UL 514C

STANDARD FOR SAFETY

Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers

UL Standard for Safety for Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers, UL 514C

Fourth Edition, Dated April 8, 2014

Summary of Topics

This revision of ANSI/UL 514C dated April 26, 2024 includes the addition of requirements for deck boxes and rooftop deck boxes; 1.4, 3.6A, Section 10 title, 10.1, 10.4, 92.1.15 and 93.7.

Text that has been changed in any manner or impacted by ULSE's electronic publishing system is marked with a vertical line in the margin.

The new and revised requirements are substantially in accordance with Proposal(s) on this subject dated March 3, 2023, August 25, 2023, November 24, 2023, and March 1, 2024.

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This ANSI/UL Standard for Safety consists of the Fourth Edition including revisions through April 26, 2024.

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The Department of Defense (DoD) has adopted UL 514C on August 17, 1989. The publication of revised pages or a new edition of this Standard will not invalidate the DoD adoption.

Comments or proposals for revisions on any part of the Standard may be submitted to ULSE at any time. Proposals should be submitted via a Proposal Request in the Collaborative Standards Development System (CSDS) at https://csds.ul.com.

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INTRODUCTION

1 Scope

1.1 These requirements cover nonmetallic outlet boxes, conduit bodies, flush-device boxes, extension rings, covers, floor boxes, floor nozzles, and concrete boxes to be employed in accordance with the National Electrical Code, NFPA 70.

1.2 These requirements do not cover boxes and covers for use in hazardous locations as defined in the National Electrical Code, NFPA 70.

1.3 These requirements do not cover cabinets and cutout boxes.

1.4 These requirements do not cover junction boxes for swimming pool luminaires.

2 Terminology

2.1 In the following text, a requirement that applies only to one or more types of box or cover is so identified by a specific reference in that requirement to the type or types of boxes or covers involved. Absence of such reference indicates that the requirement applies to all types of boxes or covers.

3 Glossary

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

3.2 BAR HANGER – An adjustable supporting device intended for the support of an outlet box, conduit box, or device box between two structural members in a finished or unfinished structure.

3.3 BOX EXTENDER – A component installed in or on a box that is mounted in a finished structure intended to extend the electrical enclosure up to the new finished surface. The box extender rests on the edge of the existing box (fixed depth) or extends into the box (adjustable depth). The flange of the box extender, if provided, rests on the finished surface.

3.4 CLAMP – Part of a box intended to secure raceway, tubing, or cable to the box.

3.5 CONCRETE BOX – A box intended for support in concrete. It may be constructed to permit end-to-end extension and the application of covers on two sides. It is not intended for installation in a floor.

3.6 CONDUIT BODY – A separate part of a raceway system intended to provide access to the interior of the system through one or more removable covers and/or sockets at a junction of two or more sections or at a terminal point. Boxes, such as FS, FD, and larger boxes, and fittings, such as capped elbows and service entrance elbows, are not considered to be conduit bodies.

3.6A DECK BOX – A box provided with means for flush mounting in outdoor deck applications.

3.7 EXTENSION RING – A ring, which is not required to be round, intended to extend the sides of an outlet box or flush-device box to increase the box depth, volume or both. It is mechanically secured to the box.

3.8 FLOOR BOX – A box provided with means for flush mounting in a floor. It is sealed against the entrance of scrub water at the floor level.

3.9 FLOOR NOZZLE – An enclosure used on a wiring system, intended primarily as a housing for a receptacle. It is provided with a means, such as a collar, for surface-mounting on a floor, and it may or may not include a stem to support it above the floor level. It is sealed against the entrance of scrub water at the floor level.

3.10 FLUSH-DEVICE BOX – A box provided with ears or flanges with No. 6-32 threaded or unthreaded holes spaced to accept the mounting yoke of a wiring device or devices. This box is provided with a mounting means, and it may or may not include clamps for connection of cable, tubing, or conduit.

3.11 OUTLET BOX – A box used on a wiring system, usually at an outlet. It is provided with means for connection to a wiring system and intended primarily to enclose splices and wiring devices, but may also be acceptable as the support of a fixture/luminaire or other equipment intended for similar installation. This box may or may not be provided with studs or a bar hanger or with clamps for securing cable, tubing, or conduit.

3.12 OUTLET BOX COVER – A cover intended to provide enclosure for the face of a box. The cover may or may not support or be provided with means for support of a wiring device, pendant cord, or the like.

3.13 PARTITION – A barrier used to separate sections of a box.

3.14 RAISED-FLOOR BOX – A floor box intended for use in raised floors, such as in electronic computer/data processing equipment rooms.

4 Units of Measurement

4.1 Values stated without parentheses are the requirement. Values in parentheses are explanatory or approximate information.

4A Normative References

UL 514A
Metallic Outlet Boxes

UL 514B
Conduit, Tubing, and Cable Fittings

BOXES AND COVERS

CONSTRUCTION

5 General

5.1 All boxes and covers

5.1.1 The construction of a box or cover shall provide sufficient strength and rigidity in the finished product to enable the product to resist the rough handling that can be encountered during shipment, installation, and use.

5.1.2 The inner and outer surfaces of a box or cover shall not be subject to peeling, scaling or flaking and shall be smooth and free from blisters, cracks, and other defects. 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 undue obstructions to the passage of wiring or mating of parts in the intended use of the product.

5.1.3 A partition shall comply with the requirements in Partitions, Section 12.

5.1.4 A box intended for use with a partition shall have provision for proper placement of the partition during and after installation.

5.1.5 A box extender shall comply with Box Extenders, Section 26.

5.1.6 An outlet box cover constructed to support a flush duplex receptacle shall be provided with more than one securement point for the receptacle.

5.1.7 A cover shall comply with Installation of Receptacles, Section 48.

Exception: The face of a receptacle may be located behind a nonmetallic cover provided it complies with all of the following:

a) The receptacle and cover shall be evaluated as an assembly, including compliance with 48.1;

b) The assembly shall be evaluated for compliance to requirements in this Standard, and the Standard for Attachment Plugs and Receptacles, UL 498;

c) The receptacle and cover shall be permanently attached or uniquely constructed to prevent securement of the cover to any other receptacle; and

d) The assembly shall be marked in accordance with 92.6.1, and provided with installation instructions in accordance with 93.6.

5.2 Boxes and covers intended for use with nonmetallic-sheathed cable or open wiring

5.2.1 The requirements in Sections 6 – 42 cover boxes and covers intended for use with nonmetallic sheathed cable or open wiring and boxes with a volume of less than 100 cubic inches (1639 cm^3), and multiple-gang flush-device boxes.

5.3 Boxes and covers intended for use with rigid nonmetallic conduit

5.3.1 The requirements in Sections 6 – 15 and 65 – 93 cover rigid nonmetallic, such as unplasticized polyvinyl chloride, boxes and covers, including blank covers.

5.3.2 The products covered by the requirements in Sections 6 – 15 and 65 – 93 are intended to be joined in the field to rigid nonmetallic conduit.

5.3.3 The nonmetallic products covered by the requirements in Sections 6 – 15 and 65 – 93 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 chromic acids, and pickling and plating baths. Resistance to specific reagents is covered in Resistance to Specific Reagents, Section 85 and in 92.3.1 and 92.3.2.

5.3.4 The outlet boxes covered by the requirements in Sections 6 – 15 and 65 – 93 have an interior volume of 100 cubic inches (1639 cm^3) or less and are intended to provide access to wiring during installation of the wiring. They are also intended to enclose splices, taps, and wiring devices. From one to four unthreaded conduit-connection sockets are provided integrally with a PVC box, or the box is blank.

5.3.5 The conduit bodies covered by the requirements in Sections 6 – 15 and 65 – 93 are pull boxes intended for use with nonmetallic conduit to enclose splices and taps and to support wiring devices not involving the generation of heat – for example, lampholders are not acceptable – mounted on cover plates.

Blank covers are to be provided with the bodies. From one to four unthreaded conduit-connections sockets are to be provided integrally with the body.

5.3.6 The flush-device boxes covered by the requirements in Sections 6 – 15 and 65 – 93 have an interior volume of 100 cubic inches (1639 cm^3) or less. Flush-device boxes made of PVC material are intended for use with nonmetallic conduit for the support of wiring devices not involving the generation of heat – for example, lampholders are not acceptable – with the wiring devices mounted directly in the box rather than on the cover but can also be used as junction and conduit bodies. Flush-device boxes may be provided with blank covers or flush-device cover plates. At least one unthreaded conduit-connection socket or knockout is provided integrally with a PVC box, or the box is blank.

5.3.7 A flush-device box that is not multi-gang, a junction box, or an outlet box, the interior of which is larger in volume than 100 cubic inches (1639 cm^3), is covered as a junction or pull box under the requirements in the Standard for Enclosures for Electrical Equipment, UL 50.

5.4 Nonmetallic outlet box covers for use in damp and wet locations

5.4.1 An outlet box cover intended for use in damp or wet locations shall comply with the applicable requirements in Sections 44 – 60 when installed as intended and shall be marked in accordance with 92.4.1 – 92.4.4.

Exception No. 1: An outlet box cover intended for use in a wet location with the cover closed is not required to comply with the requirements in 52.3.1 and 52.3.3.

Exception No. 2: An outlet box cover intended for use in a damp location is not required to comply with the requirements in 52.2.1 – 52.3.3.

5.5 Boxes and covers intended for use with electrical nonmetallic tubing

5.5.1 The products covered by the requirements in Sections 6 – 43 and 61 – 64 are boxes and covers intended for use with electrical nonmetallic tubing.

6 Protection Against Corrosion

6.1 All surfaces of all attached metal parts of a box, including screws, shall be protected against corrosion unless the metal is inherently resistant to corrosion.

Exception: The cut edges, punched holes, and the threaded surfaces of tapped holes of a part formed from galvanized stock do not need additional protection.

6.2 The thickness of the coating on a screw is not specified, but the presence of a coating is to be determined by visual inspection.

6.3 The thickness of a zinc coating on the exposed surface of a permanently attached ferrous metal mounting bracket or a clamp shall not be less than specified in Table 6.1.

Table 6.1
Thickness of coating

Material	Minimum thickness of coating inch [millimeter (mm)]			
	Intended for assembly			
	Outside of box		Inside of box	
Sheet steel	0.0005	(0.013)	0.00015	(0.0038)
Cast iron, including malleable iron	0.00015	(0.0038)	0.00015	(0.0038)

7 Assembly

7.1 Except as noted in 7.2, an assembly screw shall not have fewer than the number of threads per inch of the American National Coarse-Thread Series, in accordance with the diameter of the screw, unless it is found by investigation that the screw is not likely to abrade conductor insulation, and that the assembly is not adversely affected by vibration.

7.2 An assembly screw used to secure a cover to a box shall not have a fewer than the number of threads per inch specified in the American National Coarse-Thread Series for the diameter of the screw.

7.3 An outlet box intended to support a fixture/luminaire, but not intended to support a ceiling-suspended fan, may or may not be provided with two or more steel No. 8-32 cover retaining or fixture/luminaire support screws, and shall be provided with threaded or unthreaded holes for No. 8-32 screws.

7.4 An outlet box intended to support a fixture/luminaire, and also intended to support a ceiling-suspended fan, shall comply with Ceiling-Suspended Fan Support, Section 11.

7.5 Metal that is part of or provided with an outlet box and with which a wire or cable may make contact shall be located or protected so that contact with the part by a person or by metal outside the box will be prevented.

Exception: A grounding strap or plate may contact wires within an outlet box provided the construction complies with the requirements in 26.1.

7.6 So that contact between a supporting eyelet, nail, rivet, or screw and conductors within a box will be prevented as required by 25.3, a hole in a box that may be used for an eyelet nail, rivet, or screw shall be located in a recess, designed so that there will be a spacing of not less than 1/32 inch (0.8 mm) between the plane of the top of the recess and the head of the largest eyelet, nail, rivet, or screw that is provided with the box. If a screw or nail is not provided with the box, this spacing shall be measured:

a) Using the largest round-head screw, specified in Table 7.1, that can be inserted in a hole that is not chamfered, or

b) Using the largest flat-head screw that can be inserted in a hole that is chamfered.

Table 7.1
Supporting screw hole dimensions

Nominal screw size	Maximum diameter of threads inch (mm)		Minimum dimensions of recess, inch (mm) Diameter		Depth	
6	0.138	(3.51)	1/4	(6.4)	4/32	(3.2)
8	0.164	(4.17)	19/64	(7.5)	9/64	(3.6)
10	0.190	(4.83)	11/32	(8.7)	5/32	(4.0)
12	0.216	(5.49)	25/64	(9.9)	11/64	(4.4)

7.7 An assembly screw that can be tightened with a screwdriver is to be tightened with the torque specified in Table 7.2.

Table 7.2
Tightening torque

Nominal screw size	Tightening torque pound-inch	(N·m)
6	12	(1.36)
8	20	(2.26)
10	35	(3.96)

8 Dimensions

8.1 A flush-device box shall have a minimum internal width of not less than 1-3/4 inches (44.5 mm).

8.2 The volume of any box, raised cover, extension ring, or fitting that increases significantly the volume of a box assembly shall be verified as described in Volume Verification Test, Section 15, or by any equivalent means. See 92.1.5 and 92.1.7 for marking requirements.

8.3 A box provided with a partition shall have the volume of each partitioned section verified as described in Volume Verification Test, Section 15, or by any equivalent means. Each partitioned section of the box shall be marked in accordance with 92.1.5.

9 Device Support

9.1 Provision for supporting a device to be enclosed in a box shall be independent of the screws used to support the box.

10 Floor Boxes, Deck Boxes

10.1 In addition to the requirements for nonmetallic outlet boxes in this Standard, a floor box, deck box shall comply with the appropriate requirements for Floor Boxes in the Standard for Metallic Outlet Boxes, UL 514A, including markings and installation instructions indicated as applicable to outlet boxes for use in the United States.

10.2 Where appropriate, floor boxes shall be marked in accordance with 92.3.5 or 92.5.

10.3 *deleted*

10.4 A deck box shall have a minimum Type rating of 3R in accordance with the Standard for Enclosures for Electrical Equipment, Environmental Considerations, UL 50E.

11 Ceiling-Suspended Fan Support

11.1 In addition to the requirements for nonmetallic outlet boxes in this Standard, an outlet box intended to support a ceiling-suspended fan shall comply with the requirements in Section 32.2 and the appropriate requirements for Fixture/Luminaire Support and for Ceiling Suspended Fan Support in the Standard for Metallic Outlet Boxes, UL 514A, including markings and installation instructions indicated as applicable to outlet boxes for use in the United States.

11.2 *deleted*

12 Partitions

12.1 A partition shall fit the inside of the box in which it is intended to be used. Any openings or gaps of any length between the partition and the inside surface of the box shall not be greater than 0.080 inch (2.0 mm).

