord used for the testing shall have a temperature rating not less than the temperature rating of the fitting.

46.2.2 revised October 21, 1998

46.3 Aging Test

46.3.1 The fitting of an assembly, conditioned as described in 46.3.2, shall not warp, char, or blister.

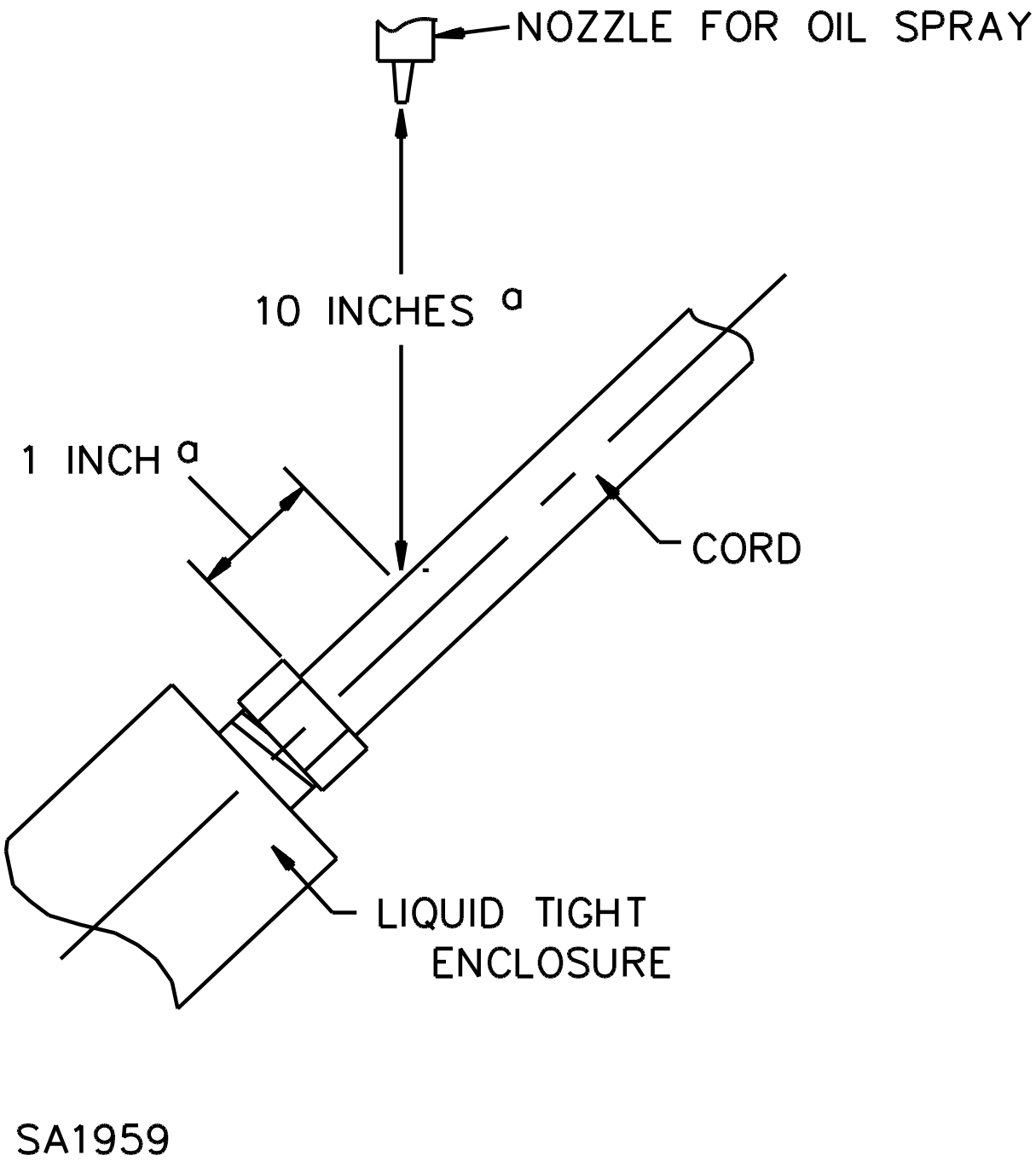
46.3.2 A fitting that is not marked for use with a specific cord type or a temperature rating is to be conditioned in an air-circulating oven for 168 hours at 70 ±1°C (158 ±2°F). For a fitting that is marked for a rating higher than 60°C (140°F), the oven temperature is to be 10 ±1°C (18 ±2°F) above the rated temperature of the fitting. See 71.1.

46.4 Oil Spray Test

46.4.1 After sample assemblies have been subjected to an oil spray for 30 minutes as described by 46.4.2, there shall not be evidence of oil inside the test enclosure.

46.4.2 A sample cord and fitting are to be assembled in the intended manner to a liquid-tight enclosure and mounted in a fixed position. The cord is to be suspended so that the axis of the entire assembly is at an angle of 45 degrees from the vertical. A stationary nozzle with a 3/8-inch (9.5-mm) diameter opening is to be located 10 inches (254 mm) above the surface of the cord and directed so as to spray oil vertically downward to strike the cord approximately 1 inch (25.4 mm), measured along the axis of the assembly, above the fitting. See Figure 46.1. A mixture of 10 parts water to 1 part water soluble oil is to be sprayed through the nozzle at a rate or not less than 2 gallons (7.6 L) per minute.

Figure 46.1
Oil spray test fixture



[a] SI units for the dimensions in this figure are:

1 inch = 25.4 mm

10 inches = 254 mm

46.5 Flexing Test

46.5.1 After sample assemblies have been mounted and subjected to 500 cycles of flexing as described in 46.5.2, there shall not be:

a) Cord displacement of more than 1/8 inch (3.2 mm),

b) Loosening of the cord in the fitting, or

c) Loss of integrity of the fitting components such that they are no longer capable of performing their intended function.

46.5.2 Sample assemblies are to be wiped dry and then mounted vertically in a fixed position. Starting from the vertical position, the cord is to be flexed through a 90-degree angle having a radius of 5 inches (127 mm) for cord 3/4 inch (19.1 mm) in diameter or less or 10 inches (254 mm) for cord more than 3/4 inch in diameter. The cord is then to be flexed through a 180-degree angle of the same radius in the opposite direction, and then back to the vertical position; this is one complete cycle of flexing.

46.6 Pull Test

46.6.1 After the sample assemblies have been subjected to the Pull Test described in 46.6.2, the cord shall not be displaced more than 1/8 inch (3.2 mm) from its original position, as measured from the plane of the test enclosure to which the fitting is secured.

46.6.2 An assembly is to be mounted in a fixed position and a reference mark is to be made on the cord jacket to indicate displacement of the jacket from the fitting. A 35-pound (15.9-kg) weight is to be secured to the end of the cord so that the load is applied to both the jacket and the conductors in a direction along the axis of the fitting. The load is to be applied gradually and is to be maintained for 1 minute. After removal of the load, the cord is to be allowed to recover for 1 minute before the displacement is measured.

46.7 Ultraviolet-Light and Water Test

46.7.1 As a result of the conditioning described in 46.7.2, a sample shall not crack or break.

46.7.2 Each sample is to be exposed to ultraviolet light and water by using either of the following methods:

a) Twin enclosed carbon-arc, Type D, in accordance with ASTM G 23. Method 1, continuous exposure to light and intermittent exposure to water spray, with a programmed cycle of 120 minutes consisting of a 102-minute light exposure and an 18-minute exposure to water spray with light, is to be used. The apparatus is to operate with a black-panel temperature of 63 ±3°C (145 ±5°F), or

b) Xenon-arc, Type B, in accordance with ASTM G 26. Test Method A, continuous exposure to light and intermittent exposure to water spary, with a programmed cycle of 120 minutes consisting of a 102-minute light exposure and an 18-minute exposure to water spray with light, is to be used. The apparatus is to operate with a 6500 W, water-cooled xenon-arc lamp, borosillicate glass inner and outer optical filters, a spectral irradiance of 0.35 $W/m^2/nm$ at 340 nm, and a black-panel temperature of 63 ±3°C (145 ±5°F).

46.7.3 The samples are to be mounted on the inside of the cylinder in the ultraviolet-light apparatus so that they do not touch each other. After the exposure, the samples are to be removed from the cylinder and visually compared to the unconditioned samples.

46.7.4 For twin enclosed carbon-arc, the samples are to be exposed for a total of 720 hours. For xenon-arc, the samples are to be exposed for a total of 1000 hours.

47 Hubs

47.1 Assembly test

47.1.1 A hub, when assembled in openings in surfaces of the types described in 11.7, shall withstand the tightening torque specified in 47.1.2 without turning in the opening, without stripping any threads, and without damaging the hub.

47.1.2 The hub is to be assembled in the enclosure opening in the intended manner making use of a wrench or other tool, if necessary, to prevent the turning of that portion of the hub inside the enclosure. The enclosure is to be firmly supported or mounted in the intended manner, a short length of intermediate metal conduit or rigid metal conduit is to be threaded into the hub, and the applicable tightening torque is to be applied to the conduit in a direction tending to tighten the conduit with the lever arm measured from the center of the conduit. The tightening torque is to be 800 lbf-in (90.4 N•m) for 3/4 (21) and smaller trade sizes, 1000 lbf-in (113 N•m) for 1, 1-1/4, and 1 1/2 (27, 35, and 41) trade sizes, and 1600 lbf-in (181 N•m) for 2 (53) and larger trade sizes.

47.2 Resistance test

47.2.1 A hub, assembled as described in 47.1.2, shall not have a voltage drop of more than 10 millivolts as a result of the test described in Resistance Test, Section 41. The two test points mentioned in 41.2 are to be on the conduit and on the outside of the enclosure.

47.3 Wet-locations test

47.3.1 A hub intended for use in wet locations or with service-entrance conduit shall provide a raintight connection to the enclosure. The hub is to be assembled to the enclosure as described in 47.1.2. Compliance is to be determined by the test described in Wet-Locations Test, Section 39.

48 Armored Cable Fittings

48.1 General

48.1.1 An armored cable fitting is to be subjected to the test sequence as described in 48.2.1 – 48.5.1.

48.2 Assembly test

48.2.1 When assembled as described in 35.4:

a) The fitting shall not crack or break,

b) The threads of any clamping means shall not strip, and

c) The cable shall not be punctured or deformed so that sharp edges will be present in the wireway.

48.2.2 The fitting is to be assembled to the end of the armored cable that winds inside itself. A fitting intended to be used with a range of cable diameters, the fitting is to be tested with the smallest and largest diameter cable in the range. A ±0.020-inch (0.51-mm) tolerance for a cable not more than 3/4 inch (19.1 mm) in diameter and a ±0.030-inch (0.762-mm) tolerance for a cable more than 3/4 inch in diameter is acceptable. The fitting is then to be assembled to an outlet box as intended.

48.2.3 During assembly, the wires in the armored cable are to be allowed to project approximately 6 inches (152 mm) inside the outlet box. Each cable is to be one foot (0.3 m) long – not including the 6 inches of wire inside the box.

48.3 Resistance test

48.3.1 The fitting shall not have a voltage drop of more than 50 milivolts as a result of the tests described in Resistance Test, Section 41. The test is to be conducted using the minimum and maximum diameter cable, as specified by the manufacturer. The two test points mentioned in 41.2 are to be between the fitting and armored cable.

48.4 Pull test

48.4.1 A fitting for armored cable shall secure the cable so that it will withstand a steady pull, as specified in Table 48.1, for 5 minutes so that the cable cannot be readily removed by bending or flexing.

Table 48.1
Pull forces

Trade size of fitting	(metric designator)	Force,	
		lbf-in	(N)
1/2	(16)	75	(333)
3/4	(21)	100	(444)
1	(27)	125	(556)
1-1/4 to 4	(35 to 103)	150	(667)

48.4.2 An armored cable fitting for multiple cables, such as a duplex fitting, is to be tested with cable attached to each opening or section as intended. Each cable is to be subjected to the pull specified in 48.4.1, applied individually.

48.5 Repeated resistance test

48.5.1 Following the test specified in 48.4.1 or 48.4.2, each test assembly shall comply with in 48.3.1.

49 Armored Cable Bushings

49.1 Assembly test

49.1.1 An armored cable bushing shall be capable of being installed readily between the conductor and the armor when subjected to the test described in 49.1.2. The bushing shall remain in place after the installation pressure is removed.

49.1.1 effective February 1, 1999

49.1.2 Samples of each size bushing are to be tested. Each bushing is to be tested with an 18-inch (457.2 mm) long piece of armored cable of the intended size. On three of the pieces of cable, two inches of armor is to be removed from the end of the cable in which the armor wraps on the outside of itself. On the remaining three pieces of cable, two inches (51 mm) of armor is to be removed from the end of the cable in which the armor wraps on the inside of itself. The fibrous covering on the two inches of exposed conductor in all six pieces of cable is also to be removed. The bushing is to be inserted between the conductors and the armor at the end where the armor and covering have been removed.

49.1.2 effective February 1, 1999

49.2 Oven aging test

49.2.1 An armored cable bushing shall not crack when closed to form a complete circle after being conditioned for 168 hours in an air-circulating oven at 112 ±1°C (234 ±2°F). Following removal from the oven, the samples are to be allowed to cool to room temperature in still air for not less than 4 hours before being handled and examined.

49.2.1 effective February 1, 1999

49.3 Low temperature test

49.3.1 An armored cable bushing shall not crack when closed to form a complete circle within 15 seconds after being conditioned at a temperature of minus 40 ±1°C (minus 40 ±2°F) for 4 hours.

49.3.1 effective February 1, 1999

49.4 Dielectric voltage-withstand test

49.4.1 Six samples of each size armored cable bushing shall be subjected to the test described in 49.4.2 and shall withstand the test potential without electrical breakdown.

49.4.1 effective February 1, 1999

49.4.2 A 60-hertz essentially sinusoidal potential of 1500 volts rms is to be applied to each bushing. The potential is to be applied between two 1/4-inch (6.3-mm) diameter brass balls. Each ball is to be supported by an adjustable rod. The bushing is to be placed between the brass balls, and the rods are to be adjusted until the balls fit snugly against the bushing.

49.4.2 effective February 1, 1999

50 Flexible Metal Conduit Fittings

50.1 General

50.1.1 Samples of flexible metal conduit fitting are to be subjected to the test sequence as described in 50.2 – 50.7.

50.2 Assembly test

50.2.1 When assembled as described in 35.4:

a) The fitting shall not crack or break,

b) The threads of any clamping means shall not strip, and

c) The conduit shall not be punctured or deformed so that sharp edges will be present in the wireway.

50.2.2 Sample flexible metal conduit fittings of the external type are to be assembled to the end of the flexible metal conduit that winds inside itself. Sample fittings of the internal type are to be assembled to the end of the flexible metal conduit that winds outside itself. Each conduit sample is to be one foot (0.3 m) long.

50.3 Resistance test

50.3.1 When tested as described in Resistance Test, Section 41, the voltage drop in a connection between a fitting and flexible metal conduit shall not be more than 50 millivolts.

50.4 Pull test

50.4.1 A fitting for flexible metal conduit shall secure the conduit so that the connection will withstand a steady pull, as specified in Table 48.1, for 5 minutes so that the conduit shall not be capable of being removed by bending or flexing.

50.4.2 A flexible metal conduit fitting for multiple conduits, such as a duplex fitting, is to be tested with conduit attached to each opening or section as intended. Each conduit is to be subjected to the pull specified in 50.4.1 applied individually.

50.5 Repeated resistance test

50.5.1 Following the test required by 50.4.1 or 50.4.2, each test assembly shall comply with 50.3.1.

51 Metal-Clad Cable Fittings

51.1 General

51.1.1 Samples of a metal-clad cable fitting are to be subjected to a resistance test, a bending test, a repeated resistance test, and a pull test, in the order given. The same samples are to be used for these tests, and the samples are not to be conditioned in any way during the tests. The Wet Locations Test is to be conducted using previously untested samples. See 51.7.1.

51.1.1 revised October 21, 1998

51.2 Assembly test

51.2.1 Sample fittings for testing are to be assembled to lengths of metal-clad cable as described in 35.2 – 35.5.

Exception No. 1: A fitting employing a gland is to be tightened with the torque specified in Table 51.1.

Exception No. 2: A fitting with a different torque specified in assembly instructions is to be assembled using the torque specified in the instructions.

Table 51.1
Tightening torque for a metal-clad cable fitting employing a gland

Trade size of fitting	(metric designator)	Tightening torque	
		lbf-in	(N•m)
1/2	(16)	300	(33.9)
3/4	(21)	500	(56.5)
Larger than 3/4	(21)	700	(79.1)

51.2.2 Twelve samples of each trade size of fitting are to be tested in accordance with the 51.2.3 – 51.6.1. A separate set of samples is to be tested for each type of cable that the fitting is intended to be used with. Six of the samples are to be tested with the minimum diameter cable and six with the maximum diameter cable, as recommended by the manufacturer. A ±0.020-inch (0.51-mm) tolerance for a cable not more than 3/4 inch (19.1 mm) in diameter, and a ±0.030 inch (0.762 mm) tolerance for a cable more than 3/4 inch in diameter is acceptable. If at least four sizes of a particular design are being investigated, three samples are to be tested with the minimum diameter cable, and three with the maximum diameter cable, as indicated in 34.3.

51.2.3 A fitting for an interlocking type metal clad cable is to be assembled to the end of the cable that winds inside itself. It is acceptable for a fitting for all other types of metal-clad cable to be assembled at either end of the cable. Each cable is to have a length as specified in Table 51.2. The assembly is then to be secured to an outlet box employing knockouts of the appropriate trade size. A 6-inch (152-mm) lead is to project out of the assembly at the point of connection between the fitting and the cable.

Table 51.2
Bending radius for metal-clad cable

External diameter of cable, in (mm)	Cable with interlocked armor or corrugated sheath			Shielded conductors			Cables with smooth sheath		
	Multiplying factor for inner radius of cable bend[a]	Minimum test cable length,		Multiplying factor for inner radius of cable bend[a]	Minimum test cable length,		Multiplying factor for inner radius of cable bend[a]	Minimum test cable length,	
		ft	(m)		ft	(m)		ft	(m)
Not more than 3/4 (19.1)	7	2	(0.61)	12	3	(0.91)	10	3	(0.91)
More than 3/4, but not more than 1-1/2 (38.1)	7	3	(0.91)	12	4	(1.22)	12	4	(1.22)
More than 1-1/2 but not more than 2-1/2 (63.5)	7	4	(1.22)	12	6	(1.83)	15	8	(2.44)
More than 2-1/2	7	6	(1.83)	12	8	(2.44)	15	10	(3.05)

[a] The factor is to be multiplied by the external diameter of the cable to get the inner radius of the bend.

51.3 Resistance test

51.3.1 The assembled samples shall be subjected to Resistance Test, Section 41. The voltage drop shall not be more than 50 millivolts. One of the two points mentioned in 41.2 is to be on the cable sheath, and the other point is to be on the steel box or equivalent mounting means.

51.4 Bending test

51.4.1 The assembly of the fitting and cable shall remain secure when subjected to a bending test as described in 51.4.2.

51.4.2 The fitting is to be secured with the axis of the cable in line with the axis of the fitting. The cable is to be bent around a wooden form having a radius as specified in Table 51.2. The cable is to be bent in one direction so that a 90-degree bend is formed. The wooden form is then to be positioned on the opposite side of the cable. The cable is then to be bent 180 degrees in the opposite direction, and then back to its original position in line with the axis of the fitting.

