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# UL 5

## STANDARD FOR SAFETY

### Surface Metal Raceways and Fittings

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## UL Standard for Safety for Surface Metal Raceways and Fittings, UL 5

Fifteenth Edition, Dated May 24, 2016

***Summary of Topics***

***This revision of ANSI/UL 5 dated July 21, 2022 includes requirements for the use of electronic transmission of installation instructions; [24.1](#).***

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

The revised requirements are substantially in accordance with Proposal(s) on this subject dated June 3, 2022.

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**MAY 24, 2016**  
(Title Page Reprinted: July 21, 2022)

ANSI/UL 5-2022

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## UL 5

### Standard for Surface Metal Raceways and Fittings

Sixth Edition – May, 1973  
Seventh Edition – May, 1977  
Eighth Edition – March, 1978  
Ninth Edition – December, 1979  
Tenth Edition – May, 1985  
Eleventh Edition – May, 1995  
Twelfth Edition – October, 1996  
Thirteenth Edition – February, 2004  
Fourteenth Edition – September, 2011

### Fifteenth Edition

**May 24, 2016**

This ANSI/UL Standard for Safety consists of the Fifteenth Edition including revisions through July 21, 2022.

The most recent designation of ANSI/UL 5 as an American National Standard (ANSI) occurred on July 21, 2022. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, and Title Page.

The Department of Defense (DoD) has adopted UL 5 on July 9, 1984. 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 UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at <https://csds.ul.com>.

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## INTRODUCTION

### 1 Scope

1.1 These requirements cover surface metal raceways and fittings for use in accordance with the National Electrical Code, NFPA 70.

1.2 Raceways of the following thicknesses are intended to enclose circuits operating at potentials not exceeding 600 volts between conductors:

- a) Raceways that are entirely of metal at least 0.040 inch (1.02 mm) thick nominal and
- b) Raceways consisting of nonmetallic covers on metal bases of the thickness indicated in (a).

Thinner all-metal raceways or raceways of thinner metal bases with nonmetallic covers are intended to enclose circuits operating at potentials lower than 300 volts between conductors.

1.3 These requirements do not cover cable trays, wireways or nonmetallic raceways.

### 2 Components

2.1 Except as indicated in [2.2](#), a component of a product covered by this standard shall comply with the requirements for that component. See Appendix [A](#) for a list of standards covering components used in the products covered by this standard.

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

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

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

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

### 3 Units of Measurement

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

### 4 Undated References

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

### 5 Installation

5.1 The method of installation, as outlined in the instructions accompanying the raceway and fittings, shall be practical and feasible under the conditions met in practice.

5.2 The raceway, fittings and any wiring devices or accessories are to be installed as intended and examined with regard to the feasibility of installation, as well as for compliance with the construction, performance, and marking requirements in this standard. Attention is to be given to items that require particular care on the part of the raceway installer.

## 6 Nonmetallic Parts

6.1 A nonmetallic cover, fitting or other part of a metal raceway shall comply with the applicable requirements in the Standard for Nonmetallic Surface Raceways and Fittings, UL 5A.

## 7 Glossary

7.1 For the purposes of this standard, the following definitions apply:

7.2 **ACCESSORY** – A part that is added to a raceway system for a special purpose (for example, guards, hangers, or retainers).

7.3 **BOX, CEILING FAN** – A box that has been evaluated and determined to be acceptable as the support of a ceiling-suspended (paddle) fan.

7.4 **BOX, FIXTURE** – A box that has been evaluated and determined to be acceptable as the support of a lighting fixture, lampholder, or other equipment intended for similar installation.

7.5 **FITTING** – A part used to connect, change direction, or terminate a raceway (for example, a transition coupler, an end cap, a corner, a tee, an adapter, or a box).

7.6 **NONMETALLIC** – A polymeric part.

7.7 **RACEWAY, SURFACE METAL** – A raceway for surface or pendant mounting with a metal base and a metal or nonmetallic cover.

7.8 **RACEWAY SYSTEM** – A system consisting of a surface metal raceway, associated fittings, and possibly wiring devices and accessories.

7.9 **WIRING DEVICE** – A part of an electrical system that is intended to carry, provide a means of connection to, or control of, electrical energy within a raceway system (for example, switches or receptacles).