12.2 A polymeric material used for a partition shall have a relative thermal index of not less than 80°C (176°F) for properties of electrical and mechanical without impact determined in accordance with the Standard for Polymeric Materials – Long Term Property Evaluations, UL 746B.

12.3 A partition manufactured from a polymeric material shall comply with the requirements for the Flammability Test as specified in 34.1.1 – 34.1.7.

Exception: A material designated 5VA, in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94, need not be tested.

12.4 A partition manufactured from a polymeric material shall comply with the requirements for the Mold Stress Test, Section 35.

12.5 A partition manufactured from a polymeric material shall comply with the requirements for the Water Absorption Test, Section 33.

12.6 A partition manufactured from a polymeric material shall not ignite within 15 seconds after application of the test current, when subjected to the Hot-Wire Ignition Test, in accordance with the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A.

Exception: A polymeric material with a Performance Level Category (PLC) of 0, 1, 2, or 3 in accordance with the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A, need not be tested.

PERFORMANCE

13 General

13.1 Unless otherwise stated, not less than six samples of each type of box, cover, and the like are to be subjected to each test.

Exception: When a line of at least four sizes of boxes or the like, of a particular design, is being investigated, not less than three samples of each box are to be tested.

14 Protection Against Corrosion

14.1 The metallic-coating-thickness test described in 14.2 – 14.9 is to be used to determine the thickness of zinc coatings. The test is only to be conducted when a required coating thickness is specified.

14.2 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 sulfuric acid (H_2SO_4). The latter is equivalent to 27 milliliters per liter of reagent grade concentrated sulfuric acid, specific gravity 1.84, containing 96 percent of H_2SO_4.

14.3 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 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 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 may be used in place of the glass tube to control the rate of dropping.

14.4 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 – 32°C (70 – 90°F).

14.5 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.

14.6 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 should be inclined about 45 degrees from horizontal.

14.7 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 off the protective metallic coating, exposing the base metal. The end point is the first appearance of the base metal recognizable by a change in color at that point.

14.8 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 may be expected to be the thinnest. On parts made from precoated sheets, a bend or the like that is subjected to the greatest deformation is likely to have thin coatings.

14.9 To calculate the thickness in inches (mm) of the coating being tested, select from Table 14.1 the thickness factor appropriate for the temperature at which the test was conducted and multiply by the time in seconds required to expose the base metal as measured in 14.7.

Table 14.1
Coating thickness factors

Temperature, Degrees		Thickness factors, 0.00001 inches (0.0003 mm) per second
F	(C)	Zinc platings
70	(21.1)	0.980
71	(21.7)	0.990
72	(22.2)	1.000
73	(22.8)	1.010
74	(23.3)	1.015
75	(23.9)	1.025
76	(24.4)	1.033
77	(25.0)	1.042
78	(25.6)	1.050
79	(26.1)	1.060
80	(26.7)	1.070
81	(27.2)	1.080
82	(27.8)	1.085
83	(28.3)	1.095
84	(28.9)	1.100
85	(29.4)	1.110
86	(30.0)	1.120
87	(30.6)	1.130
88	(31.1)	1.141
89	(31.7)	1.150
90	(32.2)	1.160

15 Volume Verification Test

15.1 A box, partitioned section, raised cover, extension cover, or fitting shall hold a volume of water equal to or greater than the marked volume when tested in accordance with 15.2 – 15.5.

15.2 All separable cable clamps, associated screws, and fixture/luminaire studs are to be removed. Any projections that extend outside the plane of the open face of a box, such as ears for mounting a cover or a flush device, are to be ground flush with the face of the box.

15.3 All large openings are to be closed by flat, rigid plates clamped in place across the openings. One of the plates is to contain two small holes, one for the entrance of a measuring fluid, the other for venting air.

15.4 Using modeling clay, putty, glazing compound, or similar material:

a) A hole through the side or bottom of the sample and a hole between the sample and the plate mentioned in 15.3 are to be filled flush with the inside surface.

b) An internal hub, if tapped through, is to be filled flush with the end of the hub.

c) A bushed opening is to be filled flush with the conduit stop.

15.5 Using a clean, graduated vessel – pipette or the equivalent – having a volume equal to or greater than the marked volume of the sample and containing water at room temperature, water is to be transferred to the test sample through the hole in the plate mentioned in 15.3. The results are acceptable if the test sample holds a volume of water equal to or greater than the marked volume.

16 Scrub-Water Exclusion Test

16.1 *deleted*

16.2 *deleted*

16.3 *deleted*

16.4 *deleted*

16.5 *deleted*

16.6 *deleted*

17 Floor Box and Cover Loading Test

17.1 *deleted*

17.2 *deleted*

17.3 *deleted*

Figure 17.1
Figure deleted

17.4 *deleted*

18 Support for Floor Boxes

18.1 *deleted*

18.2 *deleted*

18.3 *deleted*

BOXES INTENDED FOR USE WITH NONMETALLIC-SHEATHED CABLE OR OPEN WIRING CONSTRUCTION

19 Materials

19.1 A material used for a box that has not been investigated for the application shall be investigated for combustibility, aging characteristics, temperature stability, resistance to ignition, dielectric strength, and physical strength.

19.2 A material that is employed in a box not intended for the support of a fixture/luminaire, or in a box intended to support a fixture/luminaire weighing 49 lbs (22.2 kg) or less and marked for use in a wall, shall have relative thermal indices of not less than 80°C (176°F) for properties of electrical (RTI Elec) and mechanical strength (RTI Str). See 92.1.9.

19.3 A material that is employed in a box that is marked intended for support of a fixture/luminaire in a ceiling, or a ceiling suspended fan shall have relative thermal indices of not less than 90°C (194°F) for properties of electrical (RTI Elec) and mechanical strength (RTI Str).

19.3A An overmold or overlay material applied to a box described in 19.2 or 19.3 for the purpose of closing openings in air-seal applications, shall have relative thermal indices of not less than 50°C (122°F) for properties of electrical (RTI Elec) and mechanical strength (RTI Str). No openings shall be greater than 0.625 inch (15.90 mm) by 0.844 inch (21.44 mm). Overmold or overlay material does not apply to gaskets used to cover up knockouts or clamps.

19.4 The relative thermal index specified in 19.2, 19.3, 19.3A, 40.2.1, and 46.1 is to be determined in accordance with the Standard for Polymeric Materials – Long Term Property Evaluations, UL 746B.

PERFORMANCE

20 Hot-Wire Ignition

20.1 When tested as described in 20.2, a polymeric material used for a box shall not ignite within 15 seconds after the application of the test current.

Exception: A material that has been previously investigated and found to be rated for the application is not required to be tested.

20.2 To determine whether a material complies with the requirement in 20.1, three 1/2-inch (12.7 mm) by 5-inch (127-mm) specimens of polymeric material in sheet form having a thickness of not more than the minimum thickness used for the box are to be tested in accordance with the requirements for hot-wire ignition described in the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A.

21 Dielectric Voltage Withstand

21.1 The molded material used for a box shall withstand for 1 minute without breakdown the application of a 60-hertz, essentially sinusoidal potential of 2500 volts when tested as described in 21.2.

Exception: A box made of a molded material that has been previously investigated and found to be rated for the application.

21.2 To determine whether a box complies with the requirement in 21.1, sample boxes are to be tested by applying the test potential across the thinnest section of the box, excluding knockouts. Each box is then to be conditioned for 24 hours in moist air having a relative humidity of 85 ±5 percent at a temperature of 32 ±2°C (90 ±4°F). Following this conditioning, each box is again to be subjected to the specified test potential.

BOXES INTENDED FOR USE WITH NONMETALLIC-SHEATHED CABLE OR OPEN WIRING

CONSTRUCTION

22 Knockouts

22.1 A knockout shall completely cover the opening in which it is located, and the clearance between the knockout and the opening shall not be more than 0.030 inch (0.76 mm).

22.2 The maximum dimension of a knockout intended for use with a nonmetallic fixture/luminaire stud shall not exceed 27/32 inch (21.4 mm).

22.3 The dimensions of a knockout intended for use with nonmetallic-sheathed cable shall not be more than:

a) 0.500 inch (12.70 mm) by 0.625 inch (15.90 mm) for a single-stage cable knockout, and

b) 0.500 by 0.625 inch for the first stage of a multi-stage knockout and 0.625 by 0.844 inch (21.44 mm) for the second stage. See 29.4.

Exception: A box intended for use with nonmetallic-sheathed cable and either provided with or having provision for a separable cable clamp may have a single-stage knockout that does not exceed 0.625 by 0.844 inch.

23 Connections for Wiring Systems

23.1 A box shall be provided with means for connection to a wiring system.

23.2 A box intended for use with open wiring or concealed knob and tube wiring shall have provisions for the separate entry of each conductor through a hole.

23.3 Each box shall be provided with a number of means for securing open wiring, concealed knob and tube wiring, and nonmetallic - sheathed cables entering the box. This number shall be consistent with the box volume but need not exceed the number of knockouts in the box. See 23.4.

Exception: A box nominally 2-1/4 by 4 inches or smaller (single-gang) need not be provided with a means for securing nonmetallic-sheathed cable. A round or octagonal box is not considered to be such a box.

23.4 To determine the minimum number of wiring and cable securing means that shall be provided with a box, the following method shall be used:

a) For a securing means intended for use with open wiring or concealed knob and tube wiring, the number shall be calculated from the formula:

$$C = \frac{V}{2} - 1$$

in which:

C is the number of securing means, and

V is the marked volume of the box. A further subtraction of 1 is acceptable for each device intended to be fastened to the box.

b) For a securing means that is acceptable only for nonmetallic-sheathed cable, dividing the number calculated in accordance with (a) by 2 is acceptable. See 23.5.

23.5 The result calculated as described in 23.4(a) and (b) shall be rounded, if necessary, to the nearest integer.

23.6 The securing means required by 23.3 shall be integral with, fastened to, or packed securely inside each box.

Exception: A securing means may be separate from a box provided the number of means required for each box is included in the smallest unit carton in which the box is shipped, and both the box and the means are marked in accordance with 92.2.2 and 92.2.3, respectively.

23.7 Nonmetallic boxes not larger than 2-1/4 by 4 inches (57 by 100 mm) intended for installation in a finished existing structure shall be either supplied with a means of securing the cable or conduit to the box or marked in accordance with 92.2.7.

24 Clamps for Nonmetallic-Sheathed Cable

24.1 A clamp provided in a box and intended for securing nonmetallic-sheathed cable shall substantially close the opening in the box surrounding the cable.

24.2 A clamp provided as part of a box and intended for use with nonmetallic-sheathed cable shall secure cable ranging in size from 14 AWG (2.1 mm^2), two-wire cable with an uninsulated grounding wire to the largest oval or round multiconductor cable that can be accommodated by the clamp unless the clamp is marked to indicate its use with other cable sizes. See 30.1.1, 92.2.4, and 92.2.5.

25 Supports

25.1 A box shall be provided with means for support so that it can be securely fastened in place without depending upon the support furnished by any wiring system.

25.2 Sheet-steel end-supporting ears furnished with a box shall not be less than 0.036 inch (0.91 mm) thick if formed from uncoated stock, and not less than 0.039 inch (0.99 mm) thick if formed from galvanized stock. The ears shall be attached to the box and prevented from turning relative to the box.

25.3 Provision for support or other mounting means shall be outside the box, unless the box is constructed so that the conductors within the box cannot contact supporting screws.

25.4 A molded, threaded boss intended for support of a fixture/luminaire shall not be recessed more than 1/8 inch (3.2 mm) from the plane of the open face of the box. See 32.2.7– 32.4.1.

25.5 Where the supporting means is constructed of a polymeric material, the supporting means shall also comply with Polymeric Supporting Means, Section 32.6.

25.6 In addition to the requirements for nonmetallic outlet boxes in this standard, an outlet box intended for fixture/luminaire support shall comply with the requirements in Section 32.2 and the appropriate requirements for Fixture/Luminaire Support and for Ceiling Suspended Fan Support in the Standard for Metallic Outlet Boxes, UL 514A, including markings and installation instructions indicated as applicable to outlet boxes for use in the United States.

25.7 An outlet box and bar hanger assembly shall comply with the appropriate requirements for Fixture/Luminaire Support, including markings indicated as applicable to outlet boxes for use in the United States.

25.8 *deleted*

25.9 *deleted*

25.10 *deleted*

26 Grounding

26.1 A metal strap or plate provided in a box and intended for connection of a grounding conductor shall be provided with one or more grounding screws. The strap or plate shall provide a continuous conductive path from each screw to the mounting yokes or straps of all devices that may be mounted in the box.

26.2 A grounding screw provided in a box shall be No. 8-32 or larger, have a green-colored head that is slotted or hexagonal, or both, and be plated steel, stainless steel, copper, or copper alloy. A grounding screw shall engage at least two full threads and shall be used in conjunction with upturned lugs, a cupped washer, or an equivalent method that is capable of retaining a 10 AWG conductor under the head of the screw.

27 Extension Rings

27.1 An extension ring shall fit closely with a box of the type and size with which it is intended to be used.

27.2 An extension ring manufactured from a polymeric material shall comply with the following:

a) The relative thermal index in accordance with 19.2 and 19.4,

b) Hot-Wire Ignition, Section 20,

c) Dielectric Voltage Withstand, Section 21,

d) Water Absorption, Section 33,

e) Flammability, Section 34,

f) Mold Stress, Section 35,

g) Resistance to Crushing, Section 36, and

h) The Impact Test described in 37.1 and 37.2.

28 Box Extenders

28.1 A box extender shall not be used to secure any type of product and shall be provided with installation instructions in accordance with 93.4 and 93.5.

28.2 A fixed box extender shall fit on the open face of the box. There shall not be openings between the box extender and the plane of the open face of the box.

28.3 An adjustable box extender shall fit inside the box in which it is intended to be used. There shall not be openings between the box extender and the plane of the open face of the box under any intended adjustment.

28.4 An adjustable box extender shall be marked to show the maximum allowable amount of extension in accordance with 92.1.20.

28.5 A polymeric material employed in a box extender used with boxes not intended for the support of a fixture/luminaire, or for boxes intended to support a fixture/luminaire weighing 49 lb (22.2 kg) or less and marked for use in a wall, shall have relative thermal indices in accordance with 19.2 and 19.4. A polymeric material employed in a box extender used with boxes marked for support of a fixture/luminaire in a ceiling

or with boxes marked to support a ceiling suspended fan shall have relative thermal indices in accordance with 19.3 and 19.4. See 93.4.

28.6 A polymeric material used for a box extender shall not ignite within 15 seconds after application of the test current when subjected to the Hot-Wire Ignition Test in accordance with the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A.