51.5 Repeated resistance test

51.5.1 Following the bending test, the samples shall comply with 51.3.

51.6 Pull test

51.6.1 The samples of the assembled fittings and cables shall remain secure when subjected to a direct pull as specified in Table 48.1 for 5 minutes. The pull is to be in the direction that the cable exits the fitting. For a straight fitting, the pull is to be between the cable and outlet box or test plate. For an angle fitting, the pull is to be between the cable and the fitting. The cable shall not be displaced more than 1/8 inch (3.2 mm) from its original position.

51.7 Wet-locations test

51.7.1 Unless a fitting is marked in accordance with 73.2, the cable fitting assembled to cable in accordance with 51.2.2 and 51.7.2 shall comply with the Wet-Locations Test, Section 39.

51.7.1 revised October 21, 1998

51.7.2 For the Wet-Locations Test, one previously untested sample of each trade size of the fitting is to be assembled to a 6-inch (152-mm) length of cable in accordance with 51.2.2. The ends of the cable and the threaded ends of the fitting are to be sealed with tape and then dipped in wax.

51.8 Elastomeric materials test

51.8.1 An elastomer used in a part that is employed in a fitting to comply with the requirement in 51.7.1 shall show no apparent deterioration after being conditioned for 70 hours in an air-circulating oven at 100 ±1°C (212 ±2°F).

51.8.2 After being conditioned as described in 51.8.1 an elastomer used in a part that fits over the outside of the cable and that is exposed after installation shall also comply with the following:

a) The tensile strength of the elastomer shall not decrease more than 25 percent, and

b) The elongation of the elastomer shall not decrease more than 35 percent.

51.9 Thermoplastic materials test

51.9.1 A thermoplastic sleeve or ring that is employed in a fitting to comply with 51.7.1 shall show no apparent deterioration after conditioning in an air-circulating oven for 168 hours at a temperature of 121 ±1°C (250 ±2°F).

51.9.2 After being conditioned as described in 51.9.1, a thermoplastic sleeve or ring when assembled with a fitting to a short length of metal-clad cable, shall comply with 51.6.1.

51.9.2 revised October 21, 1998

51.9.3 The test described in 51.9.2 is to be conducted on previously untested samples. If agreeable to those concerned, it is to be conducted on the same samples used for the test described in 51.7.1. The samples are to be allowed to return to room temperature before the pull is applied.

52 Nonmetallic-Sheathed Cable Fittings

52.1 Pull test

52.1.1 A nonmetallic-sheathed cable fitting assembled as specified in 52.1.2 – 52.1.4 shall secure the cable so that it will withstand the pull specified in 52.1.5 for 5 minutes without:

a) Damage to the cable sheath or individual conductor insulation,

b) Displacement of more than 1/8 inch (3.2 mm) of the cable from the fitting,

c) Dislodgement of the fitting from the surface on which it is mounted,

d) Loosening so that the cable can be readily removed, or

e) Cracking, breaking, or other indication that the fitting has been damaged.

52.1.2 The fitting is to be assembled as intended to an outlet box and to nonmetallic-sheathed cable that complies with the Standard for Nonmetallic-Sheathed Cables, UL 719. The cable or cables are to be of the size that the fitting is intended to secure. See 23.1, 74.1, and 74.2.

52.1.3 After assembly, the cut end of the cable sheath is to be in contact with the end stop of the fitting when one is provided. When an end stop is not provided, the cut end of the sheath is to extend 1/4 inch (6.4 mm) beyond the fitting. The wires of the cable are to project 6 inches (152 mm) inside the box. A screw that has provision for tightening with a screwdriver is to be tightened as specified in 35.2 – 35.5.

52.1.3 revised October 21, 1998

52.1.4 The free end of the cable is to be formed into a loop and securely fastened by tape or equivalent means. The pull is to be applied to the loop by a hook or other convenient method. A fitting that is intended to secure more than one cable is to have the pull applied separately to each cable.

52.1.5 The fitting is to be subjected to either:

a) A direct pull of 60 lbs (267N) or

b) A direct pull of 25 lbs (110 N) and the tests specified in 52.3 and 52.4.

52.2 Mold-stress relief test

52.2.1 There shall not be any cracks or change in any dimension greater than 10 percent for a fitting made of a nonmetallic material or having parts made of a nonmetallic material when the fitting is conditioned as described in 52.2.2.

Exception: A fitting or part employing only thermosetting materials need not be subjected to this test.

52.2.2 Six unassembled samples of a fitting made of a nonmetallic material or parts made of a nonmetallic material are to be conditioned in an air-circulating oven for 7 hours at 90 ±1°C (194 ±2°F). Following removal from the oven, the samples are to cool to room temperature before being handled and examined. The cooling time shall not be less than 4 hours. After cooling, each sample is to be examined to determine whether it complies with 52.2.1.

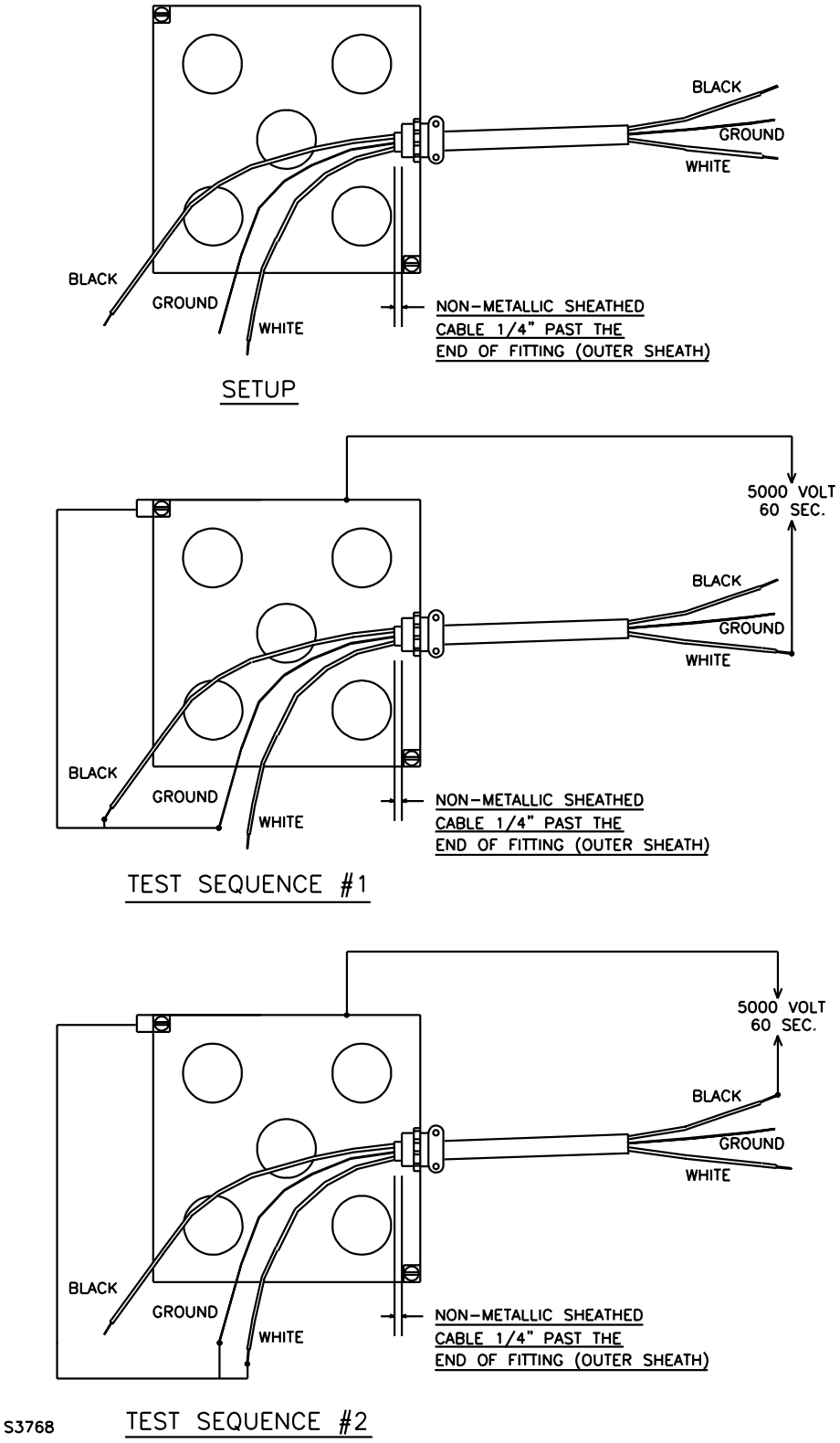
52.2.2 revised October 21, 1998

52.3 Aging and dielectric voltage-withstand test

52.3.1 When tested as described in 52.3.2 the fitting shall not damage the insulation, and the assembly shall be capable of withstanding the potential specified in 52.3.2 without electrical breakdown.

52.3.2 Each new sample is to be assembled as described in 52.1.2 – 52.1.4. The assembly is to be conditioned in air-circulating oven for 168 hours at 90 ±1°C (194 ±1°F). The samples are then to be removed from the oven and cooled to room temperature before being handled. Once the cooling process is done, each sample is to be subjected to a potential of 5000 V ac for a period of 1 minute. The potential is to be applied between the insulated conductors of the cable and the insulated conductors and the fitting or bare wire ground. See test sequence 1 or 2 in Figure 52.1.

Figure 52.1
Test set-up for nonmetallic-sheathed cable connectors utilizing a 5000 V dielectric test



52.4 Nonmetallic fittings

52.4.1 Pull test

52.4.1.1 A fitting that does not use a locknut shall comply with 52.1.1 when tested as described in 52.4.1.2 and 52.4.1.3.

52.4.1.2 Three sample fittings are to each be assembled to a nonmetallic-sheathed cable sample and an outlet box or a plate with a thickness of 0.0625 inch (1.6 mm). Each fitting is then to be subjected to a direct pull of 25 lbf (110 N).

52.4.1.3 Three sample assemblies consisting of a fitting, a nonmetallic-sheathed cable , and an outlet box or plate with a thickness of 0.0625 inch (1.6 mm) are to be conditioned for 24 hours in air at a temperature of minus 25 ±1°C (minus 13 ±2°F). Immediately after removal from the air, the assembly is to be subjected to a direct pull of 25 lbf (110 N).

53 Service-Entrance Cable Fittings

53.1 Pull test

53.1.1 A service-entrance cable fitting shall secure the smallest and largest cable size that it is intended to be used with so that it will withstand a steady pull of 50 lbf (222 N) for 5 minutes so that the cable cannot be readily removed by bending or flexing. If the fitting is intended to be used with a range of round cable, the fitting is to be tested with the smallest and largest cables in the range. The pull is to be applied between the cable and a box in which the fitting is mounted in the intended manner.

53.1.2 In preparing the sample for the test specified in 53.1, the conductors of the cable are to be allowed to project approximately 6 inches (152 mm) inside the box.

53.2 Wet-locations test

53.2.1 A service-entrance cable fitting intended for use in wet locations shall comply with Wet-Locations Test, Section 39. If the fitting is intended to be used with a range of cable diameters, the fitting is to be tested with the smallest and largest diameter cables of the shape and size in the range.

53.2.1 effective February 1, 1999

53.3 Elastomeric materials test

53.3.1 An elastomeric component of a service-entrance cable fitting shall comply with Elastomeric Materials Test, Section 44.

53.4 Thermoplastic materials test

53.4.1 A thermoplastic component of a service-entrance cable fitting shall comply with 53.1 after conditioning for 168 hours in an air-circulating oven at 100 ±1°C (212 ±2°F).

53.5 Probe test

53.5.1 A fitting, when assembled with the smallest cable intended, shall not permit the passage of a 17/64-inch (6.7-mm) diameter probe through any opening between the inside of the fitting and the cable.

54 Flexible Nonmetallic Tubing Fittings

54.1 Pull test

54.1.1 A fitting for flexible nonmetallic tubing shall secure the tubing, with a wire in place as in actual service, so that the wire will withstand a steady pull of 30 lbf (133 N) in either direction for 5 minutes so that the wire cannot be readily removed by bending or flexing. The pull shall be applied between the tubing and a box in which the fitting is mounted in the intended manner.

54.1.2 The tubing to be employed in conducting the test described in 54.1.1 is to be standard 7/32-inch flexible nonmetallic tubing. Type T, TW, or THW, No. 14 AWG (2.1 mm^2) wire is to be used. The wire is to project approximately 6 inches (152 mm) inside the box.

55 Flexible Metallic Tubing Fittings

55.1 General

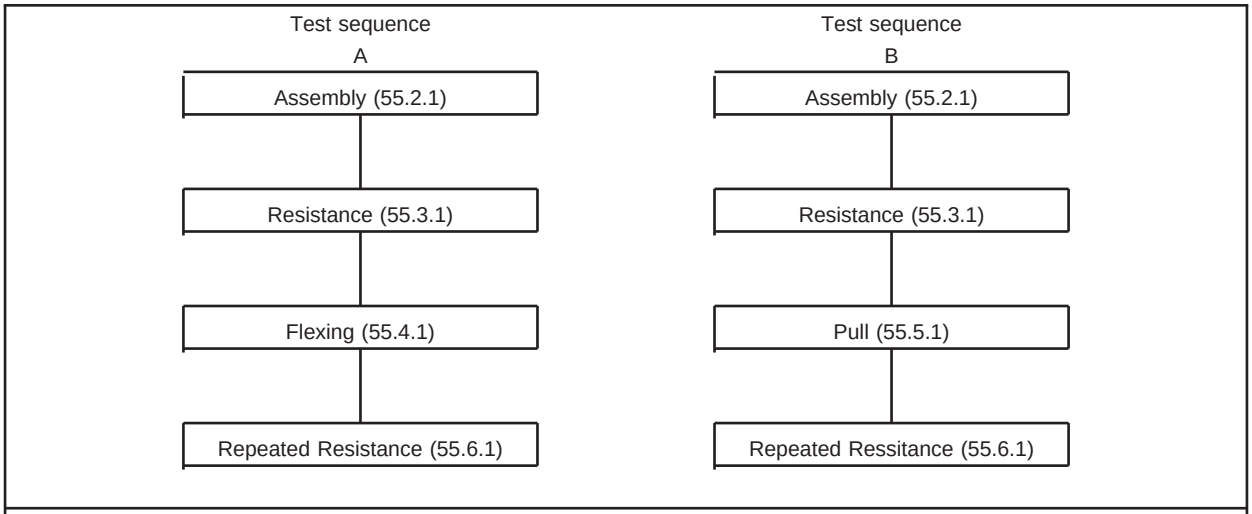
55.1.1 Six samples of flexible metallic tubing fittings of each trade size shall be subjected to each test sequence specified in Table 55.1. Two additional samples, or two of those used for either test sequence, shall comply with 55.7.1. See 55.7.2 – 55.10.2.

55.2 Assembly test

55.2.1 Flexible metallic tubing fittings are to be assembled to 3-ft (0.9-m) lengths of flexible metallic tubing of the intended trade size in the manner recommended by the manufacturer. For screw-in connectors, the tubing is to be within 0.003 inch (0.08 mm) of the maximum inside diameter of the tubing. For outside connectors, the tubing is to be within 0.005 inch (0.13 mm) of the minimum outside diameter of the tubing. See Table 25.1 and 85.1.

55.2.2 Sample flexible metallic tubing fittings of the external type are to be assembled to the end of the flexible metallic tubing that winds inside itself. Samples fittings of the internal type are to be assembled to the end of the flexible metallic tubing that winds outside itself.

Table 55.1
Test sequence for flexible metallic tubing fittings



Note – Numbers in parentheses are the paragraph numbers of the requirements.

55.3 Resistance test

55.3.1 When tested as described in Resistance Test, Section 41, the voltage drop in an assembled sample shall not be more than 50 millivolts.

55.4 Flexing test

55.4.1 The assembly of the fitting and tubing shall remain secure when subjected to the flexing test described in 55.4.2.

55.4.2 The fitting is to be secured with the axis of the tubing in line with the axis of the fitting. The tubing is to be bent around a wooden form having a radius as specified in Table 55.2. The tubing is to be bent in one direction so that a 90-degree bend is formed. The wooden form is then to be positioned on the opposite side of the tubing. The tubing is then to be bent 180 degrees in the opposite direction, and then back to its original position in line with the axis of the fitting.

Table 55.2
Bending radius for flexible metallic tubing

Table 55.2 revised October 21, 1998

Trade size of tubing	(metric designator)	Radius, in	Radius, (mm)
3/8	(12)	10	(254.0)
1/2	(16)	12-1/2	(317.5)
3/4	(21)	17-1/2	(443.5)

55.5 Pull test

55.5.1 Assembled samples shall remain secure when subjected to a direct pull of 150 pounds (667 N) for 5 minutes between the fitting and the tubing.

55.6 Repeated resistance test

55.6.1 Following the test required by 55.4.1 or 55.5.1, a sample assembly shall comply with 55.3.1.

55.7 Water spray test

55.7.1 The assembly shall provide a joint that will not permit the entrance of water when it is exposed for 1 hour to a water spray as described in 39.3 and 39.4.

55.8 Elastomeric materials test

55.8.1 A sleeve or ring of elastomeric material that is used to comply with 55.7.1 shall not show apparent deterioration after being conditioned for 70 hours in an air-circulating oven at 100 ±1°C (212 ±2°F).

55.8.2 A sleeve that fits over the outside of the tubing, and is exposed after installation on the tubing, shall comply with 51.8.2 after being conditioned in an air-circulating oven at 100 ±1°C (212 ±2°F).

55.8.3 A sleeve as described in 55.8.2 shall not show a decrease of more than 40 percent in tensile strength or elongation after immersion in mineral oil for 18 hours at 70 ±1°C (158 ±2°F).

55.9 Thermoplastic materials test

55.9.1 If the sleeve or ring is of thermoplastic material, an assembly made in accordance with 55.2.1 shall comply with 55.5.1 after conditioning in an air-circulating oven at 100 ±1°C (212 ±2°F) for 168 hours.

55.9.2 The test described in 55.9.1 is to be conducted on previously untested samples. If agreeable to those concerned, the test is to be conducted on the same samples used for the test described in 55.7.1. The samples are to be allowed to return to room temperature before the pull is applied.

56 Liquid-Tight Flexible Metal Conduit Fittings

56.1 General

56.1.1 Six samples of a liquid-tight flexible metal conduit fitting of each trade size are to be subjected to the tests specified in 56.2.1 – 56.5.1. Two additional samples of each trade size are to be subjected to the test specified in 56.6.1.

56.2 Assembly

56.2.1 Liquid-tight flexible metal conduit fittings are to be assembled to 3-ft (0.9-m) lengths of liquid-tight flexible metal conduit of the intended trade size in the manner recommended by the manufacturer.

56.3 Resistance test

56.3.1 When tested as described in Resistance Test, Section 41, the voltage drop across the connection between the box or plate and the liquid-tight flexible metal conduit shall not be more than 50 millivolts.

56.4 Pull test

56.4.1 A fitting for liquid-tight flexible metal conduit shall secure the conduit so that it will withstand a steady pull, as specified in Table 48.1, for 5 minutes so that the conduit cannot be readily removed by bending or flexing.