## CONSTRUCTION

## 8 General

8.1 A raceway system shall be constructed to facilitate compliance with the requirements for the installation of insulated wires and cables as given in the National Electrical Code, NFPA 70.

8.2 Each element of a raceway system shall comply with the requirements for the construction, performance, and use of that element.

8.3 A raceway shall consist of one or more pieces formed and constructed to make the raceway readily distinguishable from electrical conduit, electrical metallic tubing, electrical nonmetallic tubing, and other raceway systems.

8.4 A raceway system shall provide a complete enclosure that protects the wires installed therein against damage. The complete system, when installed as intended, shall comply with the following:

- a) There shall not be any openings that exceed 1/16 inch (1.59 mm) in width on surfaces that are accessible following installation of the system.
- b) A knockout or break-away tab shall completely cover the opening in which it is located, and the clearance between the knockout or break-away tab and the opening shall not be more than 0.030 inch (0.76 mm).
- c) Mounting holes having a maximum diameter of 9/32 inch (7.1 mm), or slotted openings for mounting of one dimension not larger than 5/8 inch (15.9 mm) and the other dimension not larger than 1/8 inch (3.2 mm), provided on the raceway base or fitting base surface that is installed flush with the mounting surface, are not prohibited.
- d) A partition in a raceway system shall not have any openings through which wires are capable of being passed, intentionally or otherwise, from one compartment to another.

*Exception No. 1: A gap of 1/8 inch (3.2 mm) shall be used only when means is provided to completely contain conductors in their individual compartments, such as wire retaining clips.*

*Exception No. 2: On lengths of surface metal raceway provided with openings that are intended for wiring devices, fittings or accessories, those openings are not required to be blocked by knockouts or break-away tabs where the installation instructions provided with that surface metal raceway comply with [24.7](#).*

8.5 The interior surface of the raceway system shall have a smooth finish that is free from projections, sharp edges, burrs, fins, and other faults damaging to wires when installed as intended.

8.6 A raceway shall be provided with means for securing it to the mounting surface at intervals of not more than 4 feet (1.2 m).

8.7 Where the base is intended to be secured to the mounting surface by screws or bolts extending from the inside, the arrangement shall not result in damage to the conductors.

8.8 Mounting hardware such as screws or bolts shall either be packaged with the raceway, or the installation instructions packaged with the raceway or fittings shall specify the appropriate mounting means. See [24.3](#).

8.9 An adhesive strip, when provided on the raceway, shall serve only as a positioning aid during the installation process. The raceway shall also have provisions for mechanical fastening as required in [8.6 – 8.8](#).

*Exception: An adhesive strip provided on a raceway shall be used as the sole means of securement only when the raceway is marked for use with Class 2 circuits only, as defined in Article 725 of the National Electrical Code, NFPA 70.*

8.10 Provision shall be made for securing the cover to the base of a two-piece raceway at intervals of not more than 4 feet (1.2 m). A cover shall be held in place by continuous grooves, flanges, or similar constructions only when it is securely fixed in place. See [8.12](#).

8.11 For raceways using conductors larger than 6 AWG (13.30 mm<sup>2</sup>), the Short Circuit Test, Section [23](#), shall be performed on conductors in the raceway to determine whether the cover is secure.

8.12 Raceway or fitting covers shall be constructed such that the use of a tool (such as the prying action of a screwdriver) or two simultaneous deliberate actions are required for their removal for gaining access to internal areas of the raceway after installation.

8.13 A partition provided in a raceway or fitting shall be secured in position. The partition shall have the strength required to support the maximum wire fill by weight.

## 9 Fittings

9.1 A fitting provided with means for the support of a fixture shall have strength and rigidity for the purpose as evaluated by means of the tests described in the Fixture Support Test, Section [15](#). A nipple intended only for the connection of a lampholder or similar item is not to be considered means for the support of a fixture.

9.2 A fitting provided with means for the support of a ceiling-suspended (paddle) fan shall have strength and rigidity for the purpose as evaluated by means of the tests described in the Ceiling-Suspended Fan Support, Section [16](#).