Exception: A polymeric material with a Performance Level Category (PLC) of 0, 1, 2, or 3 in accordance with the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A, is not required to be tested.

28.7 A box extender manufactured from a polymeric material shall comply with Flammability, Section 34. With reference to 34.2, the flame shall be applied only to the exterior edge and interior flat surface.

Exception: A box extender manufactured from a polymeric material designated 5VA, in accordance with the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94, is not required to be tested.

28.8 A box extender manufactured from a polymeric material shall comply with the following:

a) Dielectric Voltage Withstand, Section 21,

b) Water Absorption, Section 33,

c) Mold Stress, Section 35,

d) The Impact Test described in 37.1 and 37.2.

PERFORMANCE

29 Knockouts

29.1 A force of 10 pounds (44.5 N) shall be applied to a knockout or integral cable clamp for 1 minute by means of a minimum 1-1/2 inch (38.1 mm) long by 1/4 inch (6.4 mm) diameter mandrel with a flat end. The force is to be applied in a direction perpendicular to the plane of the knockout or clamp and at the point most likely to cause movement. The knockout or clamp shall remain in place and the clearance between the knockout or clamp and the opening shall not be more than 0.030 inch (0.75 mm) when measured 1 hour after the force has been removed.

29.2 A knockout shall be easily removed by means of a screw driver, used as a chisel, without leaving any sharp edges or causing any damage to the box. The side edge of a screwdriver may be run along the edge of the knockout opening once, to remove any fragile tabs remaining along the edge.

29.3 A box that is constructed of a material that is known to be affected by low temperatures is to be conditioned for 5 hours in air maintained at minus 20 ±1°C (minus 4 ±2°F). Immediately following this conditioning, the test described in 29.2 shall be repeated on the box.

29.4 For a box employing multi-stage knockouts, there shall be no displacement of a larger stage when a smaller stage is removed as described in 29.1 and 29.2.

30 Clamps for Nonmetallic-Sheathed Cable

30.1 Pull Test

30.1.1 A box provided with a nonmetallic-sheathed-cable clamp(s) shall comply with the appropriate requirements in Clause 8.25 of the Standard for Conduit, Tubing, and Cable Fittings, UL 514B, CSA C22.2 No. 18.3, or NMX-J-017-ANCE . The box shall be prepared for testing in accordance with 30.1.2 and 30.1.3.

30.1.2 Knockout removal is to be in accordance with 29.2. For an integral nonmetallic clamp, the holding tabs of the clamp are to be cut. The integral clamp is not to be removed.

30.1.3 Three sample assemblies from each set of boxes having an integral nonmetallic clamp for nonmetallic-sheathed cable are to be tested in the as-received condition. Three sample assemblies from each set are to be tested immediately after being removed from being conditioned for 24 hours in air at a temperature of minus 25 ±1°C (minus 13 ±2°F).

30.2 Assembly at Low Temperature Test

30.2.1 When tested as described in 30.2.2, an integral cable clamp shall remain usable and stay in place during installation of nonmetallic-sheathed cable at low temperatures.

30.2.2 After being conditioned in air maintained at minus 20 ±1°C (minus 4 ±2°F) for 5 hours, a box provided with an integral nonmetallic sheathed cable clamp is to be assembled using the largest size nonmetallic sheathed cable(s) that the clamp is intended to secure where the cable complies with the Standard for Nonmetallic-Sheathed Cables, UL 719. The cable is to be assembled to the box in the conditioned air or within 15 seconds after removal. See 92.2.4 and 92.2.5. Knockout removal during assembly is to be in accordance with 30.1.2.

31 Clamps for Flexible Nonmetallic Tubing

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

31.2 The tubing to be employed in conducting the test described in 32.1.1 is to be standard 7/32-inch flexible nonmetallic tubing; Type T, TW, or THW, 14 AWG (2.1 mm^2) wire is to be used, and is to project approximately 6 inches (152 mm) inside the box. A screw that can be tightened with a screwdriver is to be tightened as specified in 7.7.

32 Supports

32.1 General

32.1.1 A bracket or other device for securing a flush-device or other box not intended to support a fixture/luminaire to a structural wall stud shall withstand a pull of 50 pounds (222 N) when tested in accordance with 32.1.2. The bracket may bend; but the results of the test are not acceptable if the bracket breaks, or if the box is pulled loose from the bracket.

32.1.2 The bracket is to be secured so that the plane of the front of the box is vertical, and a 50-pound (22.7-kg) weight is to be suspended from the lower outer edge of the box for 5 minutes.

32.2 Fixture/Luminaire support

32.2.1 *deleted*

32.2.2 *deleted*

32.2.3 *deleted*

32.2.4 *deleted*

32.2.5 *deleted*

Table 32.1
Table deleted

32.2.6 *deleted*

32.2.7 One sample of each basic outlet box mold design intended for the support of fixtures/luminaires is to be tested. A rigid bracket for supporting the test weight is to be secured to the box with a No. 8 screw, as specified in Table 38.1, at each end. The threads of the screws are not to project more than 3/8 inch (9.5 mm) beyond the plane of the box, into the box opening. The assembly of the box and bracket is then to be conditioned for at least 7 hours in an air-circulating oven maintained at a temperature of 105 ±1°C (221 ±2°F). The box is to be supported at its open face in a manner that best preserves the configuration of the box without obstructing the test-weight support bracket. While the box is maintained at 105°C, the applicable test-weight specified in Table 32.2 is to be suspended for 5 minutes from the bracket at a point midway between the bracket mounting screws.

32.2.8 One sample of each basic outlet box mold design intended for the support of fixtures/luminaires is to be tested. The weight support bracket is to be secured to the box as described in 32.2.7. The assembly of the box and weight support bracket is to be supported in an air-circulating oven and a test-weight that equals the marked fixture/luminaire support weight is to be suspended from a point midway between the bracket mounting screws. The complete assembly is then to be maintained for 24 hours at a temperature of 105 ±1°C (221 ±2°F).

Table 32.2
Test-weight values

Weight of fixture/luminaire[a]		Test-weight[b]	
lb	(kg)	lb	(kg)
50[c]	(22.7)	200	(90.7)
60	(27.2)	240	(108.9)
70	(31.7)	280	(127.0)
80	(36.3)	320	(145.2)
90	(40.8)	360	(163.3)
100	(45.4)	400	(181.4)
110	(49.9)	440	(200.0)
120	(54.4)	480	(217.7)

Table 32.2 Continued on Next Page

Table 32.2 Continued

Weight of fixture/luminaire[a]		Test-weight[b]	
lb	(kg)	lb	(kg)
130	(59.0)	520	(235.9)

[a] The weight of the fixture/luminaire is to be determined by the marking required in 92.1.18. There is no limit on the weight of the fixture/luminaire.

[b] The test-weight that corresponds with the marked fixture/luminaire weight is to be used for the test specified in 32.2.7.

[c] For a fixture/luminaire weighing 50 lbs (22.7 kg) or less, a 200 lb (90.7 kg) test-weight is to be used.

NOTE – Values for fixtures/luminaires exceeding 130 lb (59.0 kg) not shown in the table are to be extrapolated using 10-lb increments for the fixture/luminaire weight and 40-lb increments for the corresponding test-weight values.

32.3 Ceiling-suspended fan support

32.3.1 *deleted*

32.3.2 *deleted*

32.3.3 *deleted*

Figure 32.1
Figure deleted

32.3.4 *deleted*

32.3.5 *deleted*

32.3.6 *deleted*

32.4 Boxes intended to be installed in a finished structure

32.4.1 As a result of the test described in 32.4.2 – 32.4.5, the box supporting means shall not crack or break or result in the face of the box being permanently displaced more than 1/8 inch (3.2 mm) from the plane of the face of the test surface when measured 1 minute after the test load is removed.

32.4.2 Eight boxes intended for use in walls are to be installed in a 3/8-inch (9.5-mm) thick plywood sheet reinforced with a support 6 inches (152 mm) from one edge of the opening for the boxes, or in a finished surface in accordance with the manufacturer's instructions. Screws for the box supporting means are to be tightened in accordance with the manufacturer's instructions. See 93.1. In the absence of instructions, screws larger than No. 8 are to be tightened with a torque of 35 pound-inches (3.96 N·m). A No. 8 screw is to be tightened with a torque of 20 pound-inches (2.26 N·m). A No. 6 screw is to be tightened with a torque of 12 pound-inches (1.36 N·m). See 32.4.4.

32.4.3 *Deleted*

32.4.4 Screws for the box mounting means are to be tightened to the torque specified in 32.4.2. A screw that strips before being tightened to the torque specified shall not override more than once. As a result of the testing in 32.4.5, the screw shall be capable of being removed by a screwdriver.

32.4.5 After installation as specified in 32.4.2, a force of 50 pounds (222 N) is to be applied for 5 minutes consecutively to each of two boxes in a direction normal to the plane of the face of the test surface along the center line of the box, and tending to push the box into the opening. The same force is to be applied to each of two previously untested boxes in a direction tending to pull the box out of the opening. For a clip or clamp that is an integral part of a box designed for use with nonmetallic sheathed cable, the remaining two samples are to be tested with a force of 60 pounds (267 N) applied for 5 minutes to the box wall at right angles to any pryout or punchout for the cable that applies the greatest stress to the mounting device.

32.5 Boxes for support of products up to 50 pounds (22.7 kg)

32.5.1 *deleted*

32.5.2 *deleted*

32.5.3 *deleted*

32.6 Polymeric supporting means

32.6.1 The polymeric supporting means of a box intended to be installed in an existing structure shall have a relative thermal index of not less than 60°C (140°F) for properties of electrical and mechanical without impact and a relative thermal index of not less than 50°C (122°F) for mechanical with impact properties.

32.6.2 The polymeric supporting means of a box intended to be installed in an existing structure shall not exhibit any cracks or change in any dimension greater than 10 percent following conditioning of the box as described in 32.6.3.

32.6.3 Sample boxes are to be conditioned for 7 hours at a temperature of 70°C (158°F) in an air-circulating oven. After the box has been removed from the oven and cooled to room temperature, the supporting means is to be examined for cracks and changes in dimensions.

33 Water Absorption

33.1 The molded material used for a box or part is to be conditioned as described in 33.2. The conditioning shall not result in:

a) Any dimensional change of the specimen, including thickness, of more than 3 percent; or

b) An increase in the weight of the specimen of more than 3 percent.

Exception: A box made of a molded material that has been previously investigated and found to be acceptable for the application.

33.2 To determine whether a material used for a box complies with the requirements in 33.1, three specimens of the molded material of a box or part, each being 1 inch (25.4 mm) by 3 inches (76.2 mm) and having a thickness of not more than the minimum thickness of the wall of the box, except a knockout, or part, are to be tested. Each specimen is to be dried in a calcium chloride desiccator for 24 hours. After being dried, each specimen is to be measured, weighed and then immersed for 24 hours in distilled water maintained at a temperature of 23.0 ±2°C (73 ±4°F). Following removal from the water, each sample is to be wiped dry of excess moisture, and the change in the dimensions and weight are to be determined. The percentage of change is then to be calculated in accordance with the method for measuring water absorption of plastics in the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A.

34 Flammability

34.1 Materials

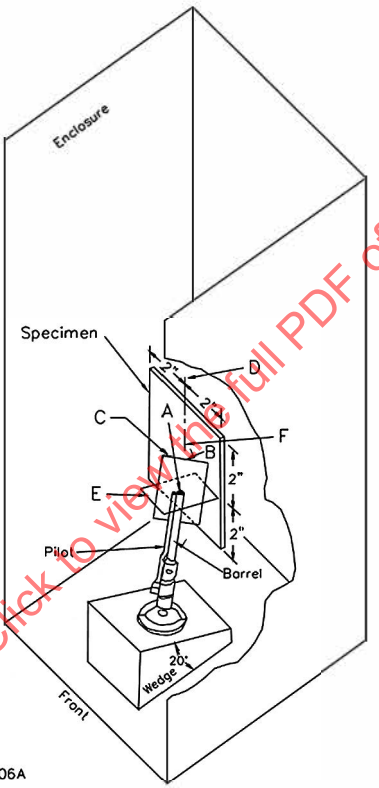
34.1.1 When tested as described in 34.1.2 – 34.1.7, a polymeric material shall not flame for more than 1 minute after the fifth application of a standard test flame.

34.1.2 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 to be prevented from affecting the test flame.

34.1.3 Each of three 4-inch-square (102-mm-square) or 4-1/2-inch-diameter (114-mm-diameter) specimens of the molded composition in sheet form having a thickness equal to the minimum thickness used for a part or the body of a box, except a knockout, 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 34.1.

Figure 34.1

Essential dimensions of apparatus and specimen



Note – SI units for the values specified are:

4 inches (102 mm); 2 inches (50.8 mm); 1-1/2 inches (38.1 mm)

C Vertical plane parallel to sides of enclosure and containing vertical axis of specimen and longitudinal axis of barrel

D Vertical axis of specimen in center of enclosure and parallel to back of enclosure

E Plane of the tip of the barrel

F Longitudinal axis of barrel

34.1.4 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). The gas supplied for the flame shall produce 1010 ±10 Btu's per cubic foot (37.63 ±0.372 MJ/m^3). With the barrel 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 (38.1 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.

34.1.5 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 34.1 – 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.

34.1.6 The jig is also adjusted toward the rear or front of the enclosure – see Figure 34.1 – to position the point A, which is the intersection of the longitudinal axis of the barrel with the plane of the tip of the barrel 1-1/2 inches (38.1 mm) from the point B at which the extended longitudinal axis of the barrel meets the front surface of the specimen. Point B is the point at which the tip of the inner blue cone will touch the specimen. The specimen is to be adjusted vertically to place point B at the center of the specimen.

34.1.7 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. The procedure is to be repeated four times for a total of five applications of flame to the specimen.

34.2 Boxes

34.2.1 When tested as described in 34.2.2 and 34.2.3:

a) A box shall not support combustion for more than 1 minute after the final application of the test flame;

b) The material in the vicinity of the test flame shall not be destroyed to an extent that the integrity of the enclosure is affected; and

c) There shall be:

1) No visible flame on the surface of the box opposite to the surface that the test flame is applied; and

2) No opening through the wall of the box after the test.

34.2.2 To determine whether a box complies with the requirements in 34.2.1, six samples of each box are to be tested. Three boxes are to be tested. Three boxes are to be tested as-received; and three boxes are to be tested after being conditioned for 168 hours at a temperature of 90°C (194°F) in an air-circulating oven. One conditioned and one unconditioned box are to be mounted in the test enclosure in each of the positions illustrated in Figure 34.2. The test is to be conducted as described in 34.1.4 – 34.1.7 except that the valve supplying the gas is to be opened for 5 seconds and closed for 5 seconds in each of the five applications of the flame.