56.5 Repeated resistance test

56.5.1 Following the test required by 56.4.1, each test assembly shall comply with 56.3.1.

56.6 Oil spray test

56.6.1 After sample assemblies have been subjected to an oil spray for 30 minutes as described in 56.6.2, there shall not be evidence of oil inside the test enclosure.

56.6.2 A sample conduit and fitting, assembled in the intended manner to a liquid-tight enclosure and mounted in a fixed position are to be tested in accordance with 46.4.2. The ends of the conduit are to be sealed.

56.7 Elastomeric materials test

56.7.1 A sleeve or ring of elastomeric material that is used to comply with 56.6.1 shall not show apparent deterioration after being conditioned for 70 hours in an air-circulating oven at 100 ±1°C (212 ±2°F).

56.7.2 A sleeve as described in 56.7.1 that fits over the outside of the tubing, and is exposed after installation on the tubing, shall comply with 51.8.2 after conditioning as described in Elastomers, Section 4.

56.7.3 A sleeve as described in 56.7.2 shall not show a decrease of more than 40 percent in tensile strength or elongation after immersion in mineral oil for 18 hours at 70 ±1°C (158 ±2°F).

56.8 Thermoplastic materials test

56.8.1 If the sleeve or ring is of thermoplastic material, an assembly made in accordance with 56.2.1 shall comply with 56.4.1 after conditioning in an air-circulating oven at 100 ±1°C (212 ±2°F) for 168 hours.

56.8.2 The test described in 56.8.1 is to be conducted on previously untested samples. If agreeable to those concerned, the test is to be conducted on the same samples used for the test described in 56.6.1. The samples are to be allowed to return to room temperature before the pull is applied.

57 Liquid-Tight Flexible Nonmetallic Conduit Fittings

57.1 General

57.1.1 Six samples of a liquid-tight flexible nonmetallic conduit fitting of each trade size are to be subjected to the tests specified in 57.2.1 and 57.3.1. Two additional samples of each trade size are to be subjected to the test specified in 57.4.1 and two other additional samples are to be tested as specified in 46.7.1 – 46.7.4.

Exception: A fitting molded from a material complying with the requirements for ultraviolet light exposure and water exposure and immersion in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluation, UL 746C, need not be tested as specified in 46.7.1 – 46.7.3.

57.1.1 effective February 1, 1999

57.2 Assembly

57.2.1 Liquid-tight flexible nonmetallic conduit fittings are to be assembled to 3-ft (0.9-m) lengths of liquid-tight flexible nonmetallic conduit of the intended trade size in the manner recommended by the manufacturer.

57.2.1 revised October 21, 1998

57.3 Pull test

57.3.1 A fitting for liquid-tight flexible nonmetallic conduit shall secure the conduit so that it will withstand a steady pull, as specified in Table 48.1, for 5 minutes so that the conduit cannot be readily removed by bending or flexing.

57.4 Oil spray test

57.4.1 After sample assemblies have been subjected to an oil spray for 30 minutes as described by 57.4.2, there shall not be evidence of oil inside the test enclosure.

57.4.2 A sample conduit and fitting, assembled in the intended manner to a liquid-tight enclosure and mounted in a fixed position are to be tested in accordance with 46.4.2. The ends of the conduit are to be sealed.

57.5 Elastomeric materials test

57.5.1 A sleeve or ring of elastomeric material that is used to comply with 57.4.1 shall not show apparent deterioration after being conditioned for 70 hours in an air-circulating oven at 100 ±1°C (212 ±2°F).

57.5.1 revised October 21, 1998

57.5.2 A sleeve as described in 57.5.1 that fits over the outside of the conduit, and is exposed after installation on the conduit, shall comply with 51.8.2 after conditioning as described in Elastomers, Section 44.

57.5.3 A sleeve as described in 57.5.2 shall not show a decrease of more than 40 percent in tensile strength or elongation when immersed in mineral oil for 18 hours at 70 ±1°C (158 ±2°F).

57.6 Thermoplastic materials test

57.6.1 If the sleeve or ring is of thermoplastic material, an assembly made in accordance with 57.2.1 shall comply with 57.3.1 after conditioning in an air-circulating oven for 168 hours at 100 ±1°C (212 ±2°F).

57.6.2 The test described in 57.6.1 is to be conducted on previously untested samples. If agreeable to those concerned, the test is to be conducted on the same samples used for the test described in 57.4.1. The samples are to be allowed to return to room temperature before the pull is applied.

58 Liquid-Tight Fittings for Rigid Metal Conduit

58.1 A liquid-tight fitting for rigid metal conduit shall not become separated from the conduit when subjected to a bending test as described in 60.7.

58.2 After the fitting assembly has been subjected to the bending test, the assembly shall not permit the entrance of oil inside the fitting when subjected for 30 minutes to an oil spray as described in 46.4.2. The ends of the conduit are to be be sealed.

59 Tray-Cable Fittings

59.1 General

59.1.1 A tray-cable fitting intended for use:

a) In dry locations shall comply with sequence A of Table 59.1 excluding the Wet Locations Test.

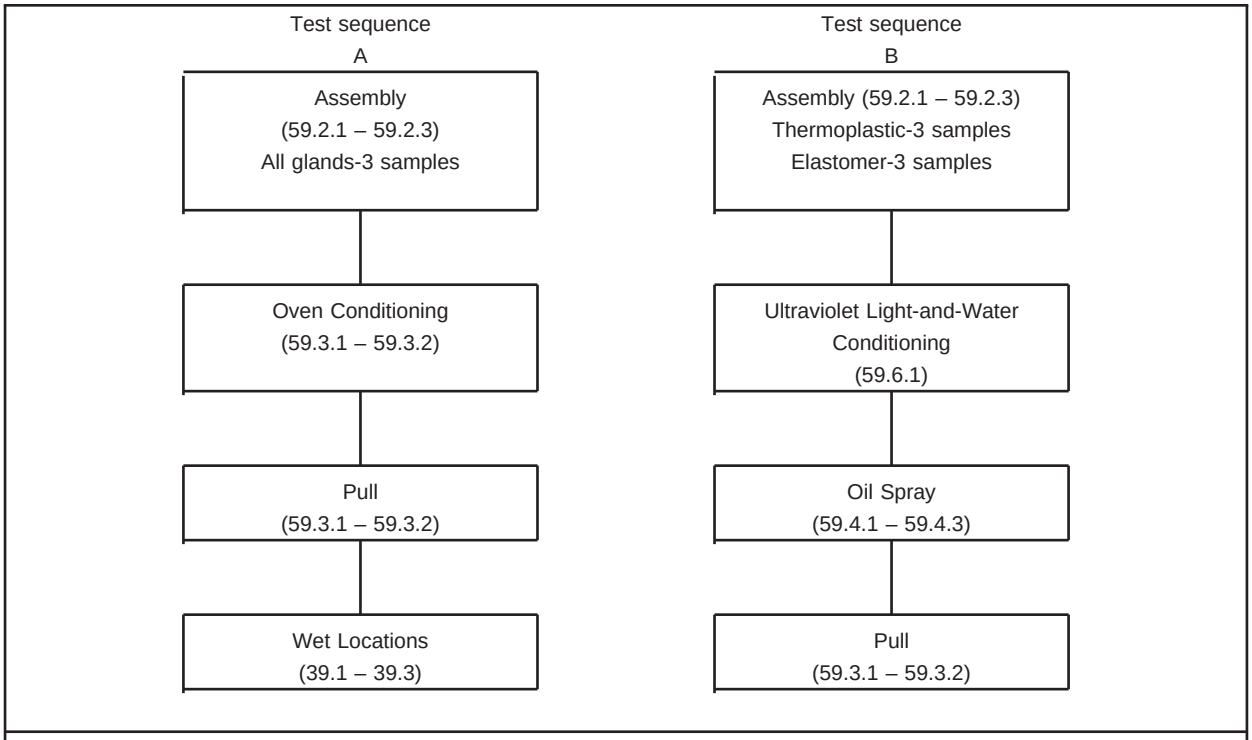
b) With sunlight-resistant tray cable shall comply with sequence A of Table 59.1 and with sequence B excluding the Oil Spray Test.

c) With sunlight-oil-resistant tray cable shall comply with sequences A and B of Table 59.1.

Each test sequence shall be conducted with the number of unconditioned test assemblies specified and in the order given.

Exception: A fitting that employs a metal gland need not comply with sequence B. See 59.7.2.

Table 59.1
Test sequences for tray-cable fittings



Note – Numbers in parentheses are the paragraph numbers of the requirements.

59.1.2 Two samples of the smallest elastomeric sealing gland in a line of fittings shall comply with Elastomers, Section 44, and two additional samples shall comply with Elastomers, Section 44, but the samples are to be conditioned as described in 46.7.2 and 46.74.

59.2 Assembly test

59.2.1 A fitting gland shall be capable of being assembled in accordance with 59.2.2 without adverse deformation of the fitting gland or its components.

Exception: A gland that deforms as part of its intended function is acceptable.

59.2.2 Three samples of each trade size of tray-fitting shall be tested with a gland that will accomodate the smallest cable specified for use with the fitting. The fitting is to be assembled to a minimum 1-foot (305 mm) length of tray-cable using a torque value specified by Table 35.1. A gland of one size that is used in fittings of two or more trade sizes, such as 3/8 and 1/2 (13 and 16) trade size, need only be tested once. Not less than one gland size is to be tested for each trade size of fitting. The tray cables and fittings used for the assemblies are to be intended for use in the same location; for example, a sunlight-resistant fitting is to be assembled to sunlight-resistant tray cable. These sample assemblies are to be used for the test sequences specified in 59.1.1.

59.2.3 A fitting intended for use with a range of tray-cable sizes is to be assembled to the largest overall diameter specified by the manufacturer that the fitting accommodates. Tolerances of ±0.020 inch (±0.51 mm) for cable not more than 3/4 inch (19.1 mm) in diameter and ±0.030 inch (±0.76 mm) for cable more than 3/4 inch in diameter apply.

Exception: A fitting that obviously accommodates the largest size tray cable is not required to be assembled.

59.2.3 revised October 21, 1998

59.3 Pull test

59.3.1 A cable shall not be displaced more than 1/8 inch (3.2 mm), measured from the plane of the test enclosure to which the fitting is to be secured, when the cable is subjected to the pull test described in 59.3.2.

59.3.2 The assembly is to be mounted in a fixed position and a direct pull of 50 lbf (222 N) is to be applied for 5 minutes between the end of the cable and the outside face of the fitting in a direction along the axis of the fitting.

59.4 Oil Spray test

59.4.1 After an assembly has been conditioned as described in 59.4.2, and subsequently subjected for 30 minutes to an oil spray as required by 59.4.3, there shall not be oil inside the enclosure.

59.4.2 A fitting assembly is to be immersed for 24 hours in Oil IRM 902:

a) At 60°C (140°F) if marked ″Oil Resistant I,″ or

b) At 75°C (167°F) if marked ″Oil Resistant II.″

The assembly is to be immersed so that the major axis of the fitting is vertical with the hub end up and the complete sealing gland is below the surface of the oil.

59.4.3 After being conditioned as described in 59.4.2, each sample is to be subjected to an oil spray as described in 46.4.2.

59.5 Oven conditioning

59.5.1 Thermoplastic material

59.5.1.1 A fitting that is not marked for use with a specific cable type or temperature rating is to be conditioned in an air-circulating oven for 168 hours at 70 ±1°C (158 ±2°F). For a fitting that is marked for a rating higher than 60°C (140°F), the oven temperature is to be 10 ±1°C (18 ±2°F) above the rated temperature of the assembly. The marking shall be in accordance with 78.3.

59.5.2 Elastomeric material

59.5.2.1 An assembly that employs parts made of elastomeric material shall not show any visible deterioration after being conditioned for 70 hours in an air-circulating oven at 100 ±1°C (212 ±2°F).

59.6 Ultraviolet-light and water conditioning

59.6.1 An assembly that employs parts made of thermoplastic material shall not show any visible deterioration after being conditioned as described in 46.7.2 and 46.7.4.

Exception: The conditioning is not required for a fitting that, when assembled to tray cable as required by 59.2.2, encloses at least 95 percent of the surface area of the gland. When determining surface area of the gland, that portion of the gland that bears directly against the cable in an assembled sample is not to be considered as part of the surface area.

59.7 Fittings that employ a metal gland

59.7.1 In addition to the test sequences required by 59.1.1, a tray-cable fitting that employs a metal gland or a direct bearing metal clamp shall comply with 59.7.2 – 59.7.5. Three sample assemblies without prior conditioning are to be used for these tests. If the fitting is intended for a range of tray-cable sizes, the largest size tray cable that the fitting will accommodate is to be used.

59.7.2 When a fitting that employs a metal gland or clamp is assembled to tray cable and conditioned as described in 59.7.3, the cable shall not be damaged. When the fitting and cable assembly are subsequently subjected to the test described in 59.7.4, the cable insulation shall not break down.

59.7.3 A fitting is to be assembled to tray cable using a torque of 130 percent of the value specified in Table 35.1. If the fitting is damaged using a 130-percent torque but the tray cable is not damaged, a new fitting is to be assembled to the cable using the applicable torque value specified in Table 35.1. The fitting and cable are then to be conditioned in an air-circulating oven for 168 hours at the temperature specified in Table 59.2.

Table 59.2
Oven temperature

Temperature rating of cable		Oven temperature ±1°C (±2°F)	
°C	°F	°C	°F
60	140	100	212
75	167	121	250
90	194	136	277

59.7.4 After the assembly has been conditioned as described in 59.7.3, the cable conductors are to be electrically connected together. A 60-hertz essentially sinusoidal potential as specified in Table 59.3 is then to be applied for 1 minute between the cable conductors and any metal of the fitting.

Table 59.3
Test potentials

Size of conductor, AWG or Kcmil (mm^2)		Test potential, volts
14 – 10	(0.82 – 5.3)	1500
8 – 2	(8.4 – 33.6)	2000
1 – 4/0	(42.4 – 107.2)	2500
250 – 500	(110 – 253)	3000
550 – 1000	(254 – 506)	3500

59.7.5 Samples of an oil-resistant fitting assembly, after being subjected to the tests specified in 59.7.2 – 59.7.4, shall comply with 59.4.1.

60 Threadless Fittings

60.1 Assembly for deformation test

60.1.1 A fitting for electrical metallic tubing, when installed as intended, shall not decrease the internal diameter of the tubing by more than 15 percent and shall not deform the end of the tubing when installed with the tubing displaced 1/4 inch (6.4 mm) from the end stop.

60.1.2 To determine whether a fitting complies with 60.1.1, one sample is to be assembled to a length of tubing in the intended manner, and another sample is to be assembled to a length of tubing with the tubing displaced 1/4 inch (6.4 mm) from the end stop. A slotted or unslotted bolthead screw is to be tightened with a torque of 160 lbf-in (18.1 N•m). All other screws are to be torqued in accordance with 35.4. After assembly in each case, the tubing shall permit passage of a plug gauge having a diameter specified in Table 60.1.

60.1.2 effective February 1, 1999

Table 60.1
Diameter of plug gauge

Table 60.1 revised October 21, 1998

Trade size of electrical metallic tubing	(metric designator)	Diameter of plug gauge,	
		in	(mm)[a]
3/8	(12)	0.419	(10.64)
1/2	(16)	0.529	(13.44)
3/4	(21)	0.700	(17.78)
1	(27)	0.892	(22.66)
1-1/4	(35)	1.173	(29.79)
1-1/2	(41)	1.369	(34.77)
2	(53)	1.757	(44.63)
2-1/2	(63)	2.321	(58.95)
3	(78)	2.853	(72.47)
3-1/2	(91)	3.269	(82.78)
4	(103)	3.684	(93.57)

[a] Tolerance, ±0.001 inch (0.03 mm)

60.2 Assembly test

60.2.1 A threadless fitting provided with a tightening nut is to have the tightening torque applied by means of an open, box, or crescent wrench. A nut that is not provided with flats for use with such wrenches is to be tightened by means of a pipe wrench in accordance with Method of Assembly, Section 35. A slotted or unslotted bolthead screw is to be torqued to 160 lbf-in (18.1 N•m).

60.2.1 revised October 21, 1998

60.2.2 A fitting shall be subjected to a resistance test, a bending test, a repeated resistance test, and a pullout test, in that order. The same samples shall be used throughout and shall not be conditioned in any way during the tests.

60.3 Resistance test

60.3.1 When subjected to the Resistance Test, Section 41, the voltage drop shall not be more than 10 millivolts.

60.4 Bending test

60.4.1 A threadless fitting shall not become separated from the conduit or tubing when subjected to the bending test described in 60.4.2.

60.4.2 For the test, on an assembly with:

a) A coupling, the assembly, with the coupling at the center is to be placed on supports 30 inches (760 mm) apart as illustrated in Figure 60.1.

b) Other than a coupling, the supports are to be separated by an additional distance that is equal to the distance between the center of the assembly and the end of the conduit or tubing in the box or assembly thereby providing the required bending moment on the sample.

The load specified for the fitting in Table 60.2 is to be suspended from the center of the fitting for 60 seconds during which time the fitting and the length of conduit are to be rotated through one complete revolution about the major axis of the assembly.

Figure 60.1
Bending test arrangement

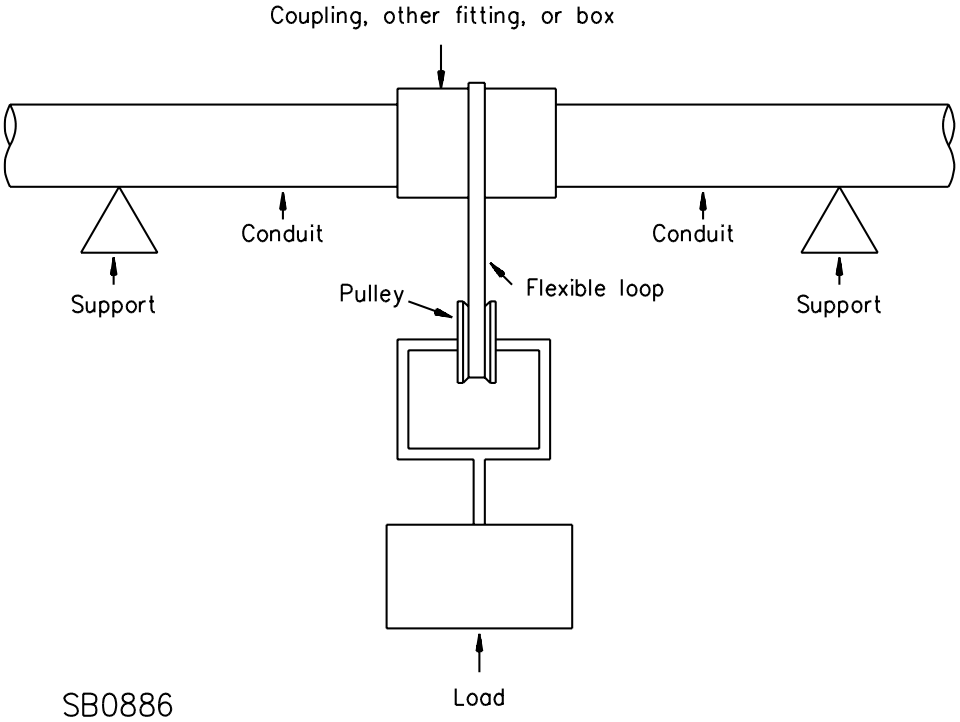


Table 60.2
Bending load, and pull force for threadless fittings

Table 60.2 revised October 21, 1998

Trade size of fitting	(metric designator)	Bending load, lb (kg)				Pull force for EMT, IMC, or rigid conduit,	
		EMT		IMC and Rigid Conduit		lbf	(N)
3/8	(12)	15	(67)	30	(133)	200	(890)
1/2	(16)	20	(89)	60	(267)	300	(1334)
3/4	(21)	35	(156)	80	(356)	450	(2002)
1	(27)	50	(272)	120	(534)	600	(2668)
1-1/4	(35)	75	(333)	160	(712)	700	(3114)
1-1/2	(41)	85	(378)	160	(712)	800	(3559)
2	(53)	110	(489)	160	(712)	1000	(4450)
2-1/2	(63)	110	(489)	160	(712)	1000	(4450)
3	(78)	110	(489)	160	(712)	1000	(4450)
3-1/2	(91)	110	(489)	160	(712)	1000	(4450)
4	(103)	110	(489)	160	(712)	1000	(4450)

60.5 Repeated resistance test

60.5.1 After the fitting has been subjected to the bending test described in 60.4.2, the voltage drop shall not be more than 15 millivolts in a repeated resistance test conducted as described in Resistance Test, Section 41.