## 10 Wiring Devices

10.1 A receptacle shall be secured to the raceway base by a positive means such as a minimum of two screws or rivets.

*Exception: A snap-fit or other non-positive securement means shall be used only when it complies with the Receptacle Secureness Test, Section [19](#).*

10.2 A receptacle shall comply with all of the applicable requirements in the Standard for Attachment Plugs and Receptacles, UL 498. A flush switch shall comply with all of the applicable requirements in the Standard for General-Use Snap Switches, UL 20.

10.3 A wiring device cover constructed to support a flush duplex receptacle shall be provided with more than one securement point for the receptacle.

## 11 Grounding and Bonding

11.1 Electrical continuity shall be provided between all metal parts of the raceway system when the parts are installed in the intended manner. See the Electrical Resistance Test, Section [21](#).

11.2 A supplemental set screw or other acceptable positive means of securement shall be provided for each connection between adjacent metal raceway section and between metal raceway sections and fittings of a metal raceway system.

*Exception: Other methods of providing electrical continuity are to be used only when in compliance with the requirements in the Fault Current Test, Section [22](#).*

11.3 A raceway system shall be provided with means for grounding at all points or with fittings intended for connection to another wiring system.

11.4 A metal raceway base or fitting intended for connection to a wiring system shall have a tapped hole adjacent to the wire entry point intended for use with a No. 10-32 or larger grounding screw. At least two full threads shall be provided in metal into which screws are to be threaded.

*Exception: A metal raceway base or fitting is not required to have a tapped hole when it is provided with a fastening means such as a wire attached by a connector, clip, or other means that has been evaluated and determined to be suitable. A self-threading or factory-assembled screw shall be provided instead of a tapped hole only when it is identified for the purpose of securing the grounding conductor. A fastening means is not required when fastening methods are referenced in the instructions.*

11.5 A grounding screw provided in the raceway base or fitting shall:

- a) Be No. 10 or larger,
- b) Have a green-colored head that is slotted or hexagonal, or both, and
- c) Be plated steel, stainless steel, copper, or copper alloy.

Only a plated steel or stainless steel grounding screw shall be provided in an aluminum raceway or fitting. 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 (5.3 mm<sup>2</sup>) conductor under the head of the screw. A sheet metal screw shall not be used as a grounding screw.

11.6 With regard to the requirements in [11.5](#), a grounding wire provided in lieu of a grounding screw shall be sized in accordance with the maximum size of wire for which the raceway is intended to be used, and shall be a minimum of either solid copper not smaller than 14 AWG (2.1 mm<sup>2</sup>) or solid aluminum not smaller than 12 AWG (3.3 mm<sup>2</sup>), and shall be a minimum of 6 inches (152 mm) long.

11.7 One end of a grounding wire shall be secured to the raceway or fitting by welding by means of a copper, copper alloy, or stainless-steel rivet when the wire is of copper or by means of an aluminum or stainless-steel rivet when the wire is of aluminum. When insulated, the insulation shall be rated for 600 volts and the color of the surface of the insulation shall be green, with or without one or more yellow stripes.

*Exception: A screw shall be used to secure the grounding wire only when the screw complies with the requirements in [11.5](#).*

## 12 Specific Materials and Dimensional Limits

12.1 The base of a raceway or fitting shall be of metal that complies with [Table 12.1](#), [Table 12.2](#), [Table 12.3](#), or [Table 12.4](#); or be of metal that provides equivalent protection for the wiring as compared to the metals and thickness provided in this standard. Sections of reduced thickness are suitable for facilitating break-offs. Break-offs shall not result in any edges protruding into the interior of the raceway or fitting. The cover of a raceway or fitting shall be of metal as indicated above or shall be of nonmetallic material.