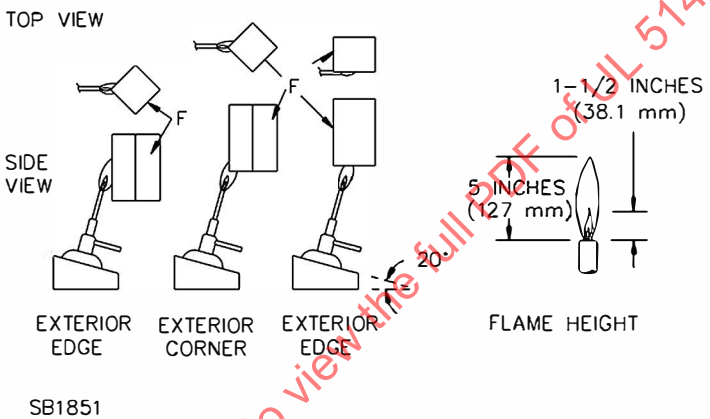
34.2.3 To determine whether a box complies with the requirements in 34.2.1, samples of each box are to be tested as described in 34.2.2 having two 30-second applications of the test flame with a 60-second interval between applications. Two knockouts are to be removed from the side of each box that is furthest from the test flame before the flame is applied. The test flame is to be applied vertically to the interior of the

box as illustrated in Figure 34.3 but is to be offset 1/2 inch (12.7 mm) from the center of any molding gate, knockout, cable entry or integral clamp.

Exception: For a box having an internal volume less than 75 cubic inches (1230 cm^3), the test flame is to be adjusted to have a yellow flame 3/4 inch (19 mm) high without any blue cone.

Figure 34.2

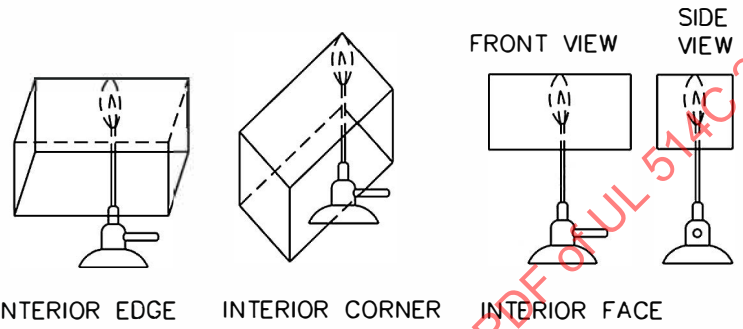
Application of flame to exterior surfaces of boxes



F Denotes the open face of the box.

Figure 34.3

Application of flame to interior surfaces of boxes



35 Mold Stress

35.1 There shall not be a change in any dimension greater than 10 percent for a box, and no openings greater than 1/16 inch (1.6 mm) between a box and the plane across the open face of the box when the box is conditioned as described in 35.2.

35.2 Sample boxes of each mold configuration and each thermoplastic material used are to be conditioned for 7 hours at a temperature of not less than 90°C (194°F) in an air-circulating oven. Following removal from the oven and after the boxes have cooled to room temperature, they are to be examined to determine whether they comply with the requirements in 35.1.

36 Resistance to Crushing

36.1 When tested as described in 36.2, a force of not less than 2500 pounds (11,121 N) shall be necessary to cause a box in the face-up position to continue to yield to the crushing force at a rate greater than the rate at which the force is applied.

36.2 To determine whether a box complies with the requirement in 36.1, three samples of a box are to be tested. Each box is to be conditioned for 7 hours at a temperature of 90°C (194°F) in an air-circulating oven. After being removed from the oven, each box is to be allowed to cool to room temperature for at least 16 hours but not more than 96 hours. Each box is then to be placed between two flat 1/2 inch (12.7 mm) thick steel plates, each having a surface area sufficient to cover the face and back of the box. So that the face of test sample is flat, any projections, such as plaster ears, are to be removed by grinding or other means. The box and the plates are then to be placed in a testing machine so that the crushing force will be applied in a direction from the face of the box toward the back. The testing machine is to be such that the distance between the plates will decrease at a rate of 1/2 inch per minute. The crushing force is to be

applied until the box continues to yield to the force at a rate greater than that at which the force is applied, or until a force is applied, or until a force of 2500 pounds (11,121 N) is applied to the box, whichever occurs first.

37 Resistance to Impact

37.1 A box tested in accordance with 37.2 shall not show any loss of integrity and shall not permit the free passage of a 1/32 inch (0.8 mm) drill rod through any resulting crack in the box or nailing attachment.

Exception: A box constructed from a material known to be unaffected by low temperatures need not be subjected to this test.

37.2 One sample of each type of box being tested is to be exposed for 5 hours to air maintained at minus 20 ±1°C (minus 4 ±2°F). Immediately after being removed from the cold chamber, each sample is to be dropped onto a concrete floor twice in rapid succession from a height of 5 feet (1.52 m). For the first drop, each box is to be oriented with the bottom parallel to the floor. For the second drop of each box, the box is to be oriented so that one bottom corner strikes the floor while two edges of the back and one vertical edge of the side or end are at an angle of approximately 45 degrees to the floor.

37.3 Eight of the ten sample boxes tested in accordance with 37.4 and 37.6 shall not show any loss of integrity and shall not permit the free passage of a 1/32 inch (0.8 mm) drill rod through any resulting crack in the box or nailing attachment.

37.4 Ten samples of each box design, using two samples from any five different molding cavities, are to be tested while at room temperature. Each box is to be secured around the edges adjacent to the back, without distorting the box, to a 27 inch (686 mm) long by 3-1/2 inch (88.9 mm) wide by 1/4 inch (6.4 mm) thick Grade 1020 steel bar that is supported at each end by the minor dimension of a nominal 2 by 4 inch piece of wood. The box is to be positioned with the open face perpendicular to the edge of the bar and with the side, adjacent to the open face and parallel to the major axis of the intended wiring device, parallel to the striking face of the test weight that is positioned at the midpoint of the steel bar. A 6 pound (2.72 kg) test weight with an 3/8 inch (9.5 mm) by 3/4 inch (19.1 mm) by 6 inch (152 mm) polyurethane striking face is to be dropped from a height of 18 inches (457 mm) to strike the box adjacent to the edge of the open face.

Exception No. 1: A box intended for the support of a fixture/luminaire need not be subjected to this test.

Exception No. 2: A box intended to be installed in a wall after the wall is in place need not be subjected to this test.

Exception No. 3: A box wider than the width of the steel bar may be tested using a 3/4 inch (19.1 mm) thick hardwood block, having surface dimensions equal to the wall of the box, between the wall of the box and the bar.

37.5 The polyurethane material used in the test described in 37.4 is to have a Shore durometer reading of not less than 90 on the A scale.

37.6 Ten sample boxes having an integrally molded nailing attachment are to be tested. The boxes are to be conditioned for 5 hours in air maintained at minus 20 ±1°C (minus 4 ±2°F). Immediately after removal from the conditioning chamber, each sample is to be placed on a 1/2-inch (12.7-mm) thick steel plate covered with a nominal 1/2-inch-thick sheet of marine plywood. The box is to be positioned with the nailing surface perpendicular to the surface of the plywood. A 3 pound (1.36 kg) 1-1/8 inch (28.6 mm) diameter cylindrical steel weight having a flat 1 inch (25.4 mm) diameter impact surface with no sharp edges is to be dropped through a vertical distance of 11 inches (279 mm). Guides are to be employed so that the impact face of the test weight strikes the nailing attachment at the point where the nail head would normally

project, but without any nails in place. Not more than 15 seconds is to elapse between the time the sample is removed from the conditioning chamber and the impact is applied.

Exception: A box that is constructed from a material known to be unaffected by low temperature may be tested while at room temperature.

38 Threaded or Unthreaded Holes for Screws in Molded Bosses

38.1 When tested as described in 38.2:

a) A threaded or an unthreaded hole in a molded boss of a box shall not be damaged by the insertion of a screw, and

b) There shall be no damage to the screw used for the test.

38.2 Six separate openings are to be tested for each screw size. If screws are provided with the box, then they are to be used for this test. If screws are not provided with the box, then round-head machine screws of the size specified in Table 38.1 having 32 threads per inch (25.4 mm) and a Rockwell B hardness of 70-100, are to be employed for the test. Rockwell B hardness is to be determined in accordance with the Industrial Fasteners Institute Standard for Mechanical and Quality Requirements for Steel Machine Screws, IFI-103. An IFI M-60 screw provides this hardness. A washer is to be employed with each screw used in test, and each washer is to have a thickness of 0.0468 ± 0.006 inch (1.2 ± 0.15 mm), and an outer diameter of 0.4375 ± 0.002 inch (11.1 ± 0.05 mm). One screw is to be threaded into each hole in the box intended to receive a screw and tightened to the torque specified in Table 38.1. The screws are then to be removed; and the box and screws are to be examined to determine whether they comply with the requirements in 38.1.

Table 38.1
Screw specifications for test of screw holes

Screw			Tightening torque,	
Screw size, Number	Thread diameter Inch [±0.002 inch]	(mm) [(±0.05 mm)]	Pound-inches	(N·m)
6	0.135	(3.50)	12	(1.36)
8	0.162	(4.11)	20	(2.26)
10	0.185	(4.70)	35	(3.97)

38.3 When tested as described in 38.4:

a) A threaded or an unthreaded hole in a molded boss of a box shall withstand for 5 minutes a pulling force not less than that specified in Table 38.2, and

b) The screw shall be easily removed with a reverse torque applied through a screwdriver after the pulling force is removed.

Table 38.2
Minimum retaining force

Screw size, Number	Minimum pull-out force, Pounds	(N)
6	50	(222)
8	100	(445)
10	200	(890)

38.4 Six separate openings are to be tested. Machine screws of the appropriate size are to be fitted into the intended openings in the box for ten full turns. An axial pulling force, applied in a direction tending to withdraw the screw, is to be gradually increased until the screw is pulled out or until the minimum pull-out force specified in Table 38.2 is reached and maintained for 5 minutes.

39 Openings Employing Quick-Set Fastening Devices

39.1 A flush-device box employing a quick-set fastening device shall be tested as described in 39.1 – 39.6. Screws installed in the fasteners shall:

a) Support the test force for 5 minutes without pullout, and

b) Be easily removed with a reverse torque applied through a screwdriver after the pulling force is removed.

39.2 The quick-set fastening device mentioned in 39.1 is an assembly in which a screw is intended to be set in position by a direct axial force causing the screw threads to be positioned and retained by overriding a flexible clip.

39.3 Each of six screw openings of a flush-device box employing a quick-set fastening device is to be conditioned using a screw as specified in Table 38.1. A new screw is to be used for each screw opening tested. The screw is to be inserted and the head is to be seated against the support fixture illustrated in Figure 39.1, positioned between the box and screw head, by applying an axial force. After the screw has been seated, a torque is to be gradually applied to the screw until the value specified in Table 38.1 is reached or until the screw overrides the thread gripping device once, whichever occurs first. Following the application of torque, the screw is to be removed by a reverse torque applied through a screwdriver. The screw is to be inserted and torqued three times and removed twice.

39.4 Following the conditioning described in 39.3, after the screw has been torqued for the third time, a force applied to the screw in a direction normal to and away from the plane of the opening is to be gradually increased to 50 pounds (22.2 N) for a No. 6 screw and 100 pounds (44.5 N) for a No. 8 screw. The force is to be maintained for 5 minutes.

39.5 The flush-device box employing a quick-set fastening device tested in 39.4 shall be tested as described in 39.6. Screws installed in the fasteners shall:

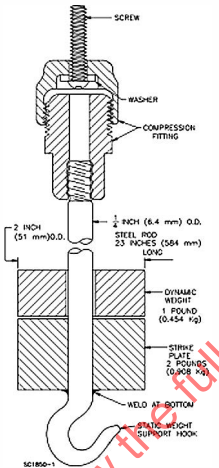
a) Not be displaced more than 3/32 inch (2.4 mm) from the plane of the opening, and

b) Be easily removed with a reverse torque applied through a screwdriver after the weight is removed.

39.6 The sample boxes are to be rigidly mounted in the face-down position. The support fixture illustrated in Figure 39.1 is to be positioned between the screw head and the box. A 1-pound (0.46 kg) weight, which will slide freely over the stem, is to be raised to a height of 18 inches (457 mm) above the strike plate and released.

Figure 39.1

Test weight support fixture



COVERS FOR BOXES INTENDED FOR USE WITH NONMETALLIC-SHEATHED CABLE OR OPEN WIRING

CONSTRUCTION

40 Materials

40.1 General

40.1.1 A material used for a box cover that has not been investigated for the application shall be investigated for combustibility, aging characteristics, temperature stability, resistance to ignition, dielectric strength, and physical strength.

40.2 Relative thermal index

40.2.1 A material that is employed in a cover that is used with a box providing support for a fixture/luminaire shall have relative thermal indices in accordance with 19.3 and 19.4.

41 Holes in Outlet Box Covers

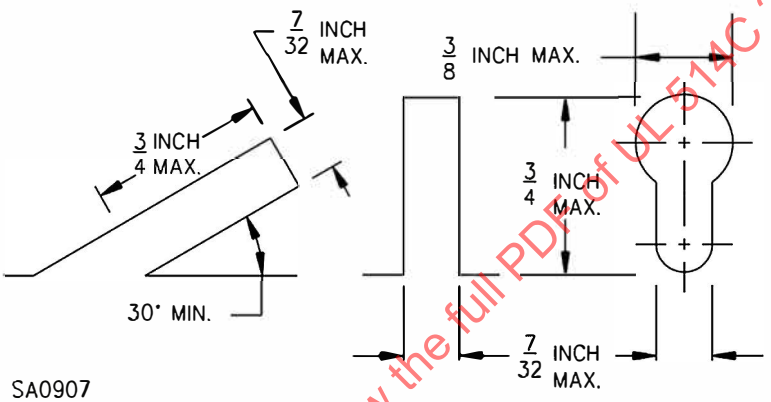
41.1 An outlet box cover shall have no open holes except those for mounting to a box as described in 41.2 and those permitted by 41.4.

41.2 Not more than four openings shall be provided for mounting a cover to a box. Each opening shall be a round hole, a single (not forked) slot, or a keyhole slot. A round hole for mounting shall not be larger than

7/32 inch (5.6 mm) in diameter. A slot shall have dimensions not larger than those illustrated in Figure 41.1.

Figure 41.1

Openings in box covers



Note – SI units for the values specified are: 3/4 inch (19.1 mm); 3/8 inch (9.5 mm); 7/32 inch (5.6 mm).

41.3 A hole may be provided that will be closed in the field by a wiring device, such as a switch, a receptacle, a lampholder, or by a flush-device cover plate.

41.4 A hole in an outlet box cover intended to permit the passage of flexible cord shall have a smooth rounded surface upon which the cord may bear.