60.6 Pull test

60.6.1 A threadless fitting shall withstand for 1 minute without damage and without pulling loose from the raceway a direct pull of the value specified in Table 60.2.

60.7 Wet-locations test

60.7.1 A threadless fitting intended for use in wet locations shall comply with the requirements in Wet-Locations Test, Section 39.

60.8 Concrete-tightness test

60.8.1 A threadless fitting intended for use in concrete shall comply with Concrete-Tightness Test, Section 40, or have a carton marking in accordance with Table 84.1.

61 Mineral-Insulated Cable Fittings

61.1 General

61.1.1 A fitting for mineral-insulated cable shall comply with the tests prescribed in 61.2.1 – 61.8.3. Other than specified in 61.5.2 and 61.5.5, a minimum of six samples of each design are to be tested. The test sequence is to be resistance, bend, and pull tests. The same samples are to be used for all three tests without conditioning between tests.

61.1.1 revised October 21, 1998

61.1.2 In view of the number of combinations of conductor size and number of conductors per cable available in mineral-insulated metal-sheathed cable, it is not necessary that fittings for each combination be tested.

61.2 Resistance test

61.2.1 When subjected to Resistance Test, Section 41, the voltage drop shall not be more than 10 millivolts. One of the two points mentioned in 41.2 is to be on the cable sheath.

61.3 Bend test

61.3.1 The assembly of the fitting and cable shall not loosen when the cable is tested as described in 61.3.2.

61.3.2 The fitting is to be connected to a solidly mounted box or other connection point with the axis of a 30-inch (760-mm) length of cable in line with the axis of the fitting. The cable is to be bent around a wooden form having a radius equal to five times the diameter of the cable. The cable is to be grasped at a point 2 feet (610 mm) from the fitting and bent in one direction so that a 90-degree bend is formed. The cable is then to be bent back 180 degrees in the opposite direction, and then back to its original position in line with the axis of the fitting.

61.4 Pull test

61.4.1 The assembly of the fitting and cable shall remain secure when a direct pull of 150 lbf (667 N) is applied for 5 minutes between the cable and the fitting.

61.5 Insulation resistance test

61.5.1 When tested as described in 61.5.2, the insulation resistance shall not be less than 1,000,000 ohms at the end of 3 hours of immersion, and not less than 250,000 ohms at the end of 720 hours of immersion.

61.5.2 Two 11-foot (3.35-m) lengths of cable are to be stripped of the outer sheath and mineral fill for 6 inches (152 mm) at each end. A fitting with insulating sleeving is to be installed at one end of each cable. The end of the cable without the fitting is to be sealed so that the mineral insulation will not absorb moisture from the air. The cable with fitting is then to be immersed in ordinary tap water at room temperature with the bared ends of the insulated conductors at the end with the fitting, and the bared conductors of the end without the fitting above the water. The insulation resistance between conductors and between the conductors and the outer cable sheath is to be measured:

a) Before the cable fitting has been installed,

b) After the fitting has been installed but before the assembly has been immersed in water,

c) After the assembly has been immersed in water for 3 hours, and

d) After the assembly has been immersed in water for 720 hours.

61.5.3 If the cable is coiled for the test described in 61.5.2, the inside diameter of the coil is not to be less than ten times the outside diameter of the cable.

61.5.4 When tested as described in 61.5.5, the insulation resistance of a 2-conductor, No. 14 AWG (2.1 mm^2) or smaller cable and a fitting provided with a means for sealing the end of the cable shall be at least 250,000 ohms after being immersed for 336 hours in water at a temperature of 50 ±1°C (122 ±2°F).

61.5.5 Two 6-foot (1.38-m) lengths of the cable are to be used. The outer sheath and mineral fill is to be stripped from approximately 30 inches (760 mm) at each end and a fitting installed at each end of the remaining 1 foot (300-mm) center section. The bared conductors are to be insulated with approximately 30 inches of the flexible tubing supplied with the fitting. The entire assembly, excluding for the bared ends of the conductors at the end of the flexible tubing, is to be immersed under a 1-foot head of ordinary tap water maintained at 50 ±1°C (122 ±2°F).

61.6 Dielectric voltage-withstand test

61.6.1 When tested as described in 61.6.2, the cable and fitting assemblies used in the insulation resistance tests described in 61.5.1 – 61.5.5 shall withstand without electrical breakdown for 1 minute an alternating potential of 1500 volts.

61.6.2 The test is to be conducted on the samples immediately following the insulation resistance test described in 61.5.2 – 61.5.5. The potential is to be applied first between conductors and then between all conductors electrically connected and the outer cable sheath. Samples are to be removed from the water for this test, and are to be wiped dry on the outside. The applied potential is to be increased from zero to 1500 volts as rapidly as is consistent with its value being correctly indicated by a voltmeter.

61.7 Wet-locations test

61.7.1 A fitting intended for use with a separate sealing fitting, when assembled as intended to mineral-insulated, metal-sheathed cable, shall not permit the entrance of water when tested as described in 39.3 and 39.4. Previously untested samples are to be used for this test.

61.8 Oven conditioning test

Thermoplastic materials

61.8.1 Parts provided for sealing the end of the cable and for insulating the cable conductors shall not show apparent deterioration and shall not adversely affect each other as a result of the conditioning specified in 61.8.2.

61.8.2 The complete assembly, including any sealing compound and insulating tubing, is to be conditioned in an air-circulating oven for 1440 hours at 97±1°C (207±2°F).

Elastomic materials

61.8.3 Internal elastomeric parts of a fitting shall not show apparent deterioration after conditioning as described in Elastomers, Section 44.

62 Locknuts and Nipples

62.1 For each trade size of a fitting employing a locknut, the voltage drop between a sheet-metal surface and the fitting, assembled as described in 62.2, shall not be more than 10 millivolts when the assembled fitting is subjected to Resistance Test, Section 41.

62.2 Six samples of a fitting employing a locknut are to be installed through a knockout in a sheet-metal surface. Three samples each are to be assembled to:

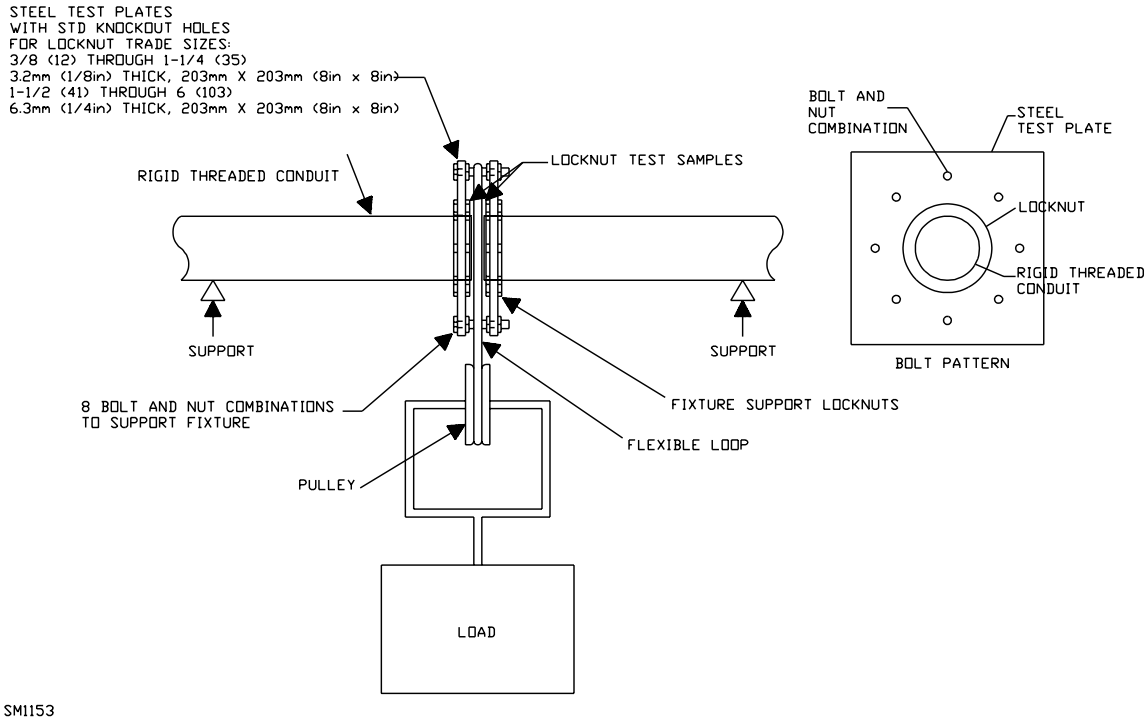
a) steel that is 0.026 and 0.075 inch (0.66 and 1.91 mm) thick, and

b) aluminum that is 0.032 and 0.091 inch (0.81 and 2.31 mm) thick.

A locknut is to be hand-tightened and then further tightened 1/4 turn with a hammer and a standard screw driver or by an equivalent method.

62.3 With reference to the Exception to 30.1, samples of a conduit locknut that is thinner than specified in Table 30.1 are to be assembled to threaded conduit and steel plates. The steel plates are to be assembled as illustrated in Figure 62.1. Each assembly is to be subjected to the sequence of tests in 60.2.2.

Figure 62.1
Locknut bending test



62.4 With reference to the Exception to 30.3, a conduit locknut having an incomplete or nonstandard thread shall freely thread onto conduit with standard National Pipe Thread (NPT) as intended without damage to the locknut or the threads of the conduit on which it is assembled.

63 Insulating Bushings

63.1 General

63.1.1 The conditioning temperature specified Table 63.1 is the rated temperature of the polymeric material plus 15°C (27°F) plus 2 percent of the rated temperature on the absolute scale.

63.2 Thermal conditioning test

63.2.1 The inside diameter of the throat of an insulating bushing shall not be reduced to a dimension less than 90 percent of the minimum value specified in Table 30.1 as a result of conditioning in an air-circulating oven for 168 hours at the temperature specified in Table 63.1. After the conditioning, the samples are to be allowed to rest at room temperature but not less than 4 hours. The inside diameter is then to be measured.

Table 63.1
Temperature for conditioning polymeric materials

Temperature rating of device,		Conditioning temperature,	
°C	(°F)	°C	(°F)
90	(194)	112	(234)
105	(221)	128	(262)
150	(302)	173	(343)
200	(392)	225	(437)

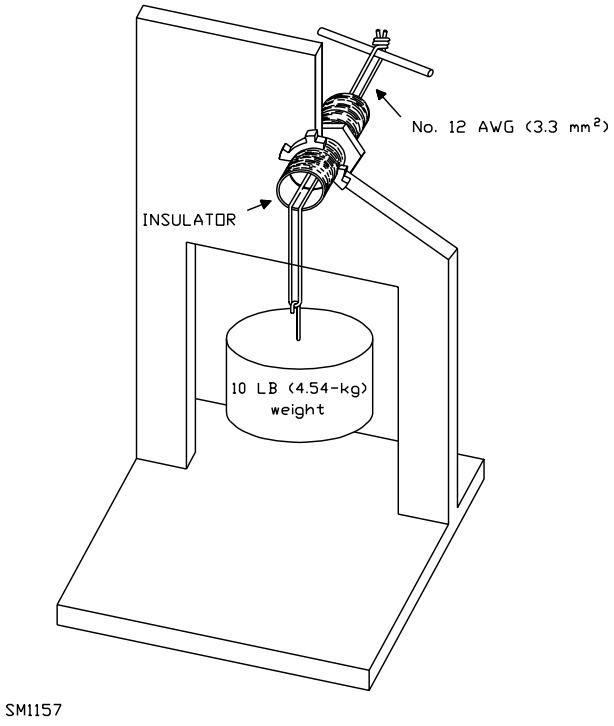
63.3 Heat distortion test

63.3.1 The test samples shall not show evidence of cracking or softening so as to expose metal or form an incomplete insulating throat. An insulating bushing is to be mounted on tubing or conduit as intended. The tubing or conduit is to be mounted horizontally as illustrated in Figure 63.1 and placed in an air-circulating oven at the temperature specified in Table 63.1. A loop of No. 12 AWG (3.3 mm^2) bare, solid copper conductor is to be brought through the open end of each section of tubing or conduit. A 10-lb (4.54-kg) weight is to be suspended from each loop of conductor. The test is to be continued for 72 hours. Immediately after the 72 hours, the weights are to be removed and the samples allowed to cool to room temperature for not less than 4 hours before being handled and examined.

63.4 Drop test

63.4.1 The samples conditioned as described in 63.3.1 are to be dropped onto a hardwood surface from a height of 1 foot (305 mm). The throat or throat liner shall not be dislodged by the impact.

Figure 63.1
Insulated bushing test setup



64 Service-Entrance Heads

64.1 Metallic

64.1.1 Assembly test

64.1.1.1 A metallic service-entrance head intended for rigid metal conduit, intermediate metal conduit, or electrical metallic tubing is to be installed as intended on each conduit or tubing to determine that the end stop will be effective as a bushing for the conductors. The edge of the stop shall extend at least to the inside edge of either conduit or tubing around the entire circumference.

64.1.2 Resistance test

64.1.2.1 A metallic service-entrance head of the type intended to be clamped to rigid metal conduit, intermediate metal conduit, or electrical metallic tubing shall not have a voltage drop of more than 10 millivolts when subjected to Resistance Test, Section 41. One of the two points mentioned in 41.2 is to be on the fitting 1/16 inch (1.6 mm) from the point at which the conduit or tubing enters the fitting.

64.1.3 Wet-locations test

64.1.3.1 A metallic service-entrance head shall be tested in accordance with the Wet-Locations Test, Section 39.

64.1.4 Heat distoration test

64.1.4.1 A metallic service-entrance head provided with a nonmetallic bushing for conductor entry shall comply with Heat Distortion Test, Section 101.6.

64.1.4.1 revised October 21, 1998

64.2 Nonmetallic

64.2.1 A nonmetallic service-entrance head shall comply with Nonmetallic Service-Entrance Heads, Section 101.

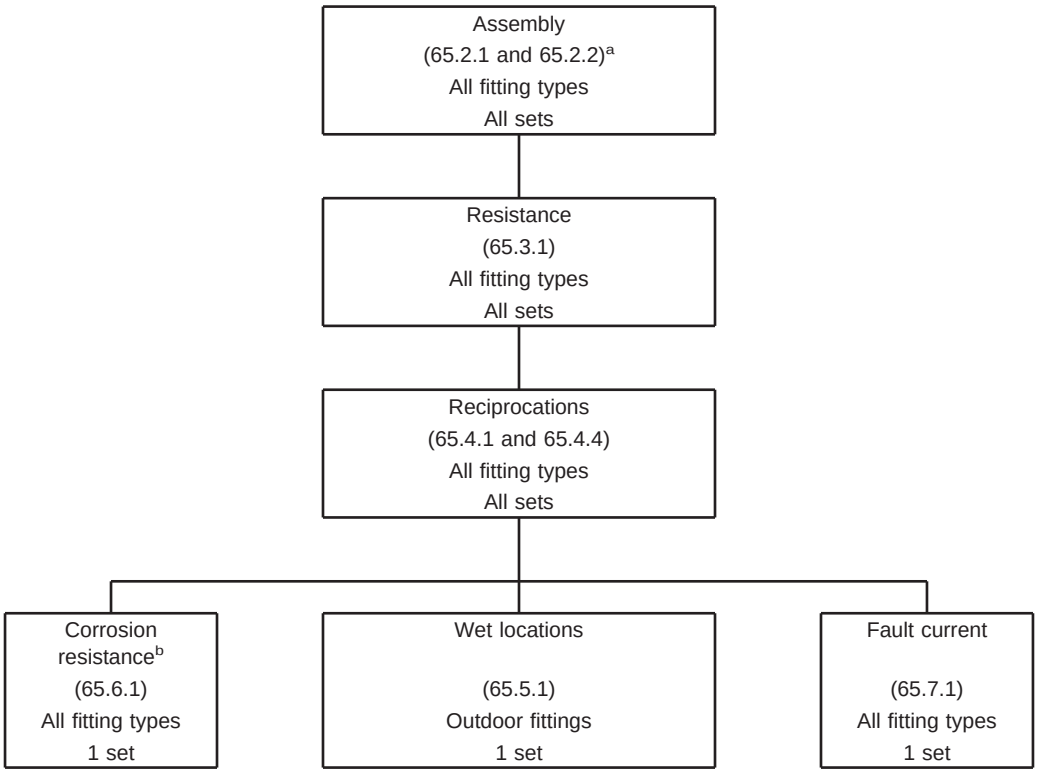
64.2.1 revised October 21, 1998

65 Expansion Fittings

65.1 General

65.1.1 An expansion fitting assembled to conduit as described in 65.2.1 and 65.2.2 is to be subjected to the test program illustrated in Table 65.1 in the order shown. See 65.8.1.

Table 65.1
Expansion fitting test program



[a] Numbers in parentheses are paragraph numbers of requirements.

[b] Test to be conducted with set of fittings that are assembled to zinc-coated ferrous-metal conduit.

65.2 Assembly test

65.2.1 For the tests in this section, a set of fittings is to consist of the smallest, the largest, and one intermediate trade size in a line of fittings, and any additional trade size that employs a construction or feature unique to that trade size.

65.2.2 For all lines of expansion fittings, one set of fittings is to be assembled in the intended manner to zinc-coated ferrous-metal conduit having the dimensions specified in Table 65.2, and one set is to be assembled to rigid nonferrous-metal conduit. If the fittings are intended for outdoor use, one additional set is to be assembled to rigid nonferrous-metal conduit.

Table 65.2
Dimension of zinc-coated ferrous-metal conduit for assembly

Trade size of conduit,	(metric designator)	Outside diameter[a],	
		in	(mm)
1/2	(16)	0.840	(21.3)
3/4	(21)	1.050	(26.7)
1	(27)	1.315	(33.4)
1-1/4	(35)	1.660	(42.2)
1-1/2	(41)	1.900	(48.3)
2	(53)	2.375	(60.3)
2-1/2	(63)	2.875	(73.0)
3	(78)	3.500	(88.9)
3-1/2	(91)	4.000	(101.6)
4	(103)	4.500	(114.3)
5	(129)	5.563	(141.3)
6	(155)	6.625	(168.3)

[a] Tolerances are plus 0.020 in (plus 0.508 mm), minus 0.000 in (minus 0.000 mm).