**Table 12.1**  
**Dimensions of raceway and fitting bases and covers for seven or fewer conductors not larger in cross-sectional area than 12 AWG (3.31 mm<sup>2</sup>)**

Material	Minimum thickness at knock-outs and other points of connection for a wiring system, inch (mm)	Minimum thickness elsewhere than in break-off areas and at points of connection for a wiring system, inch (mm)	Maximum width of raceway, inches (mm)
Steel	0.036 (0.91)	0.025 (0.64)	2-1/2 (63.5)
Aluminum	0.050 (1.27)	0.035 (0.89)	2-1/2 (63.5)

**Table 12.2**  
**Thickness of raceway and fitting bases and covers for conductors not larger in cross-sectional area than 6 AWG (13.30 mm<sup>2</sup>)**

Material	Minimum thickness, inch (mm)	
Steel	0.036	(0.91)
Aluminum	0.050	(1.27)

**Table 12.3**  
**Thickness of raceway and fitting bases and covers for conductors that are larger in cross-sectional area than 6 AWG (13.30 mm<sup>2</sup>)**

Material	Part	Minimum thickness, inch (mm)	
Steel	Base	0.053	(1.35)
	Cover	0.036	(0.91)
Aluminum	Base	0.074	(1.88)
	Cover	0.050	(1.27)

**Table 12.4**  
**Minimum thickness of parts that are cast of metal**

Material	inch	(mm)
Malleable iron	3/32	(2.4)
Iron other than malleable iron	1/8	(3.2)
Die-cast nonferrous:		
Part that is not ribbed or otherwise reinforced for mechanical strength	3/32	(2.4)
Part that is ribbed or otherwise reinforced for mechanical strength	1/16	(1.6)
Cast nonferrous other than die-cast	3/32	(2.4)

12.2 Inside and outside surfaces of each length of an iron or steel raceway or fitting shall be cleaned of all scale and rust and shall be in a condition that enables the protective coating to adhere firmly and have a smooth surface.

12.3 The thickness of the finished product is to be measured with a round-nose machinist's micrometer calibrated to read directly to at least 0.001 inch or 0.01 mm. Measurements are to be made at five different locations on each specimen examined.

12.4 Other than as noted in [12.5](#), a knockout provided in a raceway for a 1/2-inch or larger trade-size conduit shall be surrounded on both the inside and outside surfaces by a concentric flat surface to permit intended installation of a locknut. The flat surface shall extend in all directions beyond the edge of the knockout for a distance not less than that specified in [Table 12.5](#).

**Table 12.5**  
**Diameter of knockout and width of surrounding flat surface**

Trade size of conduit, inches	Knockout diameter,		Minimum width of flat surface surrounding knockout,	
	inches <sup>a</sup>	(mm)	inch	(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)

<sup>a</sup> 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 remains after removal of a knockout.

12.5 When the concentric flat surface required in [12.4](#) is not provided, the acceptability of the flat surface surrounding a knockout on both the inside and outside surfaces is able to be determined by application of a test gauge as illustrated in [Figure 12.1](#) which has the dimensions specified in [Table 12.6](#). To use the gauge, the knockout is to be removed and the appropriate trade size of test gauge is to be inserted in the resulting opening from either side of the raceway. It is not prohibited that the gauge be offset from the center of the opening, and rotated so that the flat surface including all points of the hexagonal portion of the gauge will be in intimate contact with the surface of the raceway. The test gauge is then to be inserted in the resulting opening from opposite side of the raceway with the same degree and position of offset from the center used on the other side, and the flat surface including all points of the hexagonal portion of the gauge is to be in intimate contact with the surface of the raceway as the gauge is rotated through an angle of at least 60 degrees. The test gauge is not to be canted or tilted to make the required contact with the surface of the raceway.