PERFORMANCE

42 Flammability

42.1 When tested for flame penetration as described in 42.2:

a) A box cover shall not openly flame for more than 1 minute after the fifth application of the test flame, and

b) There shall be:

1) No visible flame on the surface of the box cover opposite the surface to which the test flame is applied, or

2) No opening through the box cover after the test.

42.2 To determine whether a box cover complies with the requirements in 42.1, six covers are to be tested. Three covers are to be tested as-received; and three covers are to be tested after being conditioned for 168 hours at a temperature of 90°C (194°F) in an air-circulating oven. Each sample cover is to be subjected to the test described in 34.1.2 and 34.1.4 – 34.1.7, except that the valve supplying the gas is to be opened for 5 seconds and closed for 5 seconds in each of the five applications of the flame. The test sample is to be located so that the test flame is directed at the face side of the cover and does not impinge on any edge or opening of the box cover.

42.3 When tested for flammability as described in 42.4, polymeric material employed in a cover shall not openly flame for more than 1 minute after the fifth application of the test flame. The penetration of the flame through the cover shall not constitute a failure.

42.4 With reference to 42.3, three specimens of the material are to be tested. Each specimen is to be approximately 16 square inches (103 cm^2) – either a 4 by 4 inch (102 by 102 mm) square or a 4-1/2 inch (114 mm) diameter circle – and is to have a thickness not more than the minimum thickness of the cover, or, a finished blank cover plate may be utilized for the test in lieu of a 16 square inch specimen. Each specimen is to be subjected to the test described in 34.1.2 and 34.1.4 – 34.1.7.

43 Outlet Box Covers for Support of a Device

43.1 An outlet box cover for support of a device shall comply with:

a) Volume Verification, Section 15,

b) Threaded or Unthreaded Holes for Screws in Molded Bosses, Section 38, and

c) Flammability, Section 42.

NONMETALLIC OUTLET BOX COVERS FOR USE IN DAMP AND WET LOCATIONS

CONSTRUCTION

44 General

44.1 All parts required to comply with the applicable requirements in 44.2 – 59.2 and Sections 40 – 42 shall be provided in a single unit carton with installation and assembly instructions.

Exception: Parts such as boxes, covers, or wiring devices and installation material such as sealing compound are not required to be provided in a single unit carton when:

a) The parts required to complete the assembly or the specified sealing compound are clearly and specifically identified in the installation instructions, and

b) Gaskets that are depended upon to exclude water from the installed assembly are provided with the cover.

44.2 A cover intended for use with a wiring device that requires modification for assembly or that is a nonstandard size or shape shall be provided in the same unit carton with the wiring device. When a gasket is required, the gasket shall also be provided in the same unit carton. Any modifications of the wiring device shall be completed before shipment.

44.3 An outlet box cover intended for use in a wet location with the cover closed shall have a self-closing cover or the equivalent.

45 Protection Against Corrosion

45.1 A metal part of a cover shall be protected against corrosion in accordance with the requirements in Protection Against Corrosion, Section 8 and Table 6.1.

45.2 A spring used to close a cover of a wiring device shall be of material inherently resistant to corrosion.

46 Relative Thermal Index of Materials

46.1 A material that is employed in a cover shall have relative thermal indices in accordance with Clauses 19.2 and 19.4.

47 Gaskets

47.1 A gasket that is depended upon to exclude water or moisture shall be made of:

a) Material that has been investigated for use as gasket material,

b) Rubber that complies with the requirements in 86.4 and 86.5, or

c) Expanded (foam) closed-cell rubber that complies with the requirements in Installation of Receptacles, Section 48.

48 Installation of Receptacles

48.1 A cover for a receptacle shall not prevent complete seating of an attachment plug as specified in Table 48.1 with the face of the receptacle.

Table 48.1
Two-wire attachment plugs

Face dimensions, Inches (mm)	Length, Inches	Length, (mm)	Type of cord	Size of Conductors, AWG	Size of Conductors, (mm^2)	Length of cord, Feet	Length of cord, (m)
3/8 (9.5) by 1 (25.4)	1	(25.4)	SPT-1	18	(0.82)	3	(0.9)
7/8 (22.2) diameter	2	(50.8)	SJ	14	(2.1)	3	(0.9)
Note – Test plugs may be formed to the dimensions specified by casting plugs of smaller dimensions in hobby craft casting materials using a mold of the dimensions specified in the table.							

48.2 An opening for a receptacle shall accommodate a receptacle of a standard size, and shall locate the face of the receptacle flush with or outside the outer plane of the opening in a cover.

PERFORMANCE

49 General

49.1 A cover intended for use with a wiring device and employing a hood, a rain shield, or a similar device that requires positioning or movement in normal use shall remain functional and comply with the requirements in Resistance to Moisture, Section 52 after 1000 cycles of operation.

Exception No. 1: A cover marked "Wet Location With Cover Closed" is not required to be tested as described in 52.3.1 – 52.3.3.

Exception No. 2: A cover marked "Damp Locations" is not required to be tested as described in 52.2.1 – 52.3.3.

49.2 A cover for a wiring device:

a) Shall comply with requirements in Sections 54 – 60; and

b) After conditioning for 7 hours at a temperature of 90°C (194°F) in an air-circulating oven shall:

1) Remain functional, and

2) Comply with the requirements in Resistance to Moisture, Section 52.

Exception No. 1: A cover marked "Wet Location With Cover Closed" is not required to be tested as described in 52.3.1 – 52.3.3.

Exception No. 2: A cover marked "Damp Location" is not required to be tested as described in 52.2.1 – 52.3.3.

50 Sealing Compound

50.1 A compound provided to prevent the entrance of water between a cover and the mounting surface shall remain effective and show no apparent deterioration after conditioning as described in 50.2 and 50.3.

50.2 Three test assemblies consisting of a cover, a box with which it is intended to be used, and the compound are to be tested. The test assemblies are to be assembled in the intended manner. Each assembly is to be conditioned for 168 hours at a temperature of 90.0 ±1.0°C (194.0 ±1.8°F) in an air-circulating oven. Following the conditioning, each assembly is to be examined to determine whether it complies with the requirements in 50.1.

50.3 Three covers are to be mounted on plywood with a 1/32 inch (0.8 mm) diameter wooden rod, which may project 1/2 inch (12.7 mm) beyond the edge of the cover, between the cover and the plywood at the center of each side. The compound is to be applied around the cover. The assemblies are to be conditioned for 24 hours at minus 20°C (minus 4°F) in circulating air. Following the conditioning, each assembly is to be investigated to determine whether it complies with the requirements in 50.1.a

51 Gaskets

51.1 After conditioning as described in 51.2, the thickness of a specimen of an expanded (foam) closed-cell rubber gasket shall not be less than 50 percent of the original deflection.

51.2 Three specimens, each 1.14 ±0.02 inch (29.0 ±0.5 mm) in diameter and 0.50 ±0.02 inch (1.7 ±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.

52 Resistance to Moisture

52.1 General

52.1.1 When tested as described in 52.1.3 – 52.3.3, a part or an assembly of parts as mentioned in 5.4.1 – hereinafter referred to as the test assembly – shall exclude water from:

a) The enclosure formed by a box and a cover, and

b) The interior of a wiring device.

52.1.2 One or more passages need to be provided in the portion of the wiring device enclosed by the box and cover in order to determine whether water has entered the interior of a wiring device, as referenced in 52.1.1(b). The passages will allow any water entering the wiring device to be drained. These passages are to be blocked with putty or similar material during the required tests. The putty is to be removed after the test and any water that entered the wiring device be drained.

52.1.3 The test assembly is to be installed as intended in actual service in accordance with the assembly and installation instructions. When the instructions do not include specific details, the cover is to be installed in the manner that maximizes the potential for entry of water. The interior of the test assembly is to be vented to the exterior to equalize the atmospheric pressure during the test. The vent is to be protected so that water is unable to enter. All parts intended for use with the part under test, or that are required to complete the enclosure are to be employed for the test – for example, wiring devices, gaskets, boxes for covers, etc. A cover intended for use with a box mounted in a wall is to be tested employing a wall of the most severe irregular surface not clearly prohibited by the assembly or installation instructions – such as a wall of fieldstone, corrugated siding, flagstone, textured face brick, common brick, grooved siding, flat or drop striated siding, flat or drop embossed siding, flat or drop textured siding, flat or drop smooth siding or a similar material.

52.1.4 The test assembly is to be located under the test apparatus as described in 86.3. A flat surface 1-foot (0.3 m) wide by 2-feet (0.6 m) long is to be positioned so that:

a) The surface is horizontal and 1-foot below the center line of the test assembly, and

b) The long side of the surface is parallel to the test assembly or to the wall in which the test assembly is mounted.

The test assembly is to be closed during the test – for example, if the wiring device employed is a receptacle, the test is to be conducted without an attachment plug in the receptacle. The spray is to be applied for 1 hour. Following the spray, the test assembly is to be examined to determine whether it complies with the requirements in 52.1.1.

52.2 Assemblies for use in wet locations and wet locations with cover closed

52.2.1 The test assembly is to be located 3-feet (0.9 m) horizontally from and 2-feet (0.6 m) above a spray head as illustrated in Figure 86.1. The spray head is to be positioned so that the spray is aimed directly at the test assembly. The water pressure is to be maintained at 15 pounds per square inch [103.3 kilopascals (kPa)]. The cover, the guard, the shield, or the like is to be opened completely and then allowed to assume its natural position; that is, a self-closing cover is to be allowed to close; however, a cover with a detent or other feature designed to hold it open is not to be manually closed. If the wiring device employed is a receptacle, the test is to be conducted without an attachment plug in the receptacle. The spray is to be applied for 1 hour. Following the spray, the test assembly is to be examined to determine whether it complies with the requirements in 52.1.1.

52.3 Assemblies for use in wet locations

52.3.1 If the wiring device employed in the test assembly is a receptacle, the test described in 52.1.4 is to be repeated but with an attachment plug in the receptacle. The attachment plug is to be inserted into the receptacle by first fully opening the cover, guard, shield, or the like of the test assembly, and then completely inserting one of the attachment plugs specified in Table 48.1 – see 52.3.2 – into the receptacle. The cover, guard, shield, or the like is then to be allowed to assume its natural position – that is, a self-closing cover is to be allowed to close on the attachment plug, and a cover with a detent or other feature

designed to hold it open is not to be manually closed on the attachment plug. The insertion of the attachment plug and positioning of a shield or other device, other than a cover, that is employed to protect the wiring device is to be accomplished with the degree of misuse likely to be encountered in actual service. If a duplex receptacle is employed, the test is to be conducted using only one attachment plug. The test is then to be repeated using the other attachment plug specified in Table 48.1 – see 52.3.2.

Exception: Only one test need be conducted provided that the test with one attachment plug represents the conditions most likely to permit entry of water into the assembly.

52.3.2 For the test described in 52.3.1 a receptacle designed for use with an attachment plug other than the two wire nongrounding parallel-blade or tandem-blade type specified in Table 48.1 is to be tested with an attachment plug of the type intended for use with the receptacle.

52.3.3 If the wiring device employed in the test assembly is a receptacle, the test described in 52.2.1 is to be repeated but with an attachment plug in the receptacle as described in 52.3.1 and 52.3.2.

53 Resistance to Ultraviolet Light and Water

53.1 Any part of a cover that is nonmetallic and is intended to be exposed to sunlight shall show no apparent deterioration after exposure to ultraviolet light and water for 720 hours of twin enclosed carbon-arc (ASTM G151 and G153) or 1000 hours of xenon-arc (ASTM G151 and G155), weatherometer conditioning. For carbon-arc, the conditions are specified in 53.2 – 53.4. For xenon-arc, the conditions are specified in 53.5 and 53.6.

Exception: This requirement does not apply to the edges of a gasket.

53.2 Three samples of the part are to be fastened to the specimen drum of an apparatus as described in 53.3 and 53.4. After 720 hours of exposure, the samples are to be removed from the drum and visually compared to an unconditioned sample.

53.3 The samples are to be exposed to ultraviolet light from two carbon arcs formed between vertical electrodes 1/2-inch (12.7 mm) in diameter located at the center of a revolvable vertical metal cylinder 31 inches (787 mm) in diameter and 17-3/4 inches (451 mm) high. Each arc is to be enclosed by a clear glass globe.

53.4 The samples are to be mounted vertically on the inside of the cylinder facing the arcs, and the cylinder is to be rotated around the arcs at one revolution per minute. A system of nozzles is to be employed to spray each sample with water as the cylinder revolves. The operating cycle is to be 102 minutes of light only and 18 minutes of light and water. The temperature within the cylinder while the apparatus is in operation is to be 63.0 ±5.0°C (145 ±9.0°F), and the test is to be continued until 720 hours have elapsed.

53.5 Three samples or specimens of the part shall be mounted or placed in the ultraviolet-light apparatus in such a way that they do not touch each other. After the exposure, the samples or specimens shall be removed from the cylinder and visually compared to unconditioned samples or specimens.

53.6 The samples shall be exposed for 1000 hours to xenon-arc. There shall be continuous exposure to light and intermittent exposure to water spray. The cycle shall consist of 102 minutes without water spray and 18 minutes with water spray. The apparatus shall operate with a water-cooled xenon-arc lamp, borosilicate 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 63.0 ±3.0°C (145 ±5.4°F).

54 Mold Stress

54.1 Conditioning as described in 54.2 shall not result in:

a) Any dimension of a cover changing by more than 10 percent, or

b) Warping of a cover to the extent that a 1/16 inch (1.6 mm) opening exists between the face of a box and the cover.

54.2 Six specimens of each mold configuration and material used for the cover are to be conditioned for 7 hours at a temperature not less than 90°C (194°F) in an air-circulating oven. Following removal from the oven and after the specimens have cooled to room temperature, they are to be examined to determine whether they comply with the requirements in 54.1.

55 Water Absorption

55.1 Conditioning as described in 55.2 shall not cause:

a) Any dimension of a specimen, including thickness, to change by more than 3 percent; or

b) The weight of a specimen to increase by more than 3 percent.

55.2 Three specimens of the material, each 1 inch (25.4 mm) wide, 3 inches (76.2 mm) long, and having a thickness not more than the minimum thickness of the cover are to be tested. Each specimen is to be dried for 24 hours in a calcium-chloride desiccator. Following the drying, each specimen is to be scribed and then immersed in distilled water at a temperature of 23.0 ±2.0°C (73.4 ±3.6°F) for 24 hours. After removal from the water, each sample is to be wiped dry of excess moisture, and the change in the dimensions and weight are to be determined. The percentage of change is then to be calculated in accordance with the method for measuring water absorption of plastics in the Standard for Polymeric Materials – Short Term Property Evaluations, UL 746A.