65.3 Resistance

65.3.1 A fitting, assembled as described in 65.2.1 and 65.2.2, shall not have a voltage drop of more than 10 millivolts as a result of the tests described in Resistance Test, Section 41.

Exception: An expansion fitting intended for use with an external bonding jumper need not be subjected to the Resistance Test. See 83.1.

65.4 Reciprocations test

65.4.1 After being conditioned as described in 65.4.2 and 65.4.3 and subjected to Resistance Test, Section 41, an expansion fitting shall not have a voltage drop of more than 15 millivolts.

Exception: An expansion fitting intended for use with an external bonding jumper need not be subjected to the resistance test. See 82.1

65.4.2 Each expansion fitting assembled to rigid nonferrous-metal conduit and zinc-coated ferrous-metal conduit as required by 65.2.1 and 65.2.2 is to be subjected to 500 cycles of reciprocations. One cycle of reciprocation is to consist of a 3/4-inch (19.1-mm) insertion of the conduit into the fitting, followed by withdrawal of the conduit from the fitting to its original position. The speed of insertion and withdrawal is not to exceed 1/2 inch (12.7 mm) per minute.

65.4.3 After 500 cycles of reciprocation, each sample is to be subjected to Resistance Test, Section 41. If the millivolt drop shows an increase of 5 millivolts or more, but does not exceed the 15-millivolt requirement in 65.4.1, the total number of reciprocations is to be increased to 750 cycles. If the millivolt drop shows an increase of 5 millivolts, the total number of reciprocations is to be increased to 1000 cycles to determine compliance with 65.4.1. See 65.4.4.

65.4.4 If more than 500 cycles of reciprocations are required to determine if a fitting complies with the 15-millivolt requirement in 65.4.1, additional samples are to be assembled in accordance with 65.2.1 and 65.2.2, and subjected to 500 cycles of reciprocation. This second group of samples is then to be used for determining compliance with 65.5.1 – 65.7.1.

65.5 Wet-locations test

65.5.1 A set of outdoor expansion fittings that is assembled to conduit shall comply with Wet-Locations Test, Section 39.

65.6 Corrosion resistance test

65.6.1 As a result of the 500 cycles of reciprocation conditioning specified in 65.4.2 or 65.5.4, each sample of a fitting that is assembled to zinc-coated ferrous metal conduit shall not remove more than 25 percent of the coating used for protection against corrosion on the conduit in the area of reciprocation contact.

65.6.2 The coating thickness on the conduit at the area of reciprocation contact considered to have lost the most material is to be measured using the test method described in Metallic-Coating-Thickness Test, Section 38. To determine a reference measurement for total coating thickness, the area not subjected to reciprocations or damage that is directly adjacent to the area previously measured is also to be measured using the test method described in Section 38.

65.7 Fault current test

65.7.1 A set of expansion fittings shall withstand currents specified in Table 42.1 without damage. The same zinc-coated ferrous metal conduit used in the reciprocations conditioning is to be used in this test.

65.8 Galvanic compatibility test

65.8.1 For an outdoor expansion fitting that has dissimilar metals, such as copper and aluminum, in intimate contact when assembled to conduit shall be subjected to a comparative investigation to determine that it has galvanic compatibility and resistance to corrosion at least equivalent to that of a zinc-coated malleable-iron fitting having a copper slip-ring as assembled to zinc-coated rigid-steel conduit. Among the factors taken into consideration when judging the acceptability of the fitting are exposure to salt spray, moist carbon dioxide-sulphur dioxide-air mixtures, and warm humid air.

66 Short Radius Conduit Bodies

66.1 Wet-locations test

66.1.1 A short radius conduit body intended for use in wet-locations is to be assembled to a raceway system in accordance with 66.1.2. The assembly shall comply with Wet-Locations Test, Section 39.

Revised 66.1.1 effective February 1, 1999

66.1.2 Two previously untested samples of each trade size are to be assembled to 6-inch (152-mm) minimum lengths of raceway and tested in accordance with Wet-Locations Test, Section 39. Threaded conduit is to be tightened as specified in 47.2.

66.2 relocated as 66.1.2 effective February 1, 1999

66.2 Relocated as 66.1.2 October 21, 1998

66.2 Gasket test

66.2.1 An elastomeric gasket shall comply with Elastomers, Section 44. A gasket made of an expanded (foam) closed-cell material shall comply with Compression/Set Test, Section 43. A gasket made of any other type of nonmetallic material shall comply with the Standard for Gaskets and Seals, UL 157.

66.3.1 relocated as 66.2.1 effective February 1, 1999

66.3 Relocated as 66.2 October 21, 1998

66.3.1 Relocated as 66.2.1 October 21, 1998

67 Pulling, Strain Relief, and Support Grips

67.1 Pull test

67.1.1 A pulling grip or support grip is to be tested as described in 67.1.2 without breaking the grip or damage to the cable, conduit, or cord. The grip shall withstand for 15 minutes a direct pull equal to 67 percent of its calculated break strength specified by the manufacturer. A grip made of a nonmetallic material is to be tested as described in 67.2.1.

Revised 67.1.1 effective February 1, 1999

67.1.2 Three grips are to be assembled to rods of a specified diameter. The diameter of the rod is to be determined by using the lower part of the specified cable diameter range of the grip. For a grip having a range up to 0.50 inch (12.7 mm) diameter, a steel rod is to be used. For a grip having a range above 0.50 inch diameter, an aluminum rod is to be used.

67.1.2 effective February 1, 1999

67.1.3 A strain relief grip and an associated fitting assembled to cable, conduit, or cord shall withstand a direct pull for 5 minutes without breaking or damaging the fitting, cable, conduit, or cord. The pull force between the fitting and the cable, conduit, or cord is to be the same pull force specified in this Standard for the fitting without the grip.

Revised 67.1.3 effective February 1, 1999

67.2 Bend test

67.2.1 After conditioning in an air-circulating oven for 168 hours at the temperature specified in Table 63.1, there shall not be any cracking of a nonmetallic grip wrapped for one full turn around the applicable mandrel specified in Table 67.1. The tension applied to the sample is to cause the sample to just conform to the curved surface of the mandrel.

67.2.1 effective February 1, 1999

Table 67.1
Mandrel diameter

Table 67.1 effective February 1, 1999

Overall diameter of grip, in (mm)		Diameter of mandrel, in (mm)	
0 – 0.300	(0 – 7.62)	1.250	(31.75)
0.301 – 0.375	(7.65 – 9.53)	1.500	(38.10)
0.376 – 0.425	(9.55 – 10.80)	1.750	(44.45)
0.426 – 0.500	(10.82 – 12.70)	2.000	(50.80)
0.501 – 0.550	(12.73 – 13.97)	2.250	(57.15)
0.551 – 0.625	(14.00 – 15.88)	2.500	(63.50)
0.626 – 0.750	(15.90 – 19.05)	3.000	(76.20)
0.751 – 0.850	(19.08 – 21.59)	3.500	(88.90)
0.851 – 0.950	(21.62 – 24.13)	4.000	(101.60)
0.951 – 1.050	(24.16 – 26.67)	4.500	(114.30)
1.051 – 1.250	(26.70 – 31.75)	5.000	(127.00)
1.251 – 1.500	(31.78 – 38.10)	6.000	(152.40)
1.501 – 1.750	(38.13 – 44.45)	7.000	(177.80)
1.751 – 2.000	(44.48 – 50.80	8.000	(203.20)

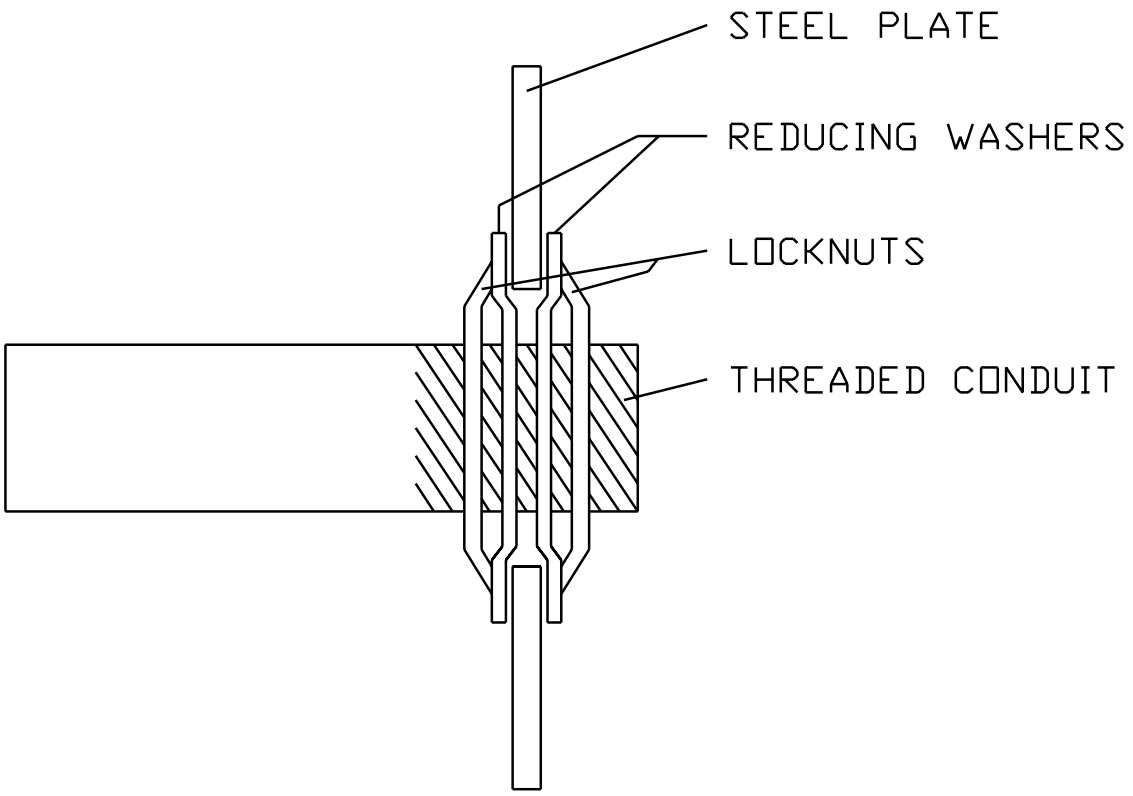
68 Reducing Washers

68.1 A pair of reducing washers, assembled to threaded conduit and unpainted steel plates as illustrated in Figure 68.1, shall not have a voltage drop of more than 10 millivolts as a result of the test described in Resistance Test, Section 41, and shall comply with Current Test, Section 42.

68.1 effective February 1, 1999

Figure 68.1
Reducing washer current and resistance test setup

Figure 68.1 effective February 1, 1999



SM1155

MARKINGS

ALL FITTINGS

69 General

69.1 All carton and product markings shall be legible. All markings on the product shall be permanent. The following types of markings or the equivalent are considered permanent:

a) Etched,

b) Molded,

c) Die stamped,

d) Paint stenciled, or

e) Indelibly stamped on a pressure sensitive label secured by adhesive and complying with the Standard for Marking and Labeling Systems, UL 969.

69.1 effective February 1, 1999

69.2 If there is not enough space on the carton or carton label, information marked on an information sheet packed in the smallest unit shipping carton is acceptable.

69.3 A fitting shall be marked with the manufacturer's name, trademark, or other descriptive marking identifying the organization responsible for the product. The fitting shall also be marked with a catalog number or an equivalent designation. The marking shall be located where it will be readily visible after the fitting has been installed.

Exception: The catalog number or its equivalent designation marked on the smallest unit shipping carton is acceptable.

69.4 If a manufacturer produces or assembles fittings at more than one factory, each finished product shall have a distinctive marking to identify it as a product of a particular factory.

69.5 A fitting intended for use in environmental conditions identified in the Standard for Enclosures for Electrical Equipment, UL 50, shall be marked on the fitting or smallest unit shipping carton in which it is packaged with a Type number, for example, ″Type___,″ indicating the environmental conditions for which it is acceptable. A fitting that complies with the requirements for more than one Type is acceptable when marked with multiple designations.

69.6 A fitting intended for use with wire pulling compound shall be marked on the fitting or carton ″For use with wire pulling compound″ or equivalent wording.

69.6 effective February 1, 1999

69.7 A fitting provided without a locknut and intended for securement to a threaded hub shall have a marking on the smallest unit shipping carton ″For securement to a threaded hub only″ or the equivalent wording.

69.7 effective February 1, 1999

70 Conduit Bodies

70.1 A conduit body that has been investigated for a specific combination of conductors shall be marked with the maximum number and maximum size of the conductors for which it is intended. See Exception No. 2 to 15.3, Exception to 15.4, and Exception No. 1 to 15.5.

71 Flexible Cord Fittings

71.1 Both a liquid-tight fitting for cord and the gland of a fitting that is intended for use in an environment requiring a relative thermal index greater than 60°C (140°F) shall be clearly marked with the applicable temperature rating.

71.2 The acceptable outside diameter range of cord for a flexible cord fitting shall be marked on the fitting or smallest unit shipping carton.

71.2 effective February 1, 1999

72 Armored Cable Fittings

72.1 A fitting for armored cable that is not rated for a No. 14 AWG (2.1 mm^2), 2-wire cable shall be marked for the cable trade size and nominal diameter of the smallest size and the trade size of the largest size cable for which it is rated. A fitting for armored cable that is rated for No. 14 AWG (2.1 mm^2), 2-wire cable shall be marked with the trade size and nominal diameter of the No. 14 AWG (2.1 mm^2), 2-wire cable and the trade size of the largest size cable for which it is rated. The marking shall be located on:

a) The fitting, or

b) The smallest unit shipping carton in which the fitting is packed.

Revised 72.1 effective February 1, 1999

72.2 An armored cable bushing shall be marked with the bushing size. The smallest unit shipping carton of armored cable bushings shall be marked with the number of bushings, size of bushing, and size or sizes of armored cable for which it will be used.

72.2 effective February 1, 1999

73 Metal-Clad Cable Fittings

73.1 The carton for a fitting for metal-clad cable shall be marked with the type of cable and range of cable diameters for which it is acceptable. The following abbreviations marked in lieu of the complete name of the type of cable is acceptable: MCI for cable with interlocking armor, MCS for continuous smooth sheath cable, MCC for continuous corrugated sheath cable, and FLAT for flat cable.

73.2 A fitting for metal-clad cable shall be marked ″For use in dry locations only″ or the equivalent.

Exception No. 1: A fitting that complies with 51.6.1 need not be marked.

Exception No. 2: If a fitting assembly is small, it is acceptable to mark the smallest unit shipping carton.

74 Nonmetallic-Sheathed Cable Fittings

74.1 A fitting intended to secure more than one nonmetallic-sheathed cable shall be marked with the number of cables it is intended to secure. The marking shall be located on:

a) The fitting, or

b) The smallest unit shipping carton in which the fitting is packed.

74.1 effective February 1, 1999

74.2 A fitting intended to secure nonmetallic-sheathed cable of a size or sizes other than specified in 23.1 shall be marked to indicate the specific size or sizes it is intended to secure. A range of sizes, a maximum or minimum size, or the equivalent shall be used to represent a group of sizes. The marking shall be located on:

a) The fitting; or

b) The smallest unit shipping carton in which the fitting is packed.

75 Service-Entrance Cable Fittings

75.1 The smallest unit shipping carton for a service-entrance cable fitting shall be marked with the diameter or diameter range of the cable that the fitting is intended to be used with.

75.1 effective February 1, 1999

75.2 The smallest unit shipping carton for a sevice-entrance cable fitting intended for wet locations shall be marked with the shape and the diameter or diameter range of the cable intended to be used with the fitting.

75.2 effective February 1, 1999

76 Liquid-Tight Flexible Metal Conduit Fittings

76.1 A fitting of the 1-1/2 (41) or larger trade size intended for use with liquid-tight flexible metal conduit of the grounding type and any fitting for flexible metal conduit in the 1 (27) or larger trade size that complies with 42.1 shall be marked ″Grounding Type″ or ″GRND″ if the carton or other container in which the fitting is packaged is marked ″Grounding Type.″

77 Liquid-Tight Flexible Nonmetallic Conduit Fittings

77.1 If intended for use with liquid-tight flexible nonmetallic conduit:

a) A fitting for Type A conduit only shall be marked ″FNMC-A only.″

b) A metallic fitting for Type B shall be marked ″FNMC-B″ or the equivalent.

Exception: If a metallic fitting that physically cannot be connected to any type of conduit other than liquid-tight flexible metallic or nonmetallic Type B conduit, the marking is acceptable on the smallest unit shipping carton in which the fitting is packed.

c) A nonmetallic fitting for Type B conduit only shall be marked ″FNMC-B only.″

78 Tray-Cable Fittings

78.1 A tray-cable fitting or the smallest unit shipping carton shall be marked with the diameter of the smallest and largest cable for which the fitting is acceptable. For oval cables, the diameter of both the minor and major axes of the smallest and largest cable shall be marked.

78.2 A tray-cable fitting or the smallest unit shipping carton shall be marked with one or more of the following as appropriate: ″Dry Location,″ ″Sunlight Resistant,″ ″Oil Resistant I,″ or ″Oil Resistant II.″

78.3 A tray-cable fitting or the smallest unit shipping carton is to be marked ″For Use With Tray Cable Rated _____°C or Less.″

79 Threadless Fittings

79.1 A fitting for the 2-1/2, 3, 3-1/2, and 4 (63, 78, 91, and 103) trade sizes of electrical metallic tubing shall be marked ″EMT only,″ or the equivalent.

Exception: A threadless fitting for use with intermediate metal or rigid metal conduit need not be marked.

80 Mineral-Insulated Cable Fittings

80.1 A mineral-insulated cable fitting intended for use in dry locations only – see 29.6 – shall be marked ″Dry location use″ or the equivalent in a location where it will be visible after installation.

81 Insulating Bushings

81.1 Other than as noted in 81.2 and 81.3, the fitting or polymeric insulator shall be marked where visible after installation with its temperature rating.

81.2 A black or brown color is acceptable to identify the temperature rating – as mentioned in 81.1 – if the rating is 150°C (302°F). A fitting component having a rating other than 150°C shall not be black or brown.

81.3 A fitting or polymeric insulator rated 90°C (194°F) need not be marked with its temperature rating.

82 Expansion Fittings

82.1 The smallest unit shipping carton of outdoor expansion fittings intended for use with external bonding jumpers shall be marked ″Intended for use with external bonding jumpers.″

83 Grips

83.1 A grip intended for use in an environment at a temperature greater than 50°C (122°F) shall be marked with the applicable temperature rating.

84 Carton Markings

84.1 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 shall be marked to indicate the condition of installation or the intended use on the smallest unit carton in which the product is packaged. Table 84.1 specifies the condition of use and the associated carton marking.