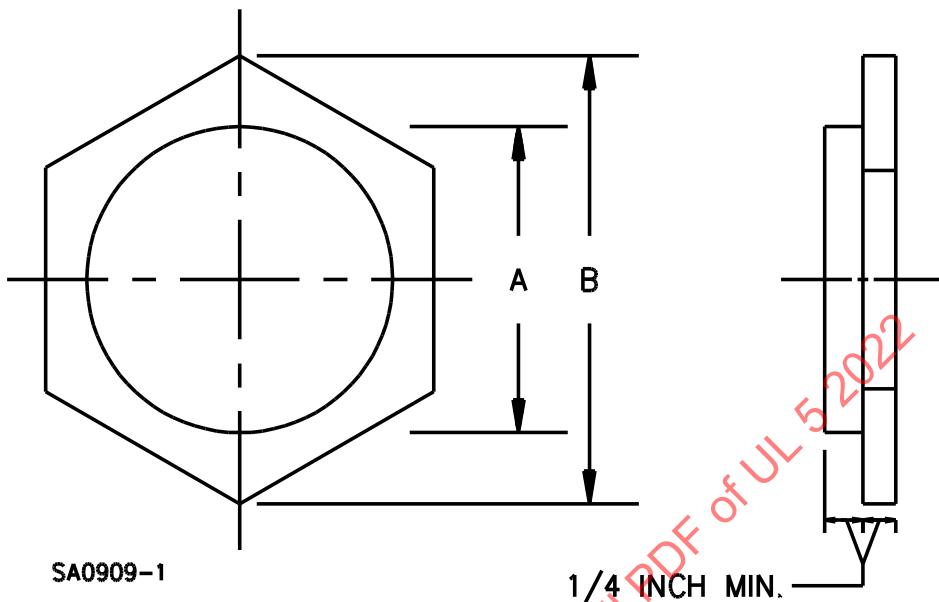
**Table 12.6**  
**Dimensions of test gauges for flat surfaces surrounding knockouts**

Trade size, inches	Nominal knockout diameter, inches (mm)	Nominal diameter of conduit, inches (mm) <sup>a</sup>	Maximum diameter of locknut, inches (mm) <sup>b</sup>
1/2	0.875 (22.23)	0.840 (21.34)	1.140 (28.96)
3/4	1.109 (28.17)	1.050 (26.67)	1.420 (36.07)
1	1.375 (34.93)	1.315 (33.40)	1.770 (44.96)
1-1/4	1.734 (44.04)	1.660 (42.16)	2.281 (57.94)

<sup>a</sup> Nominal outside diameter of rigid conduit. Tolerances for test gauge:  $\pm 0.001$  inch (0.03 mm).

<sup>b</sup> Maximum diameter of locknut. Tolerances for test gauge: plus 0.001 inch, minus 0.000 inch.

**Figure 12.1**  
**Dimensions of test gauges for flat surfaces**



12.6 When evaluating a raceway for compliance with the requirement in [12.4](#), consideration is to be given to the clearances from adjacent knockouts and the sides of the raceway, but it is not required that the raceway be constructed so that conduit can be installed simultaneously in adjacent knockouts.

## 13 Corrosion Protection

### 13.1 General

13.1.1 Metal raceway and fittings shall be protected against corrosion on all inside and outside surfaces in accordance with [13.2](#) or [13.3](#) or the metal shall have been evaluated and determined to be inherently resistant to ordinary dry-locations indoor atmospheric corrosion. Such protection is not required on cut edges. Where spotwelds are made on metallic material the integrity of the coating shall be maintained.

### 13.2 Zinc coatings

13.2.1 A zinc coating shall cover a raceway or fitting part completely, adhere firmly at all points, be smooth and free from blisters or other defects that lessen the protective value, be in metal-to-metal contact with the ferrous metal, and be evenly distributed on each surface of the finished part. A zinc coating on an interior surface shall not have an average thickness of less than 0.00015 inch (0.0038 mm) nor a minimum thickness less than 0.0001 inch (0.0025 mm). A zinc coating on an exterior surface shall not have an average thickness less than 0.0005 inch (0.013 mm) nor a minimum thickness less than 0.0004 inch (0.0102 mm). Any applicable method of determining the thickness of the zinc is satisfactory. When the results of any measurement are in doubt, the results of measurement by means of the test described in [17.1 – 17.10](#) are to be taken as conclusive.

*Exception: The zinc coating on the broad faces of a part that is formed from hot-dip-mill-galvanized steel sheet or coil is acceptable without investigation when both of the following apply to the unformed sheet or coil:*