56 Dielectric Voltage Withstand

56.1 When tested as described in 56.2, a cover shall withstand for 1 minute without breakdown the application of a 60-hertz sinusoidal potential of 2500 volts.

Exception: A cover made of a material that has been previously investigated, using specimens not thicker than the minimum thickness of the cover, and found to be rated for the application is not required to be tested.

56.2 Six covers are to be subjected to the specified potential – the potential is to be applied across the thinnest section of each cover by electrodes located on each side of the cover. Each cover is then to be conditioned for 24 hours in moist air having a relative humidity of 85 ±5 percent at a temperature of 32.0 ±2°C (89.6 ±3.6°F). Following the conditioning, each cover is to be subjected to the potential specified in 56.1.

57 Hot-Wire Ignition

57.1 When tested as described in 57.2, a polymeric material used for a cover shall not ignite within 15 seconds after the application of the test current.

Exception: A polymeric material with a mean hot-wire ignition time not less than 15 seconds is not required to be tested.

57.2 Three 1/2-inch (12.7-mm) by 5-inch (127.0-mm) specimens of polymeric material in sheet form having a thickness of not more than the minimum thickness used for the cover are to be tested in accordance with the requirements for hot-wire ignition described in the Standard for Polymeric Materials – Short-Term Property Evaluations, UL 746A.

58 Crushing

58.1 When tested as described in 58.2, a cover shall withstand without cracking a crushing force of 400 pounds (1779 N).

58.2 Three covers are to be tested. Each cover is to be conditioned for 7 hours at a temperature of 90°C (194°F) in an air-circulating oven. After removal from the oven, each cover is to be allowed to cool to room temperature for at least 16 but not more than 96 hours. Each cover is then to be placed between two rigid, flat, steel plates of sufficient area to cover the face and back of the cover. The cover and the steel plates are then to be placed in a testing machine so that the crushing force is applied in a direction from the face of the cover towards the back. The testing machine is to be such that the jaws will close at a rate of 1/2 inch (12.7 mm) per minute. The crushing is to be continued until the cover cracks, or until a force of 400 pounds (1779 N) is applied to the cover, whichever occurs first.

59 Impact

59.1 Eight of ten covers, tested as described in 59.2 or 59.3, whichever is applicable:

a) Shall not crack to the extent that a 1/32-inch (0.8-mm) diameter rod can be inserted through the crack, and

b) Shall comply with the requirements in 52.1.1 – 52.1.4.

59.2 Ten covers are to be tested. A cover of material known to be unaffected by low temperatures is to be tested at room temperature. Each cover is to be placed on 1/2-inch (12.7-mm) thick marine plywood supported by a 1/2-inch thick flat steel plate. The cover is to be placed so that the back will rest on the plywood and the face will be exposed to the impact. The impact is to be produced by dropping a cylindrical, steel weight, 1-1/8 inches (28.6 mm) in diameter, and weighing 3 pounds (1.36 kg), through a vertical distance of 11 inches (279 mm). One end of the weight is to have a flat impact surface at least 1-inch (25.4 mm) in diameter and without any sharp edges. Guides are to be employed so that the center of the impact surface of the weight will be located above the center of the face of the cover. Following the impact, the weight is to be removed and the cover is to be investigated to determine whether it complies with the requirements in 59.1.

59.3 A cover of a material, the properties of which are unknown at low temperatures, is to be conditioned before being tested. Each of ten covers is to be conditioned for 5 hours in circulating air at a temperature of minus 20 ±1°C (minus 4 ±2°F). Within 15 seconds after removal from the conditioning chamber, each cover is to be subjected to the impact test described in 59.2.

60 Flammability

60.1 When prepared as described in 60.2, and tested for flame penetration as described in 42.2:

a) A cover shall not openly flame for more than one minute after the fifth application of the test flame; and

b) There shall not be:

1) Visible flame on the surface of the cover opposite the surface to which the test flame is applied, or

2) An opening through the cover after the test.

60.2 For the test required by 60.1 and described in 42.2, any removable appendage – hinged cover, boot, or the like – intended solely to restrict the exposure of a device opening to moisture shall be removed prior to testing, and any device opening shall be obturated with a material having a resistance to heat or flaming equal to or greater than that of the plate material.

BOXES INTENDED FOR USE WITH ELECTRICAL NONMETALLIC TUBING

CONSTRUCTION

61 General

61.1 A box intended for use with electrical nonmetallic tubing shall comply with:

a) Materials, Section 19,

b) Knockouts, Section 22,

c) Supports, Section 25,

d) Grounding, Section 26, and

e) Extension Rings, Section 27.

PERFORMANCE

62 General

62.1 A box intended for use with electrical nonmetallic tubing shall comply with:

a) Volume Verification, Section 15,

b) Hot-Wire Ignition, Section 20,

c) Dielectric Voltage-Withstand, Section 21,

d) Knockouts, Section 29,

e) Supports, Section 32,

f) Water Absorption, Section 33,

g) Flammability, Section 34,

h) Mold Stress, Section 35,

i) Resistance to Crushing, Section 36,

j) Resistance to Impact, Section 37,

k) Threaded or Unthreaded Holes for Screws in Molded Bosses, Section 36, and

l) Openings Employing Quick-Set Fastening Devices, Section 39.

COVERS INTENDED FOR USE WITH BOXES INTENDED FOR USE WITH ELECTRICAL NONMETALLIC TUBING

CONSTRUCTION

63 General

63.1 A cover intended for use with a box intended for use with electrical nonmetallic tubing shall comply with:

a) Materials, Section 19, and

b) Holes in Outlet Box Covers, Section 41.

PERFORMANCE

64 General

64.1 A cover intended for use with a box intended for use with electrical nonmetallic tubing shall comply with:

a) Volume Verification, Section 15,

b) Knockouts, Section 22, and

c) Flammability, Section 42.

BOXES AND COVERS INTENDED FOR USE WITH RIGID NONMETALLIC CONDUIT

CONSTRUCTION

65 General

65.1 The construction of a box shall include means for attachment to rigid nonmetallic conduit.

Exception: A box having blank sides for holes to be cut in the field for the attachment of conduit fittings need not comply with this requirement.

65.2 A box shall not be provided with means for the mounting of a fixture/luminaire or equipment other than a wiring device such as a snap switch or a receptacle unless the box acts solely as an enclosure and is not relied upon solely for the securement or support of a fixture/luminaire or equipment. Such a box is to be:

a) Provided with steel hardware or steel support brackets intended to provide securement and support of a fixture/luminaire or equipment to a structural member;

b) Meet the material requirements of 19.3; and

c) When assembled is required to yield compliant results when subjected to the applicable support tests in this standard.

66 Bodies, Boxes, and Covers

66.1 General

66.1.1 A flush-device box shall have a means for supporting a wiring device to be mounted in it and shall be completely enclosed on its back, or bottom, and sides.

66.1.2 There shall be no holes in a conduit body except those for connection of conduit and screw holes for securing the cover.

66.1.3 Threaded inserts or equivalent means shall be provided for mounting a wiring device in a flush-device box. This means shall be separate from the means provided for securing a cover or plate to the box. The inserts shall comply with the requirements in 66.4.3 except that they shall be acceptable for 6-32 machine screws only. The equivalent means shall comply with the requirements in Threaded or Unthreaded Holes for Screws in Molded Bosses, Section 38, or Openings Employing Quick-Set Fastening Devices, Section 39, as applicable.

66.2 Thickness

66.2.1 A blank cover, an outlet box cover, and the sides, end walls, and bottom of a box shall have a thickness not less than that specified in Table 66.1.

Table 66.1
Thickness of boxes and blank covers

Item	Trade size of conduit, Inches	Minimum wall thickness Inches	(mm)
Conduit bodies and blank covers for these bodies	1/2, 3/4, 1	0.125	(3.18)
	1-1/4, 1-1/2	0.156	(3.96)
	2	0.203	(5.16)
	2-1/2, 3	0.234	(5.94)
	3-1/2 – 6	[a]	
Flush-device boxes	1/2, 3/4, 1	0.125[b]	(3.18)
	1-1/4 – 6	[a]	
Outlet boxes and covers for these boxes	All	0.125[b]	(3.18)

[a] The minimum acceptable wall thickness of a box intended for use with the larger sizes of conduit is to be determined from the results of impact, crushing, and other tests with consideration given to the size of the box and its rigidity when assembled to the intended sizes of conduit.

[b] A box is able to have a minimum wall thickness of 0.090 inch (2.3 mm) when it is marked in accordance with 92.3.5.

66.3 Connections for conduit

66.3.1 A box shall:

a) Have one or more unthreaded conduit-connection sockets integral with the box that comply with the requirements in 66.3.4 – 66.3.6,

b) Be blank for use with junction-box adapters or with male adapters in conjunction with a locknut,

c) When marked in accordance with 92.3.4, have threaded sockets for PVC connectors, or

d) When marked in accordance with 92.3.5, have knockouts with a thickness of at least 0.090 inch (2.3 mm) and a diameter and surface area as specified in Table 66.2 for PVC connectors.

66.3.2 A flat surface of sufficient area shall be provided on the side wall of a box to accommodate the bearing surfaces of the locknut and male adapter.

66.3.3 A knockout in a box shall comply with the requirements in 22.1 and be provided with a concentric flat surface on the inside and outside to permit proper installation of a male adapter and a locknut. The flat surfaces shall extend from the edge of the knockout for a distance not less than that specified in Table 66.2. A box need not be constructed so that male adapters can be installed simultaneously in adjacent knockouts.

Table 66.2
Diameter of knockout and width of surrounding flat surface

Trade size of conduit,	Knockout diameter,		Minimum width of flat surface surrounding knockout,	
Inches	Inches[a]	(mm)	Inches	(mm)
1/2	0.875	(22.23)	0.133	(3.38)
3/4	1.109	(28.17)	0.156	(3.96)
1	1.375	(34.93)	0.198	(5.03)
1-1/4	1.734	(44.04)	0.274	(6.96)

[a] A plus tolerance of 0.031 inch (0.79 mm) and a minus tolerance of 0.015 inch (0.38 mm) applies to the knockout diameter. Knockout diameters are to be measured other than at points where a tab may remain after removal of knockout.

66.3.4 A socket for the connection of conduit shall provide a positive end stop for the conduit, and the socket diameters, the throat diameter at the entrance to the box, and the wall thickness shall be within the limits specified in Table 66.3, Table 66.4 and Table 66.5.

Table 66.3
Throat diameters

Trade size of conduit,	Minimum throat diameter, inches (mm)			
Inches	For use with heavy-wall conduit		For use with thin-wall conduit	
1/2	0.591	(15.01)	0.728	(18.49)
3/4	0.783	(19.89)	0.840	(21.34)
1	0.997	(25.32)	1.205	(30.61)
1-1/4	1.311	(33.30)	1.532	(38.91)
1-1/2	1.529	(38.84)	1.752	(44.50)
2	1.964	(49.89)	2.187	(55.55)
2-1/2	2.346	(59.59)	2.670	(67.82)
3	2.915	(74.04)	3.365	(85.47)
3-1/2	3.371	(85.62)	3.760	(95.50)
4	3.825	(97.16)	4.250	(107.95)
5	4.795	(121.79)	–	–
6	5.762	(146.35)	–	–

66.3.5 The socket depth shall be within the limits specified in Table 66.4 (inches) or Table 66.5 (millimeters) or shall be sufficient to permit assembly to rigid nonmetallic conduit in a manner that will

provide strength of both the joint and assembly between conduit and socket as determined by compliance with the tests in Bending, Section 83 and Pull Out, Section 84.

Exception No. 1: The tests in Bending, Section 83 and Pull Out, Section 84 are not required for sockets, fixed or interchangeable, complying with the minimum depth specified in Table 66.4 (inches) or Table 66.5 (millimeters).

Exception No. 2: The tests in Bending, Section 83 and Pull Out, Section 84 are not required for conduit bodies with removeable sockets that may be interchanged with removeable covers when depths of those sockets comply with the minimum depth specified in 66.4 (inches) or Table 66.5 (millimeters).

66.3.6 The wall thickness of the socket shall not be less than specified in Table 66.4 (inches) or Table 66.5 (millimeters).

66.4 Covers

66.4.1 A nonmetallic outlet box or conduit body shall be furnished with a blank cover.

Exception: A blank cover need not be furnished with a box intended for the mounting of a flush device.

Table 66.4
Dimensions in inches of conduit-connection sockets

Trade size of conduit	Socket diameter						Socket depth		Minimum thickness	
	At entrance			At bottom					Over male or female threads	Wall of unthreaded portion
	Maximum	Minimum	Average	Maximum	Minimum	Average	Maximum	Minimum*		
1/2	0.860	0.844	0.852 ±0.004	0.844	0.828	0.836 ±0.004	1.500	0.652	0.109	0.085
3/4	1.074	1.054	1.064 ±0.004	1.056	1.036	1.046 ±0.004	1.500	0.719	0.113	0.095
1	1.340	1.320	1.330 ±0.005	1.320	1.300	1.310 ±0.005	1.875	0.875	0.133	0.100
1-1/4	1.689	1.665	1.677 ±0.005	1.667	1.643	1.655 ±0.005	2.000	0.938	0.140	0.120
1-1/2	1.930	1.906	1.918 ±0.006	1.906	1.882	1.894 ±0.006	2.000	1.062	0.145	0.120
2	2.405	2.381	2.393 ±0.006	2.381	2.357	2.369 ±0.005	2.000	1.125	0.154	0.130
2-1/2	2.905	2.875	2.890 ±0.007	2.883	2.853	2.868 ±0.007	3.000	1.469	0.203	0.185
3	3.530	3.500	3.515 ±0.008	3.507	3.477	3.492 ±0.008	3.125	1.594	0.216	0.216
3-1/2	4.065	3.965	4.015 ±0.038	4.007	3.977	3.992 ±0.008	3.250	1.687	0.226	0.226
4	4.565	4.465	4.515 ±0.009	4.506	4.476	4.491 ±0.009	3.375	1.750	0.237	0.237
5	5.643	5.543	5.593 ±0.010	5.583	5.523	5.553 ±0.010	3.625	1.937	0.258	0.258
6	6.708	6.608	6.658 ±0.011	6.644	6.584	6.614 ±0.011	3.750	2.125	0.280	0.280

* See 66.3.5.

Table 66.5
Dimensions in millimeters of conduit-connection sockets

Trade size of conduit	Socket diameter						Socket depth		Minimum thickness	
	At entrance			At bottom					Over male or female threads	Wall of unthreaded portion
	Maximum	Minimum	Average	Maximum	Minimum	Average	Maximum	Minimum[a]		
1/2	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	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	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	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	49.02	48.41	48.72 ±0.15	48.41	47.80	48.11±0.15	50.80	28.97	3.68	3.05
2	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	73.49	73.03	73.41 ±0.18	73.23	72.47	72.85 ±0.18	78.20	37.31	5.16	4.19
3	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	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	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	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	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] See 66.3.5.