Table 84.1
Carton markings

Item	Condition of Use or Installation	Carton Marking[a]
1.	For use in poured concrete	Concrete–tight or Concrete–tight when taped
2.	For use with unthreaded rigid or intermediate metal conduit	Unthreaded for ___[b] conduit
3.	For use with threaded rigid or intermediate metal conduit	Unthreaded for threaded __[b] conduit
4.	For liquid–tight applications	Liquid–tight
5.	For use with steel(FE) EMT	For EMT or EMT
6.	For use with steel (FE) or aluminum (AL) EMT	For (FE or STEEL or AL) EMT
7.	For use in dry locations	Dry locations
8.	For use in wet locations	Wet locations[d]
9.	For use in wet locations only with a separate gasket installed between the box and fitting	In wet locations, use ___[e] between box and fitting
10.	For use with specific type of rigid nonmetallic conduit above or below ground	For ____[c] rigid nonmetallic conduit
11.	For use in coupling cable and/or conduit to different raceway systems	For ____[f] and rigid metal conduit, IMC and EMT
12.	For mechanical connection to electrical nonmetallic tubing	Use ____[g] ENT or Use ____[h] or ____[h] ENT

Table 84.1 Continued on Next Page

Table 84.1 Continued

Item	Condition of Use or Installation	Carton Marking[a]	
		Complete	Abbreviated
13.	For use with all types of FMC (flexible metal conduit)	For FMC	FMC
14.	For use with steel (FE) or aluminum (AL) FMC only	For FE FMC	FEFMC
		For STEEL FMC	STEELFMC
		For AL FMC	ALFMC
		For ALUM FMC	ALUMFMC
		For ALUMINUM FMC	ALUMINUMFMC
15.	For use with reduced–wall FMC only	For RWFMC	RWFMC
16.	For use with reduced–wall steel (FE) or aluminum (AL) FMC only	For FE RWFMC	FERWFMC
		For STEEL RWFMC	STEELRWFMC
		For AL RWFMC	ALRWFMC
		For ALUM RWFMC	ALUMRWFMC
		For ALUMINUM RWFMC	ALUMINUMRWFMC

[a] The carton marking specified above shall be prefixed by ″Suitable for″ instead of ″For″ or shall use the word ″only″ as desired or appropriate.

[b] Blank to be filled in with ″rigid,″ ″intermediate,″ or a combination of the two, followed by the material type – FE (or STEEL) or AL (or ALUM or ALUMINUM).

[c] Blank to be filled in with the use of the appropriate type of conduit, such as ″PVC underground,″ as required or appropriate.

[d] ″Raintight″ is also acceptable for the carton marking.

[e] Blank to be filled in with specific identification of the component to be used, including the part number, to identify the gasket, seal or the like that must be installed to provide a raintight connection.

[f] Blank to be filled in with specific identification of the cable or conduit to be used, such as NM, AC, MC or FMC.

[g] Blank to be filled in with the name of a particular manufacturer.

[h] Blank to be filled in with the name of more than one manufacturer.

84.2 Additional marking in the complete form specified in Table 84.1 or in an equivalent abbreviated form provided on the product is acceptable.

INSTRUCTIONS

85 Assembly

85.1 If specific assembly techniques are required for a fitting, instructions for proper assembly shall be provided with the fitting when shipped from the factory.

FITTINGS FOR RIGID POLYVINYL CHLORIDE (PVC) CONDUIT

INTRODUCTION

86 Scope

86.1 These requirements cover fittings, other than elbows and other bends, for rigid polyvinyl chloride (PVC) conduit. These products are intended to be used with both heavy-wall and thin-wall rigid PVC conduit, elbows, and other bends in accordance with the National Electrical Code, ANSI/NFPA 70-1990. Rigid PVC conduit, elbows, and other bends in both thicknesses are covered separately in the Standard for Schedule 40 and 80 Rigid PVC Conduit, UL 651.

86.2 The products covered by these requirements are intended to be joined to rigid polyvinyl chloride (PVC) conduit and rigid PVC elbows and other bends in the field by means of a cement that is, or contains, a solvent for polyvinyl chloride.

86.3 The products covered by these requirements are considered to be inherently resistant to the corrosive influences of common industrial atmospheres including the vapors and mists of bases, hydrofluoric and chromic acids, and pickling and plating baths. See Resistance to Specific Reagents Test, Section 100, and Details, Section 103.

86.4 The expansion joints covered by these requirements are fittings intended to compensate for linear thermal expansion of a span of rigid polyvinyl chloride (PVC) conduit.

86.5 The couplings covered by these requirements are fittings intended for joining two lengths of rigid polyvinyl chloride (PVC) conduit, a length of rigid PVC conduit to a rigid PVC elbow or other bend, and – in conjunction with a junction-box adapter – a length of rigid PVC conduit or a rigid PVC elbow or other bend to a box.

86.6 The junction-box adapters covered by these requirements are fittings intended for the connection of a length of rigid polyvinyl chloride (PVC) conduit or a rigid PVC elbow or other bend to a rigid PVC box – not limited to junction boxes – in conjunction with a coupling.

86.7 The internally-threaded adapters covered by these requirements are fittings intended for joining a length of rigid polyvinyl chloride (PVC) conduit or a rigid PVC elbow or other bend to threaded rigid metal conduit or other externally threaded devices.

86.8 The externally-threaded adapters – also referred to as terminal adapters – covered by these requirements are fittings intended for joining a length of rigid polyvinyl chloride (PVC) conduit or a rigid PVC elbow or other bend to the knockout area of a metal box in conjunction with a metal locknut, to a threaded metal hub or fitting on a metal box, to a threaded hub on a phenolic box, or to a knockout in a phenolic box.

86.9 The reducers covered by these requirements are fittings intended for joining lengths of two different sizes of rigid polyvinyl chloride (PVC) conduit.

86.10 The caps covered by these requirements are fittings intended for closing the ends of unused lengths of rigid polyvinyl chloride (PVC) conduit.

86.11 The bell ends covered by these requirements are fittings intended to provide a bushed opening at the open end of a length of rigid polyvinyl chloride (PVC) conduit.

86.12 These requirements do not cover cabinets, cutout boxes, or cover plates for wiring devices.

CONSTRUCTION

87 General

87.1 A fitting shall be of an acceptable unplasticized polyvinyl chloride material.

Exception: A nonmetallic service-entrance head in accordance with the Exceptions to 101.1.1(c), 101.1(d), and 101.1.1(i) need not be made of unplasticized polyvinyl chloride.

87.2 The inner and outer surfaces of a fitting shall not be subject to peeling, scaling, or flaking and shall be smooth and free from blisters, cracks, and other defects. The fitting shall have a smooth rounded inlet hole to afford protection to the conductors. In the case of a molded product, excess flashing shall be removed from the mold line of all interior surfaces so that there are no sharp edges or obstructions to the passage of wiring or mating of parts in the intended use of the product.

88 Conduit bodies

88.1 A conduit body shall also comply with the requirements in Conduit Bodies, Section 15.

88.2 A conduit body shall be provided with a blank cover.

88.3 Mating surfaces of a cover and body shall provide a close fit. A gasket, if required to provide a tight fit, shall be provided with the cover but need not be cemented or otherwise secured in place on the cover.

88.4 A cover shall be attached to the body by No. 6 or larger machine screws having 32 or fewer threads per inch. The screws shall thread into metal having at least two full threads. Inserts molded or assembled into the body are acceptable.

89 Fittings

89.1 General

89.1.1 A conduit fitting shall be constructed so that it can be secured to polyvinyl chloride (PVC) conduit by means of a solvent type of cement without damage to the fitting or conduit.

89.1.2 To preclude snags and restrictions in a finished conduit system, the socket and threaded surfaces of an internally or externally threaded polyvinyl chloride (PVC) adapter or a coupling shall have a circular cross section. The socket shall be tapered. The socket shall be provided, other than noted in 89.1.3, with an end or centering stop:

a) On which there are no burrs, sharp edges, or the like to damage wires being pulled over the stop, and

b) That limits the depth of penetration of PVC conduit and, in the case of an internally threaded adapter, also limits the depth of penetration of threaded rigid metal conduit.

89.1.3 A centering stop is not required in a coupling that is intended for attachment to conduit only at the conduit factory. If a factory-applied coupling is provided with a centering stop:

a) The minimum throat diameter shall comply with the last two columns of Table 90.1,

b) The stop need not extend entirely around the circumference of the coupling, and

c) The stop shall not project into the conduit for which the coupling is intended; for example, the minimum acceptable throat diameter is the maximum acceptable inside diameter of the thin- or heavy-wall conduit for which the coupling is intended.

Table 90.1
Throat diameters at any point in fittings other than adapters

Table 90.1 revised February 7, 2002

Trade size of conduit	(metric designator)	Minimum throat diameter, in (mm)					
		Field-attached couplings and fittings other than adapters[a]		Factory-applied couplings with stops			
				For use with heavy-wall conduit		For use with thin-wall conduit	
1/2	(16)	0.630	(16.00)	0.630	(16.00)	0.728	(18.49)
3/4	(21)	0.834	(21.18)	0.834	(21.18)	0.840	(21.34)
1	(27)	1.059	(26.90)	1.059	(26.90)	1.205	(30.61)
1-1/4	(35)	1.392	(35.36)	1.392	(35.36)	1.532	(38.91)
1-1/2	(41)	1.622	(41.20)	1.622	(41.20)	1.752	(44.50)
2	(53)	2.079	(52.81)	2.079	(52.81)	2.187	(55.55)
2-1/2	(63)	2.484	(63.09)	2.484	(63.09)	2.670	(67.82)
3	(78)	3.083	(78.31)	3.083	(78.31)	3.365	(85.47)
3-1/2	(91)	3.598	(91.39)	3.598	(91.39)	3.760	(95.50)
4	(103)	4.076	(103.53)	4.076	(103.53)	4.250	(107.95)
5	(129)	5.097	(129.46)	5.097	(129.46)	–	–
6	(155)	6.115	(155.32)	6.115	(155.32)	–	–

[a] For reducers, the throat for the smaller of the two sizes of conduit applies.

89.1.4 The walls of a polyvinyl chloride (PVC) conduit fitting shall be at least as thick as specified in Table 90.2. The dimensions of a PVC externally threaded adapter with tapered threads shall be as specified in Table 90.3.

Table 90.2
Dimensions of fittings and conduit connection

Table 90.2 revised October 21, 1998

Trade size of conduit (metric designator)	Socket diameter, in (mm)						Socket depth, in (mm)		Minimum thickness, in (mm)	
	At entrance			At bottom					Over male or female threads[b]	Wall of unthreaded portion
	Max	Min	Avg	Max	Min	Avg	Max	Min[a]		
1/2 (16)	0.860	0.844	0.852 ± 0.004	0.844	0.828	0.836 ± 0.004	1.500	0.652	0.109	0.095
	(21.84)	(21.44)	(21.64 ± 0.10)	(21.44)	(21.03)	(21.23 ± 0.10)	(38.10)	(16.56)	(2.77)	(2.41)
3/4 (21)	1.074	1.054	1.064 ± 0.004	1.056	1.036	1.046 ± 0.004	1.500	0.719	0.113	0.095
	(27.28)	(26.77)	(27.03 ± 0.10)	(26.82)	(26.31)	(26.57 ± 0.10)	(38.10)	(18.26)	(2.87)	(2.41)
1 (27)	1.340	1.320	1.330 ± 0.005	1.320	1.300	1.310 ± 0.005	1.875	0.875	0.133	0.100
	(34.04)	(33.53)	(33.78 ± 0.13)	(33.53)	(33.02)	(33.27 ± 0.13)	(47.63)	(22.23)	(3.38)	(2.54)
1-1/4 (35)	1.689	1.665	1.677 ± 0.005	1.667	1.643	1.655 ± 0.005	2.000	0.938	0.140	0.120
	(42.90)	(42.29)	(42.60 ± 0.13)	(42.34)	(41.73)	(42.04 ± 0.13)	(50.80)	(23.83)	(3.56)	(3.05)
1-1/2 (41)	1.930	1.906	1.918 ± 0.006	1.906	1.882	1.894 ± 0.006	2.000	1.062	0.145	0.120
	(49.02)	(48.41)	(48.72 ± 0.15)	(48.41)	(47.80)	(48.11 ± 0.15)	(50.80)	(26.97)	(3.68)	(3.05)
2 (53)	2.405	2.381	2.393 ± 0.006	2.381	2.357	2.369 ± 0.006	2.000	1.125	0.154	0.130
	(61.09)	(60.48)	(60.78 ± 0.15)	(60.48)	(59.87)	(60.17 ± 0.15)	(50.80)	(28.58)	(3.91)	(3.30)
2-1/2 (63)	2.905	2.875	2.890 ± 0.007	2.883	2.853	2.868 ± 0.007	3.000	1.469	0.203	0.165
	(73.79)	(73.03)	(73.41 ± 0.18)	(73.23)	(72.47)	(72.85 ± 0.18)	(76.20)	(37.31)	(5.16)	(4.19)

Table 90.2 Continued on Next Page

Table 90.2 Continued

Trade size of conduit (metric designator)	Socket diameter, in (mm)						Socket depth, in (mm)		Minimum thickness, in (mm)	
	At entrance			At bottom					Over male or female threads[b]	Wall of unthreaded portion
	Max	Min	Avg	Max	Min	Avg	Max	Min[a]		
3 (78)	3.530	3.500	3.515 ± 0.008	3.507	3.477	3.492 ± 0.008	3.125	1.594	0.216	0.216
	(89.66)	(88.90)	(89.28 ± 0.20)	(89.08)	(88.32)	(88.70 ± 0.20)	(79.38)	(40.49)	(5.49)	(5.49)
3-1/2 (91)	4.065	3.965	4.015 ± 0.008	4.007	3.977	3.992 ± 0.008	3.250	1.687	0.226	0.226
	(103.25)	(100.71)	(101.98 ± 0.20)	(101.78)	(101.02)	(101.40 ± 0.20)	(82.55)	(42.85)	(5.74)	(5.74)
4 (103)	4.565	4.465	4.515 ± 0.009	4.506	4.476	4.491 ± 0.009	3.375	1.750	0.237	0.237
	(115.95)	(113.41)	(114.68 ± 0.23)	(114.45)	(113.69)	(114.07 ± 0.23)	(85.73)	(44.45)	(6.02)	(6.02)
5 (129)	5.643	5.543	5.593 ± 0.010	5.583	5.523	5.553 ± 0.010	3.625	1.937	0.258	0.258
	(143.33)	(140.79)	(142.06 ± 0.25)	(141.81)	(140.28)	(141.05 ± 0.25)	(92.08)	(49.20)	(6.55)	(6.55)
6 (155)	6.708	6.608	6.685 ± 0.011	6.644	6.584	6.614 ± 0.011	3.750	2.125	0.280	0.280
	(170.38)	(167.84)	(169.11 ± 0.28)	(168.76)	(167.23)	(168.00 ± 0.28)	(95.25)	(53.98)	(7.11)	(7.11)

[a] The minimum socket depth is not specified. Strength is to be evaluated by the bending and pull tests in Bending Test, Section 99, and Pull Test, Section 100. The depths shown are the smallest yet accepted. Tests are not needed on sockets complying with these minimums.

[b] The thickness is to be measured at the end of the fitting from the crest of the thread through the material to the smooth wall surface.

Table 90.3
Dimensions of polyvinyl chloride externally threaded adapters with tapered threads

Trade size of conduit,	(metric designator)	Minimum wall thickness over tapered threads,		Effective thread length for five full, perfect threads,	
		in	(mm)[a]	in	(mm)[b]
1/2	(16)	0.097	(2.46)	0.357	(9.07)
3/4	(21)	0.102	(2.59)	0.357	(9.07)
1	(27)	0.119	(3.02)	0.435	(11.05)
1-1/4	(35)	0.126	(3.20)	0.435	(11.05)
1-1/2	(41)	0.131	(3.33)	0.435	(11.05)
2	(53)	0.140	(3.56)	0.435	(11.05)
2-1/2	(63)	0.183	(4.65)	0.625	(15.88)
3	(78)	0.197	(5.00)	0.625	(15.88)
3-1/2	(91)	0.207	(5.26)	0.625	(15.88)
4	(103)	0.217	(5.51)	0.625	(15.88)
5	(129)	0.239	(6.07)	0.625	(15.88)
6	(155)	0.261	(6.63)	0.625	(15.88)

[a] The thickness is to be measured at the end of the fitting from the crest of the tread through the material to the inner wall surface

[b] See 90.5.3.

89.1.5 The socket depth and diameters of a conduit fitting shall be within the limits specified in Table 90.2 and shall permit assembly to polyvinyl chloride (PVC) conduit in a manner that provides acceptable strength for both the joint and the assembly as determined by compliance with Bending Test, Section 98, and Pull Test, Section 99.

Exception: A socket depth greater than the maximum specified in Table 90.2 is acceptable provided the fitting is marked in accordance with 103.3.

89.1.6 The throat diameter of a coupling and a fitting other than an internally and externally threaded adapter shall not be less than specified in Table 90.1 as determined either by application of the limit gauges illustrated in Figure 90.1 or by measurement as described in 89.1.8 and 89.1.9. The dimensions of the gauges are given in Tables 90.4 and 90.5

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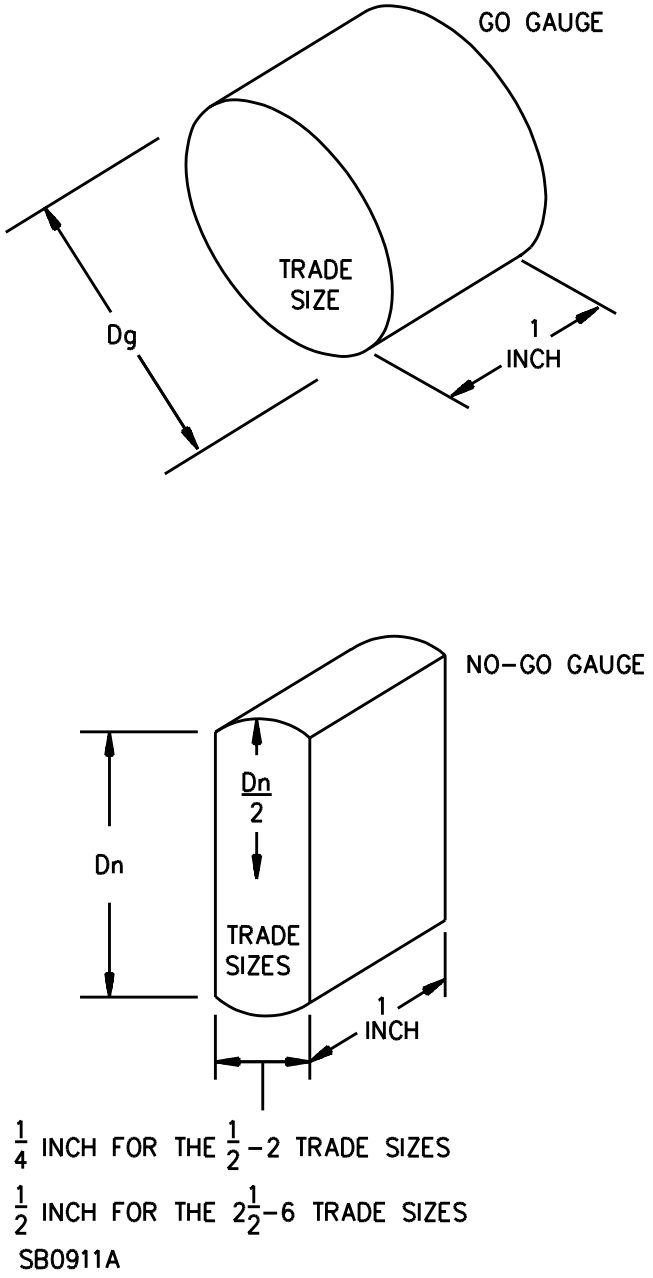
Figure 90.1
Hardened tool steel limit gauges for throats of fittings



Note – SI values for the dimensions in this figure are:

Inch	mm
1/4	6.4
1/2	12.7
1	25.4

Table 90.4
Dimensions of limit gauges for throats of fittings

Trade size of conduit	(metric designator)	For internally and externally threaded adapters				Diameter (Dg) of go gauge for all field-attached couplings and for factory attached couplings that have stops and are for use with thin-wall pvc conduit and for fittings other than adapters,		Diameter (Dg) of go gauge for factory attached couplings that have stops and are for use with heavy-wall pvc conduit,	
		Diameter (Dg) of go gauge,		Diameter (Dn) of no-go gauge,					
		in	(mm)[a]	in	(mm)[a]	in	(mm)[a]	in	(mm)[a]
1/2	(16)	0.5900	(14.986)	0.6230	(15.824)	0.7270	(18.466)	0.6290	(15.977)
3/4	(21)	0.7820	(19.863)	0.8250	(20.955)	0.8390	(21.311)	0.8330	(21.158)
1	(27)	0.9960	(25.298)	1.0500	(26.670)	1.2040	(30.582)	1.0580	(26.873)
1-1/4	(35)	1.3100	(33.274)	1.3810	(35.077)	1.5310	(38.887)	1.3910	(35.331)
1-1/2	(41)	1.5280	(38.811)	1.6110	(40.919)	1.7510	(44.475)	1.6210	(41.173)
2	(53)	1.9630	(49.860)	2.0680	(52.527)	2.2860	(58.064)	2.0780	(52.781)
2-1/2	(63)	2.3450	(59.593)	2.4700	(62.738)	2.6690	(67.793)	2.4830	(63.068)
3	(78)	2.9140	(74.016)	3.0690	(77.953)	3.3640	(85.446)	3.0820	(78.283)
3-1/2	(91)	3.3700	(85.598)	3.5490	(90.145)	3.7590	(95.479)	3.5970	(91.364)
4	(103)	3.8240	(97.130)	4.0270	(102.286)	4.2490	(107.925)	4.0750	(103.505)
5	(129)	4.7940	(121.768)	5.0480	(128.219)	5.0960	(129.438)	5.0960	(129.438)
6	(155)	5.7610	(146.329)	6.0660	(154.076)	6.1140	(155.296)	6.1140	(155.296)

[a] A tolerance of ± 0.0005 inch (0.013 mm) applies.

Table 90.5
Diameters of limit gauges for throats of bushings

Table 90.5 revised October 21, 1998

Trade size of conduit	(metric designator)	Diameter (Dg) of go gauge,		Diameter (Dg) of no-go gauge,	
		in[a]	(mm)	in[a]	(mm)
3/8	(12)	0.4430	(11.252)	0.4940	(12.548)
1/2	(16)	0.5590	(14.199)	0.6230	(15.824)
3/4	(21)	0.7410	(18.821)	0.8250	(20.955)
1	(27)	0.9430	(23.952)	1.0500	(26.670)
1-1/4	(35)	1.2410	(31.521)	1.3810	(35.077)
1-1/2	(41)	1.4480	(36.779)	1.6110	(40.919)
2	(53)	1.8590	(47.219)	2.0680	(52.527)
2-1/2	(63)	2.2210	(56.413)	2.4700	(62.738)
3	(78)	2.7600	(70.104)	3.0690	(77.953)
3-1/2	(91)	3.1920	(81.077)	3.5490	(90.145)
4	(103)	3.6220	(91.999)	4.0270	(102.286)
5	(129)	4.5410	(115.341)	5.0480	(128.219)
6	(155)	5.4570	(138.608)	6.0660	(154.076)

[a] A tolerance of ± 0.0005 in (0.013 mm) applies.

89.1.7 The curved surfaces of the limit gauges illustrated in Figure 90.1 are to be ground and lapped to the diameters specified in Table 90.4 within the tolerances specified in Table 90.4. The handles for these gauges are not specified, nor is the means by which the handles are joined to the gauges. Each gauge for an internally threaded adapter is to have the letters FEM or some other designation on the same face on which the size appears.

89.1.8 The measurements from which the throat diameter of a finished fitting is to be determined for comparison with the minimum specified in Table 90.1 are to be made by means of a machinist's inside micrometer caliper that is equipped with a ratchet. The calibration of the scale is to facilitate estimation of each measurement to 0.0001 inch (0.003 mm).

89.1.9 The throat diameter at any point in a fitting shall be equal to or greater than the applicable value specified in Table 90.1. Four measurements of the throat diameter of each fitting are to be made to make certain that the smallest diameter has been included. Each measurement is to be estimated to the nearest 0.0001 inch (0.003 mm) and recorded. The smallest of all of the recorded diameters is to be rounded to the nearest 0.001 inch (0.03 mm). When rounding, an even number in the third decimal place is unchanged if the number in the fourth decimal place is five and there is no number or zero in the fifth place.

89.1.10 The throat diameter of the stop in an internally or externally threaded adapter shall be within the limits specified in Table 90.6 as determined by application of the limit gauges illustrated in Figure 90.1. The dimensions of the gauges are specified in Table 90.4.

Table 90.6
Throat diameters of threaded adapters

Trade size of conduit	(metric designator)	Throat diameter, in (mm)			
		Maximum		Minimum	
1/2	(16)	0.622	(15.80)	0.591	(15.01)
3/4	(21)	0.824	(20.93)	0.783	(19.89)
1	(27)	1.049	(26.64)	0.997	(25.32)
1-1/4	(35)	1.380	(35.05)	1.311	(33.30)
1-1/2	(41)	1.610	(40.89)	1.529	(38.84)
2	(53)	2.067	(52.50)	1.964	(49.89)
2-1/2	(63)	2.469	(62.71)	2.346	(59.59)
3	(78)	3.068	(77.93)	2.915	(74.04)
3-1/2	(91)	3.548	(90.12)	3.371	(85.62)
4	(103)	4.026	(102.26)	3.825	(97.16)
5	(129)	5.047	(128.19)	4.795	(121.79)
6	(155)	6.065	(154.05)	5.762	(146.35)

SPECIFIC FITTINGS

89.2 Fabricated fittings

89.2.1 If a polyvinyl chloride (PVC) conduit fitting is fabricated or machined from a length of PVC conduit, the conduit used shall comply with the Standard for Rigid Nonmetallic Conduit, UL 651, but the fittings need not be subjected to the tests specified in 93.1, 94.1, 95.1, 97.1, 98.1, and 99.1.

89.2.2 A polyvinyl chloride (PVC) conduit fitting fabricated from a nonstandard size of rigid PVC pipe is acceptable. That pipe need not be investigated for compliance with all of the requirements applicable to rigid PVC conduit if:

a) An acceptable compound is employed using the same extrusion techniques as are used for rigid PVC conduit, and

b) The pipe is subjected to and complies with the extrusion-process requirements applicable to rigid PVC conduit.

89.3 Junction-box adapters

89.3.1 A junction-box adapter shall be capable of being secured by means of a solvent type cement in a hole that is field cut – drilled or sawn – in a wall of a polyvinyl chloride (PVC) box. The adapter shall have smooth, rounded surfaces and shall have a flange wide enough to completely cover the edges of the hole in the box. The flange shall be at least 1/8 inch (3.2 mm) wide on adapters for 1-1/2 (41) and smaller sizes of conduit and shall be at least 1/4 inch (6.4 mm) wide for larger trade sizes of conduit.

89.3.2 When assembled to a box with a coupling as intended, an adapter shall provide a positive end stop for conduit. The outside diameter of the adapter, at the point where it enters the coupling, shall be within the limits specified for polyvinyl chloride (PVC) conduit in the Standard for Schedule 40 and 80 Rigid PVC Conduit, UL 651.

89.4 Expansion joints

89.4.1 An expansion joint shall be capable of being connected to conduit or a coupling at both ends by means of a solvent type cement.

89.4.2 Unless an expansion joint is fastened at one end to conduit, a stop shall be provided to prevent the movable member of the joint from exposing either of the cut ends of the lengths of conduit to which the joint is connected.

89.4.3 In no position of adjustment shall the inside end or ends of conduit or the joint of an expansion joint, present any snag to a fish tape, wires, or the like being passed through the joint. In most cases, this necessitates beveling the ends.

89.5 Threaded Adapters

89.5.1 A threaded adapter shall be internally or externally threaded.

89.5.2 All threads shall be full and cleanly cut or molded and shall comply with General Purpose Pipe Threads, ANSI/ASME B1.20.1-1983(R1992).

89.5.3 The threaded portion shall be long enough so that the fitting complies with Bending Test, Section 98, and Pull Test, Section 99. There shall not be fewer than five full perfect threads.

89.5.4 The threads shall be straight or, if tapered, have a taper of 3/4 inch or less per foot (5 mm or less per 80 mm).

PERFORMANCE

90 General

90.1 If a fitting differs from the construction requirements previously specified, tests other than, or in addition to, those specified in Sections 91 – 102 shall be considered. Among the considerations are installation, resistance to arcing, dimensional stability, and resistance to the corrosive or degrading effects of reagents.

91 Water Absorption Test

91.1 A fitting shall not absorb more water than 0.5 percent of its weight as a result of being immersed for 24 hours in tap water at a temperature of 23 ±2°C (73 ±4°F).

91.2 Samples are to be cut into three specimens for the water-absorption test. These specimens are to be cleaned and dried in a desiccator for 24 hours. Each specimen is to be weighed and then immersed in water at the specified temperature. After removal from the water, each specimen is to be dried with a clean piece of soft, lint-free cloth to remove all surface water before reweighing.

92 Flammability Test

92.1 When tested as described in 92.2:

a) A fitting shall not continue to flame for more than 5 seconds after the third application of the test flame;

b) Flaming particles or drops shall not fall from the fitting during or after any application of the test flame; and

c) The fitting shall not be entirely consumed during or after any application of the test flame.

92.2 Each sample fitting is to be subjected to the test described in 36.1.3 and 36.1.5 – 36.1.8, but the valve supplying the gas is to be opened for 1 minute and closed for 30 seconds for each of three applications of the test flame. The test sample is to be located so that the test flame is directed at the center of the largest surface.

92.3 If the fitting is too large to be tested in the chamber described in 36.1.3, it is acceptable to test the fitting in a chamber that is constructed as described in 36.1.3 with proportionately larger dimensions.

93 Heat-Distortion Test

93.1 There shall not be a change in any dimension greater than 15 percent for a fitting, cracks or openings in a fitting, or openings wider than 1/16 inch (1.6 mm) between a fitting and its cover as a result of the test described in 93.2.

93.2 Samples are to be heated for 1 hour at a temperature of 92 ±1°C (198 ±2°F) in an air-circulating oven. Samples are to be supported in the oven so that they cannot touch each other or the sides of the oven. A conduit body is to be tested with its blank cover in place.

94 Extrusion or Molding-Process Test

94.1 The surface of a fitting shall not exhibit any evidence of incomplete fusion after immersion of the finished product in reagent grade anhydrous acetone.

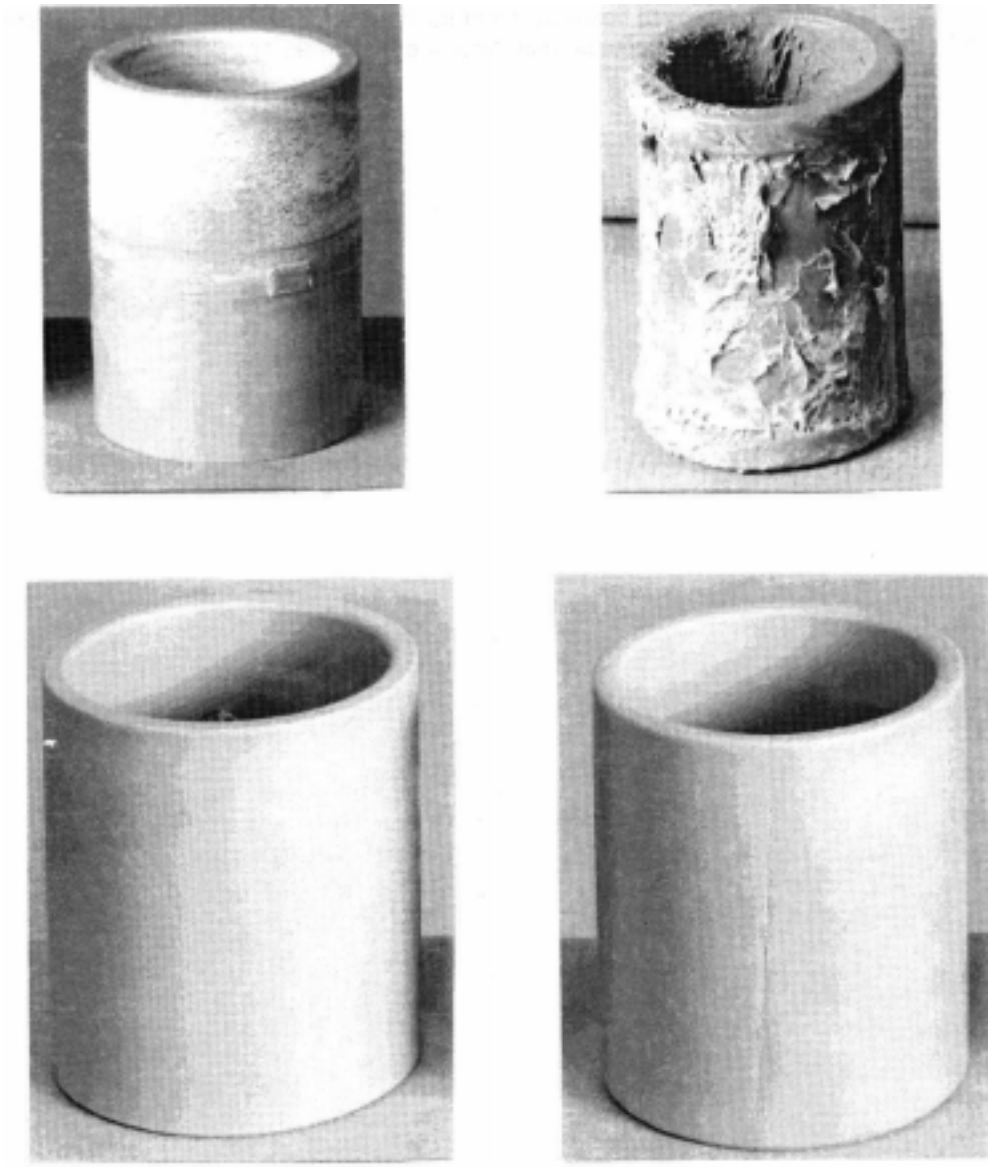
94.2 Because acetone [dimethyl ketone, $(CH_3)_2CO$] is an extremely volatile liquid, the vapors of which form explosive mixtures with air, it is imperative that open flames, glowing cigarettes, and other sources of ignition be kept away. Acetone and acetone-PVC products are toxic, damaging to clothing, and rapidly absorb moisture from air, the skin, and the like. They should not be allowed to touch the skin, nor should the vapors of these substances be inhaled. Because acetone with moisture in it is not effective in this test, the test is to be conducted with each specimen in its own covered container. Acetone can be dehydrated by filtering it through anhydrous calcium sulphate, $CaSO_4$.

94.3 With appropriate attention to the health and fire risks involved (see 94.2), a sample of the fitting is to be immersed in reagent grade anhydrous acetone for 5 minutes at a temperature of 23 ±2°C (73 ±4°F) and then examined.

94.4 A fitting is not acceptable if there is flaking or peeling over most of the interior or exterior surfaces (see Note 2 of Figure 95.1) or if it splits. The presence of a weld (bond) line that is not uniform in width and depth or that is positively recessed below adjacent surfaces – for example, shows a definite crack or separation in the material – is not acceptable (see Note 4 of Figure 95.1).

Figure 95.1
Samples after molding-process test

Figure 95.1 revised October 21, 1998



NOTES –

1. Upper left corner – Acceptable flaking (mild and covers only part of surface).

2. Upper right corner – Unacceptable flaking and peeling (severe and covers most surfaces).

3. Lower left corner – Acceptable weld line (uniform width and depth with no cracks).

4. Lower right corner – Unacceptable weld line (uneven depth and definite crack in center).

95 Identification Tests

95.1 The ash content and the specific gravity of the polyvinyl chloride (PVC) material shall be as specified by the manufacturer and within the manufacturer's specified tolerance for the compound used.

96 Resistance to Crushing Test

96.1 The resistance to crushing of all sizes of conduit fittings shall be such that, when the fittings are tested as described in 96.2 – 96.5, the minor axis shall retain at least 70 percent of its original inside diameter. There shall not be evidence of buckling and there shall not be reduction in performance as a result of the conditioning.

Exception: A nipple and the threaded section of an externally threaded adapter need not be tested.

96.2 Specimens for the test are to consist of circular sections cut from the socket end of six samples of molded fittings, three of which have been conditioned as described in 96.3 and three of which are unaged.

96.3 The specimens are to be supported in a full-draft, air-circulating oven that has been preheated at full draft to 113 ±1°C (235 ±2°F). The specimens are to be supported so that they do not touch each other or the sides of the oven. The specimens are to be conditioned for 168 hours at full draft and then allowed to cool gradually for 16 to 96 hours in still air before being handled.

96.4 Prior to application of the load, measurements are to be made of the internal diameters of the test specimens. Each specimen is to be placed with its longitudinal axis horizontal between two rigid, flat, parallel, steel plates that are at least as long as the specimen. The load is to be applied to the center of the upper plate by means of a machine, the jaws of which close at the rate of 1/2 inch (12.7 mm) per minute.

96.5 The load is to be increased until the load value specified in Table 97.1 is attained. Measurement of the minor axis of the inside dimension is to be made at the instant the load is attained. Observations for buckling are to be made at the points at which the specimen is in contact with the test plates. Buckling is considered to have occurred if a surface of the specimen in contact with a test plate starts to pull away from the plate. The load is then to be released immediately.

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Table 97.1
Load for crushing test on fittings

Trade size of conduit socket	(metric designator)	Load, lbf per linear in[a]
1/2	(16)	166.7
3/4	(21)	166.7
1	(27)	166.7
1-1/4	(35)	166.7
1-1/2	(41)	125.0
2	(53)	116.7
2-1/2	(63)	166.7
3	(78)	166.7
3-1/2	(91)	166.7
4	(103)	150.0
5	(129)	141.7
6	(155)	141.7

[a] SI equivalents of dimensions in this table are:

Pounds per linear in	Newtons per linear mm
116.7	20.4
125.0	21.9
141.7	24.8
150.0	26.3
166.7	29.2

97 Low-Temperature Handling Test

97.1 There shall not be cracking or shattering of a molded polyvinyl chloride (PVC) coupling as a result of the test described in 97.2 and 97.3.

97.2 Two samples of each type of molded polyvinyl chloride (PVC) coupling, each assembled to a 2-1/2-foot (760-mm) length of PVC conduit, are to be conditioned for 5 hours in air maintained at minus 20 ±1°C (minus 4 ±2°F).