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

66.4.3 Screws and other metal parts that extend outside a covered box or are accessible from outside a covered box – including inserts – shall be located so that they cannot contact uninsulated live parts or insulated conductors – live or not – inside the box. They shall be of an inherently corrosion-resistant metal alloy.

67 Boxes Intended for Use in Wet Locations

67.1 A box intended for use in a wet location shall be constructed so that it will comply with the requirements for resistance to weather in Resistance to Ultraviolet Light and Water, Section 53, and exclude water when tested as described in Wet Locations, Section 86. The box shall be provided with a cover for use in wet locations and with an external means for mounting. See 92.3.3.

Exception: An internal means for mounting may be employed if the construction will exclude water from the enclosure.

67.2 A gasket that is depended upon to exclude water shall be of treated or fabricated material investigated for use as gasket material or shall be of rubber that complies with the requirements in 86.4 and 86.5. A material such as paper, paper impregnated with a substance having a low melting point, such as tar, fiber, or the like shall not be employed for a gasket.

68 Conduit Bodies

68.1 A conduit body having a volume exceeding 100 cubic inches (1639 cm^3) and a conduit body having provision for not more than two conduit entries shall not have provision for mounting switches, fuseholders, or other control devices.

Exception: A conduit body having a volume of 100 cubic inches or less and having less than three conduit entries is able to have provision for mounting a wiring device when the conduit body is marked in accordance with 92.1.5 and the volume is verified in accordance with Dimensions, Section 8.

68.2 A conduit body with an internal volume of 100 cubic inches (1639 cm^3) or less need not be provided with a means for support other than the wiring system to which it is connected.

68.3 A conduit body shall have an internal cross-sectional area not less than that specified in Table 68.1, based on the largest size raceway that may be connected to it.

Table 68.1
Internal cross-sectional area required for conduit bodies

Trade size of raceway,	Cross section,	
Inch	Square inches	(cm^2)
1/2	0.608	(3.92)
3/4	1.067	(6.88)
1	1.729	(11.15)
1-1/4	2.991	(19.30)
1-1/2	4.072	(26.27)

Table 68.1 Continued on Next Page

Table 68.1 Continued

Trade size of raceway, Inch	Cross section, Square inches	(cm^2)
2	6.711	(43.30)
2-1/2	9.576	(61.78)
3	14.785	(95.39)
3-1/2	19.774	(127.57)
4	25.461	(164.26)
4-1/2	31.894	(205.77)
5	40.012	(258.14)
6	57.781	(372.78)

68.4 A conduit body having a provision for the connection of conduit or tubing larger than the 1/2-inch-trade size shall comply with the requirements in 68.5 and 68.6.

Exception: A conduit body marked for use only with 6 AWG (13.3 mm^2) or smaller conductors need not comply.

68.5 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 box 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 may 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. See 92.1.6.

Table 68.2
Minimum space inside a conduit body

Maximum size of wire, AWG or MCM	(mm^2)	Minimum distance to cover, Inches	(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)
1,000 – 1,250	(507 – 633)	10	(254)
1,500 – 2,000	(760 – 1013)	12	(305)

68.6 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 (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 on the same wall of the body.

Exception No. 1: A conduit body having smaller dimensions may be investigated for installation of a combination of conductors, including 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. See 92.1.6.

Exception No. 2: A conduit body having a raceway entry on the wall opposite the removable cover may have a distance from the cover to the opposite wall not less than that specified in Table 68.2.

68.7 With reference to 68.6, 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.

PERFORMANCE

69 General

69.1 When a box differs significantly from those of common construction, utilizing tests other than or in addition to those specified in Sections 74 – 84, 86, and 87 is acceptable. Among the considerations are installation, resistance to arcing, dimensional stability, water absorption, and resistance to the corrosive or degrading effects of reagents.

70 Knockouts

70.1 A knockout shall comply with the requirements in Knockouts, Section 29.

71 Supports

71.1 A bracket or other device for securing a box shall comply with the requirements in 32.1.1 and 32.1.2.

72 Closures

72.1 A nonmetallic closure shall maintain the integrity of the enclosure in which it is installed when subjected to the flame test described in 34.1.2– 34.1.7.

Exception: A phenolic closure need not be tested.

72.2 A nonmetallic plug or other closure intended to be assembled to a box without a lock nut shall not be damaged or its effectiveness impaired when installed as intended.

72.3 Not fewer than 18 samples of each plug or other closure are to be tested as specified in 72.2. Not fewer than six of these samples are to be in each of the following conditions for test:

a) As received,

b) At room temperature after exposure for 168 hours to circulating air at 90.0 ±1.0°C (199.0 ±1.8°F), and

c) Immediately after exposure for 24 hours in air maintained at minus 20.0 ±1.0°C (minus 4.0 ±1.8°F), and while still in the test chamber.

73 Water Absorption

73.1 A box or a blank cover shall not absorb more water than 0.5 percent of its weight after being conditioned as described in 33.2.

74 Flame-Retardant Properties

74.1 Other than as noted in 74.4, when tested as described in 74.2:

a) A box or a blank cover shall not support combustion for more than 5 seconds after the third application of the test flame,

b) Flaming particles or drops shall not fall from the box or blank cover during or after any application of the test flame, and

c) The box or blank cover shall not be completely consumed.

74.2 Each sample box or blank cover is to be subjected to the test described in 34.1.2 and 34.1.4 – 34.1.7, except that the valve supplying the gas is to be opened for 1-minute and closed for 30 seconds in 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.

74.3 A sample box that is too large to be tested in the enclosure described in 34.1.2 may be tested in an enclosure that is constructed with proportionately larger dimensions.

74.4 A nonmetallic outlet box having a minimum thickness of 0.090 inch (2.3 mm) and marked in accordance with 92.3.5 shall comply with the flammability requirements in 34.2.1.

75 Heat Distortion

75.1 When tested as described in 75.2, there shall be no change in any dimension greater than 10 percent for a nonmetallic box, no cracks or openings in the body of a box or in a cover, and no openings wider than 1/16 inch (1.6 mm) between a box and its cover or, if no cover is provided, between a box and a plane across its open face.

75.2 Samples are to be heated for 1 hour at a temperature of 92.0 ±1.0°C (197.6 ±1.8°F) in an air-circulating oven. Samples are to be supported in the oven so that they do not touch each other or the sides of the oven. A conduit body or a box is to be tested with its blank cover in place. A blank thermosetting wiring-device cover plate is to be secured in place on a flush-device box. Following removal from the oven and after the samples have returned to room temperature, they are to be again examined to determine whether they comply with the requirements in 75.1.

76 Extrusion or Molding Process

76.1 The process of extrusion or molding shall result in PVC boxes and blank covers the surfaces of which do not exhibit any evidence of incomplete fusion after immersion of the finished product in anhydrous acetone.

76.2 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 $CaSO_4$.

76.3 With appropriate attention to the risks involved – see 76.2 – one sample of each type and size of box and cover is to be immersed for 5 minutes in reagent grade anhydrous acetone at a temperature of 23.0 ±2.0°C (73.4 ±3.6°F) and then examined.

76.4 The product is not acceptable if there is flaking or peeling over most of the interior or exterior surfaces 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 also not acceptable.

77 Physical Properties

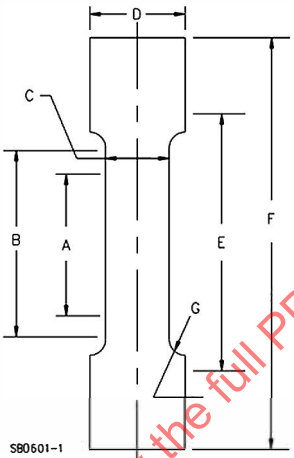
77.1 General

77.1.1 The average tensile strength of three aged specimens prepared from a molded PVC box shall equal or exceed 95 percent of the average tensile strength of three unaged specimens from the box. The average tensile strength of the unaged specimens shall comply with the limit established for the compound used but, in any case, shall not be less than 5,000 pounds per square inch ((34.5 MN/m^2) (3.45 kN/cm^2) (3515 gf/mm^2). The procedures (similar to those described in the Standard Test Method for Tensile Properties of Plastics, ASTM D 638) for preparing and conditioning the specimens, for making the measurements, and for calculating the average tensile strengths are indicated in 77.2.1 – 77.3.4.

77.2 Preparation of specimens

77.2.1 Test specimens are to be machined to the shape illustrated in Figure 77.1 having dimensions in accordance with Table 77.1 from material cut from the flat wall surface of the box. The width and thickness of the flat section of each specimen are to be measured and recorded.

Figure 77.1
Shape of specimen



77.2.2 All surfaces of each specimen are to be free from visible flaws, scratches, or imperfections. Marks left by coarse machining operations are to be carefully removed with a fine file or abrasive, and the filed surfaces are then to be smoothed with No. 00 or finer abrasive paper. The finishing sanding strokes are to be made in a direction parallel to the longitudinal axis of each specimen. All flash is to be removed from a molded specimen, taking great care not to disturb the molded surfaces. In machining a sample, undercuts that would exceed the dimensional tolerances in Figure 77.1 are to be avoided. Care is also to be taken to avoid other common machining errors.

Table 77.1
Dimensions of specimen

Item	Inch	(mm)
A[a]	2.00 ±0.02	50.8 ±0.5
B	2.25 ±0.02	57.2 ±0.5
C	0.500±0.020	12.70 ±0.51
D	0.750 ±0.020	19.05 ±0.51
E[b]	4.5 ±0.2	114 ±5
F[c]	8.5	216
G	3.00 +0.02 -0.00	76.0 +0.5 -0.0

[a] Distance between gauge marks.

[b] Distance between grips at start of test.

[c] May be 6.5 inches (165 mm), minimum.

77.2.3 The specimens that are to be aged are to be supported in a full-draft, air-circulating oven that has been preheated at full draft to 113.0 ±1.0°C (235.4 ±1.8°F). The samples are to be supported so that they do not touch each other or the sides of the oven. The specimens are to be aged for 168 hours at full draft and are then to be allowed to cool gradually for 16 to 96 hours in still air before being handled.

77.2.4 Gauge marks are to be applied to each aged and unaged specimen with a wax crayon or India ink that will not affect the material being tested. Gauge marks are not to be scratched, punched, or impressed on any specimen.

77.3 Test method

77.3.1 The tensile-strength test is to be conducted with the specimens, the testing machine, and the surrounding air in thermal equilibrium at a temperature of 23.0 ±2.0°C (73.4 ±3.6°F).

77.3.2 The test is to be conducted using a power-driven machine that will indicate the actual load at which a specimen breaks. The machine is to have grips that are suitable for the material being tested and is to be adjusted so that the speed of separation of the power-actuated grip from the stationary grip will be 1/2 inch per minute (12.7 mm per minute). Each specimen is to be tested separately. Each specimen is to be clamped in position with neither gauge mark within the jaws of a grip and with gauge marks between the grips. The movable grip is to be adjusted to take up any slack in the specimen but not to put the specimen under tension.

77.3.3 The grips are to be separated at the rate of 1/2 inch per minute (12.7 mm per minute) until the specimen ruptures or the elastic limit of the PVC material has been exceeded.

77.3.4 After rupture of the specimen or its exceeding the elastic limit, the maximum load in pounds is to be noted from the dial or scale and recorded.

77.3.5 The tensile strength of each specimen is to be determined from the formula:

$$T = P / Wt$$

in which:

T is the tensile strength in pounds per square inch,

P is the maximum load in pounds,

W is the width of the reduced section of the specimen in inches, and

t is the thickness of the specimen in inches.

If a specimen breaks or yields within the jaws of a grip at a load that results in a tensile strength less than the tensile strength limit established as being the minimum acceptable for the compound used, the test results for that specimen are to be disregarded and another specimen is to be tested.

78 Identification Tests

78.1 The specific gravity of the PVC material shall be within the limits established for the compound used.

79 Flexural Strength

79.1 The flexural strength of samples of PVC material taken from box walls or blank covers shall not be less than 10,000 pounds per square inch (7.03 kg per mm^2) as determined in accordance with the calculation for the determination of the flexural properties of polymeric materials as described in the Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials, ASTM D 790.

79.2 Three rectangular samples of the PVC material that are 2 inches (50.8 mm) long, 1/2 inch (12.7 mm) wide, and of the box or cover thickness t are to be tested as a flat beam loaded at the center between two points of simple support placed 1 inch (25.4 mm) apart. The load member and the supports are each to have a radius of 1/16 inch (1.6 mm).

79.3 The load is to be applied by a power-driven testing machine the jaws of which close at a rate of 1/2 inch (21.7 mm) per minute. A device to indicate the actual applied load is to be provided on the machine.

80 Resistance to Crushing

80.1 Other than as specified in 80.3, the resistance of each size of nonmetallic box to crushing shall be such that, when a box is subjected to a force of 5,000 pounds (22,241 N) as described in 80.2, the reduction in height of 1/2-, 3/4-, or 1-inch conduit box is not more than 15 percent of its original height, and the reduction in height of any other box is not more than 10 percent of its original height.

80.2 One sample of each size and type of box is to be subjected to this test. Each sample box, without a cover and with its open side down, is to be placed between two rigid flat steel plates in a compression machine the jaws of which close vertically at the rate of 1/2 inch per minute (12.7 mm per minute). The machine is to be provided with a device that will indicate the actual applied load.

80.3 A nonmetallic box having a minimum thickness of 0.090 inch (2.3 mm) and marked in accordance with 92.3.5 shall comply with the requirements for resistance to crushing in 36.1.

81 Low-Temperature Handling

81.1 There shall be no cracking or shattering of a molded nonmetallic box when tested as described in 37.2.

82 Resistance to Impact

82.1 Other than as indicated in 82.3, six samples of a nonmetallic box shall withstand the impact specified in 82.2 without showing any loss of integrity, and shall not crack or split to the extent that a 1/32-inch (0.8-mm) diameter rod can be inserted through the crack or split.

82.2 Each sample is to be placed with its open side down on a 1/2 inch (12.7 mm) thick, rigid, flat, steel plate and subjected to the impact of a 75 pound (34.02-kg) 6-inch (152-mm) diameter cylindrical steel weight free of sharp edges and having a flat impact surface. The weight is to be dropped vertically and is to be provided with guides so that the bottom of the weight will strike the center of the sample squarely. Table 82.1 specifies the distance through which the weight is to fall.

Table 82.1
Impact weight and distance

Type of box	Trade size of conduit sockets on box, Inches	Distance through which 75-pound (34.02-kg) weight falls, Feet[a]	(m)[a]
Conduit body, flush-device box or outlet box	1/2, 3/4, 1	1	(0.30)
	1-1/4, 1-1/2	2	(0.61)
	2 – 4	4	(1.22)

[a] Measured from the bottom face of the weight to the top of the sample.