97.3 Immediately after removal from the cold chamber, each sample is to be dropped onto a concrete floor twice in rapid succession from a height of approximately 5 feet (1.5 m). For the first drop of each assembly, the conduit is to be parallel to the floor. For the second drop of each assembly, the conduit is to be at an angle of approximately 45 degrees to the floor, and the coupling is to strike the floor first.

98 Bending Test

98.1 A fitting or body shall not be damaged or separated from the conduit when subjected to the bending test described in 98.2 – 98.4.

98.2 If breakage of the conduit occurs prior to separation at the joint, performance is considered to be acceptable.

98.3 Samples secured by cement welded in the intended manner to 18-inch (457-mm) lengths of heavy-wall polyvinyl chloride (PVC) conduit of the appropriate trade size are to be tested as described in 98.4. The test is to be performed no sooner than 24 hours after assembly.

99.4 For the test, on an assembly with:

a) A coupling, the center of the coupling is to be placed on supports 30 inches (760 mm) apart as illustrated in Figure 60.1.

b) Other than a coupling, the supports are to be separated by an additional distance, to be added to the 30 inches (760 mm) specified in (a), that is equal to the distance between the center of the assembly and the end of the conduit in the box or assembly to give the required bending moment on the sample under test.

The load specified in Table 99.1 for the size of conduit used is to be suspended from the center of the coupling for 60 seconds, during which time the coupling and the lengths of conduit are to be rotated through 1 complete revolution about the major axis of the assembly.

Table 99.1
Bending load and pull force

Trade size of fitting	(metric designator)	Bending load,		Pull force,	
		lb	(kg)	lbf	(N)
1/2	(16)	20	(9.07)	300	(1334)
3/4	(21)	35	(15.88)	450	(2002)
1	(27)	50	(22.68)	600	(2669)
1-1/4	(35)	75	(34.02)	700	(3114)
1-1/2	(41)	85	(38.56)	800	(3559)
2	(53)	110	(49.89)	1000	(4448)
2-1/2	(63)	110	(49.89)	1000	(4448)
3	(78)	110	(49.89)	1000	(4448)
3-1/2	(91)	110	(49.89)	1000	(4448)
4	(103)	110	(49.89)	1000	(4448)
5	(129)	110	(49.89)	1000	(4448)
6	(155)	110	(49.89)	1000	(4448)

99 Pull Test

99.1 Following the bending test described in 98.4, a polyvinyl chloride (PVC) fitting shall withstand a direct pull of the value specified in Table 99.1 for 1 minute without damage and without pulling loose from the conduit. See 98.2.

100 Resistance to Specific Reagents Test

100.1 General

100.1.1 Usually, a reagent is understood to be a substance used to produce a characteristic reaction in chemical analysis. For the purpose of this standard, however, it is convenient to consider the word in the less restrictive sense of any chemical, oil, or other substance that has a corrosive or degrading influence on polyvinyl chloride (PVC) conduit.

100.2 Reagent absorption test

100.2.1 If the fitting is intended for use where it is wet by, or immersed in a specific reagent as defined in 100.1.1, specimens of the finished fitting – each 2 inches or 50 mm in length (see 17.4) – that have been immersed for 60 and 120 days in the reagent at the intended concentration and temperature shall exhibit a 2.50 percent or smaller gain or loss in weight. If there is a gain in weight after 120 days and if that gain exceeds 1.00 percent, that gain shall not be more than 1.65 times the gain after 60 days.

100.3 Crushing strength test

100.3.1 If the fitting is intended for use where it is wet by, or immersed in, a specific reagent as defined in 100.1.1, specimens of the finished conduit – each 2 inches or 50 mm in length – that have been immersed for 60 and 120 days in the reagent at the intended concentration and temperature shall have at least 85 percent of the crushing strength of similar unaged specimens. The tests are to be made as indicated in 100.3.3 – 100.3.11.

100.3.2 The results of tests on the 1-inch (27) or smaller trade size of fitting are to be considered representative of the results that would be obtained from tests on the larger trade sizes of conduit.

100.3.3 Twelve specimens that are each 2 inches or 50 mm long are to be cut from clean sample lengths of the finished conduit and cleaned of loose particles and ragged edges. Six specimens are each to be weighed (W_1) and the remaining six are to be set aside for unaged tests.

100.3.4 Care is to be taken throughout the procedure outlined in 100.3.5 – 100.3.11 to reduce the risk of injury from handling reagents that involve such a risk.

100.3.5 The weighed specimens are each to be immersed in the reagent in separate, covered containers that do not react with the reagent. Each container is to be filled with the reagent at the intended concentration and temperature to the depth necessary to completely cover the specimen that is to be placed in it. When the liquid comes to rest in each container, the specimens are to be stood on end in their containers. The containers are to be closed and kept at the intended temperature for 60 days without agitation of the reagent.

100.3.6 After 60 days, the specimens are to be removed from the reagent and given time to cool in still air before being rinsed carefully and wiped dry inside and out with a clean piece of lint-free, absorbent cloth. Each of the six dried specimens is to be weighed (W_2) to within 10 mg of balance. W_2 shall not be more than 2.50 percent heavier or lighter than W_1.

100.3.7 Three of the specimens immersed for 60 days and three of those set aside for unaged tests are to be brought into thermal equilibrium with one another, the testing machine, and the surrounding air at a temperature of 23.0 ±2.0°C (73.4 ±3.6°F) and are to be kept so throughout the test. The inside diameter of each specimen is to be measured. The specimens are then to be tested separately between a pair of rigid, flat, steel plates that are at least 6 inches or 150 mm long and are horizontal and parallel to one another. One plate is to be moved toward the other at the rate of 1/2 ±1/8 inch per minute or 10.0 ±2.5 mm per minute until the surface of the specimen pulls away from contact with either plate – that is, until the specimen buckles, or until the minor axis measured inside the flattening specimen is 60 percent of the inside diameter measured before the test.

100.3.8 The crushing loads at the buckling and the 60-percent points are to be noted from the dial on the machine and recorded for each specimen. The loads at each of these points are to be averaged for each of the three sets of specimens. The average loads at each of these points for the aged specimens are each to be divided by the average loads at each of these points for the unaged specimens. The resulting ratios shall not be less than 0.85, and the specimens shall not crack or collapse before the buckling or 60 percent points are reached.

100.3.9 The three remaining specimens immersed for 60 days are to be returned to their containers and the immersion continued for an additional 60 days at the intended temperature. After the full 120 days, the specimens are to be removed from the reagent and given time to cool in still air before being rinsed carefully and wiped dry inside and out with a clean piece of lint-free absorbent cloth. The three dried specimens are each to be weighed (W_3) to within 10 mg of balance. W_3 shall not be more than 2.50 percent heavier or lighter than W_1. If W_3 is more than 1.00 percent heavier than W_1, $W_3 - W_1$ shall not be more than 1.65 ($W_2 - W_1$).

100.3.10 The three specimens immersed for 120 days and the last three of the specimens set aside for unaged tests are to be brought into thermal equilibrium with one another, the testing machine, and the surrounding air at a temperature of 23.0 ±2.0°C (73.4 ±3.6°F) and are to be kept so throughout the test. The inside diameter of each specimen is to be measured. The specimens are then to be tested separately between a pair of rigid, flat, steel plates that are at least 6 inches or 150 mm long and are horizontal and parallel to one another. One plate is to be moved toward the other at the rate of 1/2 ±1/8 inch per minute or 10.0 ±2.5 mm per minute until the surface of the specimen pulls away from contact with either plate – that is, until the specimen buckles – or until the minor axis measured inside the flattening specimen is 60 percent of the inside diameter measured before the test.

100.11 The crushing loads at the buckling and the 60-percent points are to be noted from the dial on the machine and recorded for each specimen. The loads at each of these points are to be averaged for each of the three sets of specimens. The average loads at each of these points for the aged specimens are to be divided by the average loads at each of these points for the unaged specimens. The resulting ratios shall not be less than 0.85 and the specimens shall not crack or collapse before the buckling or 60 percent points are reached.

101 Nonmetallic Service-Entrance Heads

101.1 General

101.1.1 Nonmetallic service-entrance heads shall comply with the following:

a) Water Absorption Test, Section 90.

b) Flammability Test, Section 92.

c) Extrusion or Molding-Process Test, Section 94.

Exception: A service-entrance head constructed of material other than polyvinyl chloride (PVC) need not comply with this test.

d) Identification Tests, Section 95.

Exception: A service-entrance head constructed of material other than polyvinyl chloride (PVC) need not comply with this test.

e) Ultraviolet-Light and Water Test, Section 101.2.

f) Aging Test, Section 101.3.

g) Impact Test, Section 102.4.

h) Impact Test After Cold Conditioning, Section 101.5.

i) Heat Distortion Test, Section 101.6.

Exception: A service-entrance head constructed of a thermosetting material need not be subjected to the Heat Distortion Test.

j) Pull Tests, 101.7.1.1 and 101.7.1.2.

k) Pull Tests, 101.7.2.1 and 101.7.2.2.

l) Wet-Locations Test, Section 39.

101.2 Ultraviolet-light and water test

101.2.1 Six as-received service-entrance heads are to be conditioned as described in 46.7.2. As a result of the conditioning, the fittings:

a) Shall not have cracks or openings, and

b) Shall comply with Impact Test, Section 101.4.

101.3 Aging test

101.3.1 Six as-received service-entrance heads are to be conditioned in an air-circulating oven for 168 hours at 100 ±1°C (212 ±2°F). As a result of the conditioning, the fittings:

a) Shall not have cracks or openings, and

b) Shall comply with Impact Test, Section 101.4.

101.4 Impact test

101.4 Eighteen service-entrance heads are to be subjected to an impact as described in 101.4.2. The 18 fittings are to come from the following sources: six in the as-received condition, six that have been subjected to the Ultraviolet-Light and Water Test, Section 101.2, and six that have been subjected to the Aging Test, Section 101.3. The fittings shall withstand the impact without splitting, crushing, or breaking.

101.4.2 A fitting to be impacted is to be placed on a flat steel plate. The impact is to be produced by dropping a weight through the vertical distance specified in Table 102.1 to strike the fitting. The weight is to consist of a steel cylinder 1-1/4 inches (31.8 mm) in diameter and weighing 5 pounds (2.3 kg). Nine fittings, three from each of the sources described in 101.4.1 are to be impacted on the top of their cover. The remaining nine fittings are to be impacted on the side of their cover where the cover is secured to the body.

Table 102.1
Vertical drop distance for impact test

Trade size of fitting	(metric designator)	Vertical distance of weight above fitting, ft (mm)			
		Top of cover		Side of cover	
1/2, 3/4, 1	(16, 21, 27)	3	(910)	2	(610)
1-1/4, 1-1/2, 2 – 4	(35, 41, 53 – 103)	3	(910)	3	(910)

101.5 Impact test after cold conditioning

101.5.1 Six as-received service-entrance heads are to be conditioned at minus 20 ±1°C (minus 4 ±2°F) for 5 hours. Immediately after removal from the conditioning, the samples shall comply with Impact Test, Section 101.4.

101.6 Heat distortion test

101.6.1 Six as-received service-entrance heads are to be conditioned as described in 101.6.2. As a result the conditioning:

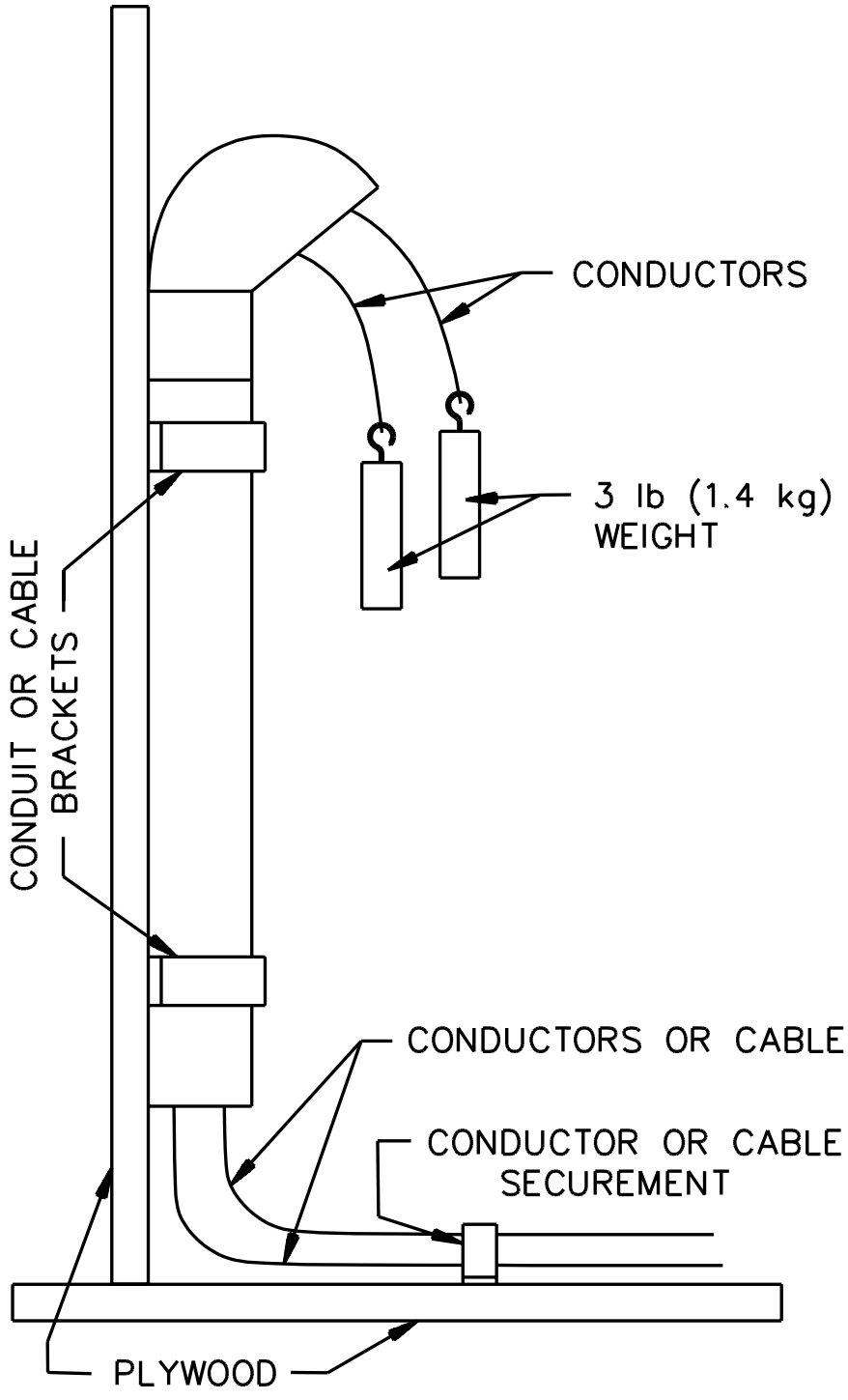
a) The fittings shall not have cracks or openings, and

b) There shall not be an opening to the inside of the fitting, between the body and the cover, which permits passage of a 1/16 inch (1.6 mm) diameter probe.

101.6.2 A service-entrance head is to be mounted on a short length of rigid nonmetallic conduit or a short length of service-entrance cable. Two insulated conductors are to be installed in each service-entrance head/conduit assembly. The conduit or cable is to be attached to a wood board. A 3-pound (1.3-kg) weight is to be attached to the two insulated conductors. See Figure 102.1. The board is to be placed in an oven so that the weights hang free. The oven is to be maintained at 70 ±1°C (158 ±2°F) for 300 hours. The fittings are to be removed from the oven and examined for compliance with 101.

101.6.2 revised October 21, 1998

Figure 102.1
Heat distortion test



101.7 Pull tests

101.7.1 Service-entrance heads with clamps to secure to conduit

101.7.1.1 When tested as described in 101.7.1.2 – 101.7.1.4:

a) The force required to pull a service-entrance head from the nonmetallic conduit on which it is mounted shall not be less than 50 lbf (222 N), and

b) The average force required to pull off the conditioned fittings shall not be less than the average force required to pull off the as-received fittings.

101.7.1.2 Six as-received service-entrance heads of each trade size are to be mounted on a 6-inch (152-mm) length of nonmetallic conduit in the intended manner, and the clamping screw is to be tightened to 35 lbf-in (4.2 N•m).

101.7.1.2 revised October 21, 1998

101.7.1.3 Three as-received fitting/conduit assemblies of each trade size are to be subjected to a pulling force between the fitting and the conduit until the assembly separates. The force required to separate each fitting/conduit assembly shall comply with 101.7.1.1 (a). The average force required to separate the three fitting/conduit assemblies is to be calculated.

101.7.1.4 Three fitting/conduit assemblies of each trade size are to be conditioned for 21 days in a air-circulating oven at 92 ±1°C (198 ±2°F). The fitting/conduit assemblies are to be removed from the oven and allowed to cool to room temperature but not less than 4 hours. The assemblies are then to be subjected to a pulling force between the fitting and the conduit until the assembly separates. The force required to separate each fitting/conduit assembly shall comply with 101.7.1.1 (a). For each trade size, the average force required for separation is to be in compliance with 102.7.1.1 (b).

101.7.2 Service-entrance heads with clamps to secure to cable

101.7.2.1 Six as-received service-entrance heads are to be tested as described in 102.7.2.2. There shall not be slipping of the cable or loosening of the clamp on the fitting.

101.7.2.2 A service-entrance head is to be secured to a length of service-entrance cable in the intended manner and mounted by its bracket. A force of 50 lbf (222 N) is to be applied between the fitting and the cable for 5 minutes.

MARKING

102 General

102.1 Markings shall be permanent, legible, and visible after the product is installed. The following types of markings or the equivalent are considered permanent:

a) Etched,

b) Molded,

c) Die stamped,

d) Paint stenciled, or

e) Indelibly stamped on a pressure sensitive label secured by adhesive and complying with the Standard for Marking and Labeling Systems, UL 969.

102.2 Markings in addition to those specified in Sections 102 and 103 are acceptable if they do not conflict with and cannot be confused with the specified markings.

102.3 Each polyvinyl chloride (PVC) fitting shall be marked with the manufacturer's name, trademark, or other descriptive marking by which the organization responsible for the product is identified. The fitting shall also be marked with the catalog number or an equivalent designation.

Exception: The catalog number or its equivalent designation marked on the smallest unit shipping carton is acceptable.

102.4 If the manufacturer produces polyvinyl chloride (PVC) fittings at more than one factory, each product shall be marked with a distinctive designation by which it can be identified as the product of a particular factory.

103 Details

103.1 Each fitting that has been found to be acceptable for wetting by, or immersion in, one or more specific reagents (see 86.3 and Resistance to Specific Reagents Test, Section 100) shall be marked (see 103.2) reagent-resistant A or with an equivalent designation.

103.2 Unless all of a manufacturer's products that are marked reagent-resistant have been found by the method described in Resistance to Specific Reagents Test, Section 100, to be acceptable for use with the same reagent or the same group of reagents – the concentrations and maximum temperatures being identical as well as the reagents themselves – the manufacturer shall add a different designation to the marking on each product as the means of differentiating between products in the field; for example, reagent-resistant A on one fitting and reagent-resistant B on another.

103.3 A fitting having a socket depth greater than the maximum specified in Table 90.2 shall be permanently marked ″Extra long sockets – Not for use with standard elbows or bends,″ or with equivalent wording.