82.3 Six samples of a nonmetallic outlet box having a minimum thickness of 0.090 inch (2.3 mm) and marked in accordance with 92.3.5 shall comply with the requirements for resistance to impact in 37.3.

83 Bending

83.1 A nonmetallic box shall not be damaged or separated from the conduit when subjected to the bending test described in 83.2 – 83.4.

83.2 In the event that breakage of the conduit occurs prior to damage to the box or separation of the joint, performance is acceptable.

83.3 Samples welded in the intended manner to 18-inch (457-mm) lengths of suitable heavy-wall PVC conduit of the proper trade size are to be tested as described in 83.4 no sooner than 24 hours after assembly.

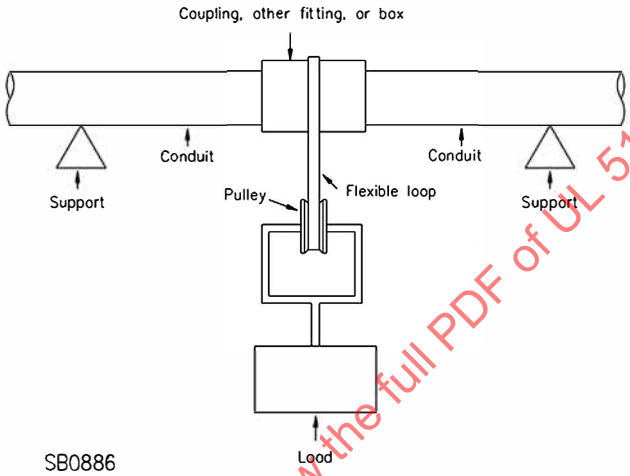
83.4 The assembly, with the box at the center, is to be placed on supports as illustrated in Figure 83.1. The supports are to be separated by a distance of 30 inches (762 mm) plus the distance between the ends of the conduit in the box to give the required bending moment on the sample under test. The load specified in Table 83.1 for the size of conduit used is to be suspended from the center of the box for 60 seconds, during which time the box and the lengths of conduit are to be rotated through one complete revolution about the major axis of the assembly.

Table 83.1
Bending load and pull-out force

Trade size of conduit sockets on box, Inches	Force exerted by bending load, Pounds	(N)	Axial pull-out force, Pounds	(N)
1/2	20	(89.0)	300	(1334.5)
3/4	35	(155.7)	450	(2001.7)
1	50	(222.4)	600	(2668.9)
1-1/4	75	(333.6)	700	(3113.7)
1-1/2	85	(378.1)	800	(3558.6)
2	110	(489.3)	1000	(4448.2)
2-1/2	110	(489.3)	1000	(4448.2)
3	110	(489.3)	1000	(4448.2)
3-1/2	110	(489.3)	1000	(4448.2)
4	110	(489.3)	1000	(4448.2)

Figure 83.1

Bending test arrangement



84 Pull Out

84.1 A nonmetallic box shall withstand for 1-minute an axial pull of the value specified in Table 83.1 without damage and without pulling loose from the conduit.

84.2 If breakage of the conduit occurs before damage to the box or separation of the joint, the performance is acceptable.

84.3 The same test sample assembly used in the bending test described in Bending, Section 83, is to be used for this test.

85 Resistance to Specific Reagents

85.1 Usually, a reagent is understood to be a substance used to produce a characteristic reaction in chemical analysis. For the purposes of these requirements, however, a reagent is considered to be any chemical, oil, or other substance that has a corrosive or degrading effect on PVC products.

85.2 If a nonmetallic box is intended for use where it will be wet by or immersed in a specific reagent as defined in 85.1, specimens that have been immersed for 1440 and 2880 hours in the reagent at the intended concentration and temperature shall have at least 85 percent of the crushing tensile strength of unaged specimens. The tests are described in 85.3 – 85.7. See 85.8.

85.3 Nine specimens of each cylindrical box are to be tested separately. Each specimen is to consist of a circular section cut to include the socket end of the box. Three are to be immersed for 1440 hours and three for 2880 hours in the reagent at the intended concentration and temperature. Care is to be taken throughout the test procedures to minimize the likelihood of injury from handling reagents that are

hazardous. The remaining three are to be tested unaged. The specimens, the testing machine, and the surrounding air are to be in equilibrium with one another at a temperature of 23.0 ±2.0°C (73.4 ±3.6°F) during the test.

85.4 Prior to the test, measurement is to be made of the internal diameter of each test specimen. Each specimen is to be laid with its longitudinal axis horizontal between two rigid, flat, parallel steel plates that are at least as wide as the specimens are long. One plate is to be moved toward the other at the rate of 1/2 inch (12.7 mm) per minute until the surface of the specimen pulls away from contact with either plate – for example, until the specimen buckles – or until the minor axis measured inside the specimen is 60 percent of the inside diameter measured before the test.

85.5 The crushing loads at the buckling and the 60-percent points are to be 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 are each to be divided by the average loads at each of these points for the unaged specimens. The box is not acceptable if any of the resulting ratios is less than 0.85 or if one or more specimens crack or collapse before the buckling or 60-percent points are reached.

85.6 Nine specimens of each non-cylindrical box are to be tested for tensile strength using the machine described in 77.3.2. The specimens are to be prepared as described in 77.2.1 – 77.2.4. Three are then to be immersed for 1440 hours and three for 2880 hours in the reagent at the intended concentration and temperature. The remaining three are to be tested unaged.

85.7 The specimens, the testing machine, and the surrounding air are to be in thermal equilibrium with one another at a temperature of 23.0 ±2.0°C (73.4 ±3.6°F) during the test. The test and calculations of tensile strength are to be made as described in 77.3.1 – 77.3.5. The box is not acceptable if the average tensile strength for either the 1440- or 2880-hour-aged specimens is less than 85 percent of the average tensile strength of the unaged specimens.

85.8 If a nonmetallic box – whether cylindrical or not – is intended for use where it will be wet by or immersed in a specific reagent as defined in 82.1, samples of the box or specimens cut from the box shall not exhibit a gain or loss in weight of more than 2.50 percent as a result of immersion for 1440 and 2880 hours in the reagent at the intended concentration and temperature. If there is a gain weight after 2880 hours and if that gain exceeds 1.00 percent, that gain shall not exceed 1.65 times the gain after 1440 hours.

86 Wet Locations

86.1 A box intended for use in a wet location shall comply with requirements in 52.1 when tested as described in 86.2.

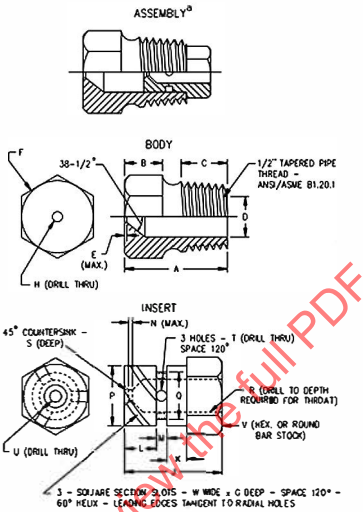
86.2 A box and cover, with raceway connections mounted in accordance with 52.1.3, is to be subjected to the water spray test described in 86.3 and to the test described in 52.1.4 and 52.2.1. In each test, the water spray is to be applied for 1 hour. See 52.3.1.

86.3 The water-spray-test apparatus is to consist of three spray heads constructed in accordance with the details illustrated in Figure 86.1 and mounted in a water-supply pipe rack illustrated in Figure 86.2. The water pressure at each spray head is to be maintained at approximately 5-pounds-per-square inch (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, except that consideration is to be given to the normal mounting position.

86.4 When tested in accordance with 86.5, a rubber or rubber-like component of a box intended for use in a wet location shall not show any apparent deterioration, and shall not show a change in hardness of more than 10 units.

86.5 The hardness of the unaged material is to be determined as the average of five readings with a gauge, such as the Rex hardness gauge or the Shore durometer, and the component is then to be placed in an air oven for 70 hours at 100 ±2°C (212 ±3.6°F). The component is to be allowed to rest at room temperature for not less than 4 hours after removal from the oven, 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 air oven aging is the change in hardness.

Figure 86.1
Rain-test spray head



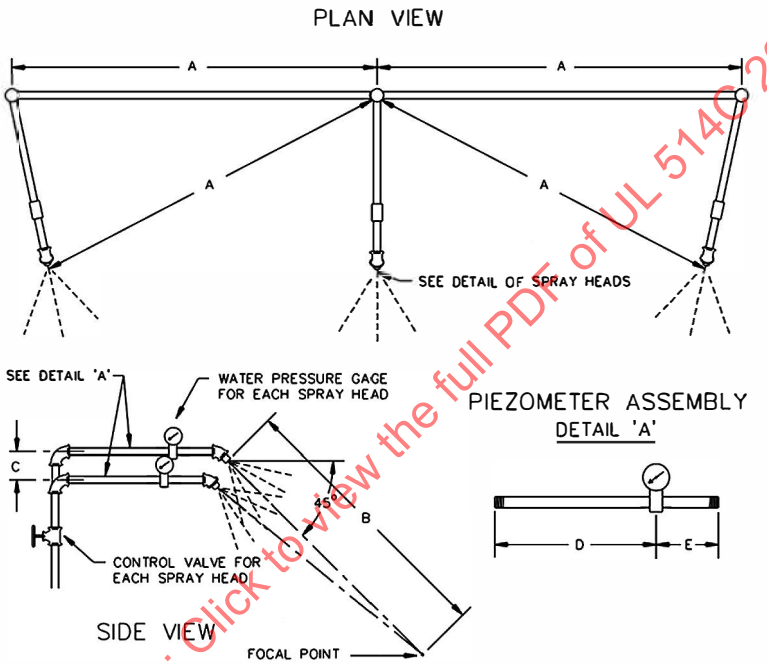
Item	inch	mm	Item	inch	mm
A	1-7/32	31.0	N	1/32	0.80
B	7/16	11.0	P	.575	14.61
C	9/16	14.0		.576	14.63
D	.578	14.68	Q	.453	11.51
	.580	14.73		.454	11.53
E	1/64	0.40	R	1/4	6.35
F	c	c	S	1/32	0.80
G	.06	1.52	T	(No. 35)[b]	2.80
H	(No.9)[b]	5.0	U	(No. 40)[b]	2.50
J	23/32	18.3	V	5/8	16.0
K	5/32	3.97	W	0.06	1.52
L	1/4	6.35			
M	3/32	2.38			

[a] Nyton Rain-Test Spray Heads are available from Underwriters Laboratories

[b] ANSI B94.11M Drill Size

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

Figure 86.2
Rain-test spray-head piping



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

RT101E

87 Concrete Tightness

87.1 A concrete-tight box shall be tested as described in 87.2 – 87.5. There shall be no entrance of concrete aggregate into the box.

Exception No. 1: A box that is constructed so that it will obviously exclude concrete aggregate need not be tested.

Exception No. 2: A box that excludes water when tested as described in 86.2 and 86.3 is considered to be concrete-tight and need not be tested.

87.2 The box is to be assembled in accordance with the installation instructions. If no instructions are provided, a box with adjusting means is to be tested in an adjusted position such that concrete will be most likely to enter, except that consideration is to be given to the normal mounting position. The box is to be secured to the bottom of the formwork used to contain the concrete. The formwork is to be filled with concrete prepared in accordance with 87.3. The concrete is to be vibrated immediately after it is poured using a vibrator that is in accordance with 87.4. A box intended to be used in a wall or ceiling is to be tested in accordance with 87.5. Twenty-four hours after the concrete has been poured, the box is to be broken loose from the concrete and the interior of the box is to be examined.

87.3 Portland-type cement is to be used in the preparation of the concrete for the test required by 87.1. The sand is to be of the type known to the construction industry as mason sand. The cement-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.

87.4 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 which is not less than 3.75 inches (95 mm) and not greater than 5.5 inches (140 mm), and

b) Length which is not less than 14 inches (356 mm) and not greater than 16 inches (406 mm).

87.5 A box intended to be used in a concrete wall or ceiling 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 its major axis is vertical and its free end is within 1 inch (25.4 mm) of the bottom of the formwork and within 1 inch of the assembly. The head is then to be withdrawn at a rate not less than 1 inch per second and not more than 2 inches (50.8 mm) per second. This procedure is to be repeated until all the concrete has been vibrated as indicated by an overlap of vibration patterns over the entire surface. The vibrator head 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.

87.6 *deleted*

FLOOR NOZZLES

CONSTRUCTION

88 Materials

88.1 General

88.1.1 A material used for a floor nozzle that has not been investigated for the application shall be investigated with respect to the factors mentioned in 19.1.

88.2 Relative thermal index

88.2.1 A material used for a floor nozzle shall have a relative thermal index of at least 80°C (176°F) when tested as described in 19.4.

PERFORMANCE

89 General

89.1 A floor nozzle shall comply with the requirements in Hot-Wire Ignition, Section 20, Dielectric Voltage Withstand, Section 21, Water Absorption, Section 33, Flammability, Section 34, Mold Stress, Section 35, Threaded or Unthreaded Holes for Screws in Molded Bosses, Section 38, and Gaskets, Section 51, and the appropriate requirements for Scrubwater Tightness for Floor Boxes in the Standard for Metallic Outlet Boxes, UL 514A.

90 Resistance to Impact

90.1 When tested as described in 90.2 – 90.4, there shall not be:

a) Damage to the body of a floor nozzle,

b) More than 3/16-inch (4.8 mm) displacement of a nozzle faceplate from its mounting surface, or

c) An opening in the faceplate that will permit the free passage of a 1/8-inch (3.2-mm) drillrod.

90.2 Each of two sample floor nozzle assemblies, including receptacle and faceplate, is to be subjected to a single impact of 5 foot-pounds (6.8 J) at one of each of the locations specified in 90.3. The samples are to be installed as intended to a floor or rigid supporting surface. A steel sphere, 2 inches (50.8 mm) in diameter and weighing 1.18 pounds (0.54 kg), is to be swung as a pendulum through a vertical distance of 51 inches (1.3 m), as illustrated in Figure 86.1, to contact the test sample approximately 1-inch above the floor or surface with the cord or chain in a vertical position. Eight individual samples may be used for the test so that the two couples are tested at each impact location; however, the same sample, if it has not been damaged, may be tested at more than one location. Following the test, each sample shall comply with the requirements in 90.1.

90.3 With reference to 90.2, each of the following locations is to be tested:

a) 1-1/2 inches (38.1 mm) to the right of the center of the receptacle face, tending to loosen the sample by rotating it counterclockwise.

b) 1-1/2 inches to the left of the center of the receptacle face, tending to tighten the sample by rotating it clockwise.

c) In the center of the receptacle face.

d) In the center of either side.