- a) *The sheet or coil comes from the steel mill with either of the standard surface markings "G60" or "A60," or with a proprietary coating identification. Large coils that are not surface marked shall have the "G60" or "A60," or the proprietary coating identification, marked on the mill certificate. These markings indicate that the zinc coating is designated G60 or A60 in conformance with Table 1 of the Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process, ASTM A653/A653M, or has been determined to be equivalent to a standard G60 or A60 coating.*
- b) *Not less than 40 percent of the zinc is on any one side of the sheet or coil based on the minimum single-spot-test check-limit total for both sides of the sheet or coil of 0.50 oz/ft<sup>2</sup> (152 g/m<sup>2</sup>) specified in ASTM A653/A653M. The method of determining the weight of zinc coating per unit area (sum of the weights of coating on both sides of the sheet or coil) is to be any applicable method. However, in cases where the results of any measurement are in doubt, the results of measurements by means of the standard method or standard alternative method for galvanized sheets (coils included) described in the Standard Test Methods for Weight [Mass] of Coating on Iron and Steel Articles with Zinc or Zinc Alloy Coatings, ASTM A90, are to be taken as conclusive.*

13.2.2 An annealed zinc coating (A60 or its proprietary equivalent included, G60 or its proprietary equivalent excluded) on steel sheet or coil that is bent, extruded, rolled, or otherwise formed after annealing, is to be considered damaged and not in compliance with the requirements when flaking or cracking of the zinc is visible under 25-power magnification at the outside radius of the formed area unless additionally nonmetallic-coated in the formed area.

13.2.3 Steel sheet or coil which has an annealed zinc coating and is sheared, cut, or punched to result in a hole or an edge (straight or other) without also being formed at the edge or hole, is not required to have protection added at the edge or hole. However, in cases where the metal is formed at the edge or hole and the examination under magnification reveals damage to the zinc (see [13.2.2](#)), added protection shall cover the damaged area.

### **13.3 Nonmetallic coatings**

13.3.1 A nonmetallic protective coating, applied either before or after forming of the metal, shall:

- a) Cover each coated surface completely,
- b) Adhere firmly at all points on each coated surface,
- c) Be smooth and free from blisters or other defects which can lessen the protective value,
- d) Be evenly distributed on each coated surface of the finished raceway or fitting part,
- e) Meet the requirements of the Standard Test Method for Film Hardness by Pencil Test, ASTM D3363, with a 2H hardness rating, and the Standard Test Method for Measuring Adhesion by Tape Test, ASTM D3359, with a 4B rating, and
- f) Comply with the Rust Resistance Test for Nonmetallic Coatings, Section [18](#).

13.3.2 A nonmetallic coating on precoated sheets shall additionally comply with the requirements of the Standard Test Method for Coating Flexibility of Preprinted Sheet, ASTM D4145.

## 14 Ceiling-Suspended Fan Support

14.1 A box or fitting intended to support a ceiling-suspended fan shall:

a) Be provided with a minimum of two steel cover retaining or fan mounting screws and matching threaded or unthreaded holes. Where screws other than No. 8-32 or No. 10-32 are provided, the box shall be marked in accordance with [25.7](#). A box or fitting having unthreaded holes shall be provided with:

1) Screws of the thread cutting type or

2) A screw and nut assembly for use with clearance holes. The screws shall be held such that they are not able to rotate.

b) Comply with the support tests in Sections [15](#) and [16](#),

c) Be marked in accordance with [25.6](#) and

d) Be provided with installation instructions in accordance with [24.8](#).

14.2 Screws intended to secure a ceiling-suspended fan mounting bracket to a box in accordance with [14.1\(a\)](#) shall not have more than 9/16 in (14.3 mm) of exposed screw threads when a 1/8 in (3.2 mm) thick bracket is secured to the box. Screws with more exposed threads comply with the requirement when a means to reduce the risk of contact between the screw threads and the wire insulation is employed.

## PERFORMANCE

### 15 Fixture Support Test

15.1 A box or fitting identified for fixture support shall not pull apart and shall not have any openings that exceed 1/16 inch (1.59 mm) in width between the box cover and base and between the box/raceway covers. A direct pull force equal to four times the manufacturer's identified maximum load is to be supported by the fitting or box, when tested in accordance with [15.2](#). The manufacturer's identified maximum load to be supported by the fitting or box shall not exceed 50 lbf (223 N).

15.2 The box or fitting is to be mounted as intended for service with one piece of raceway and secured in accordance with the manufacturer's installation instructions. A direct pull is to be applied to a rigid steel bracket attached to the fixture-support studs on the fitting or box. A weight that equals 4 times the maximum load identified by the manufacturer is to be suspended from the bracket at a point midway between the fixture-support studs for a period of 5 minutes.

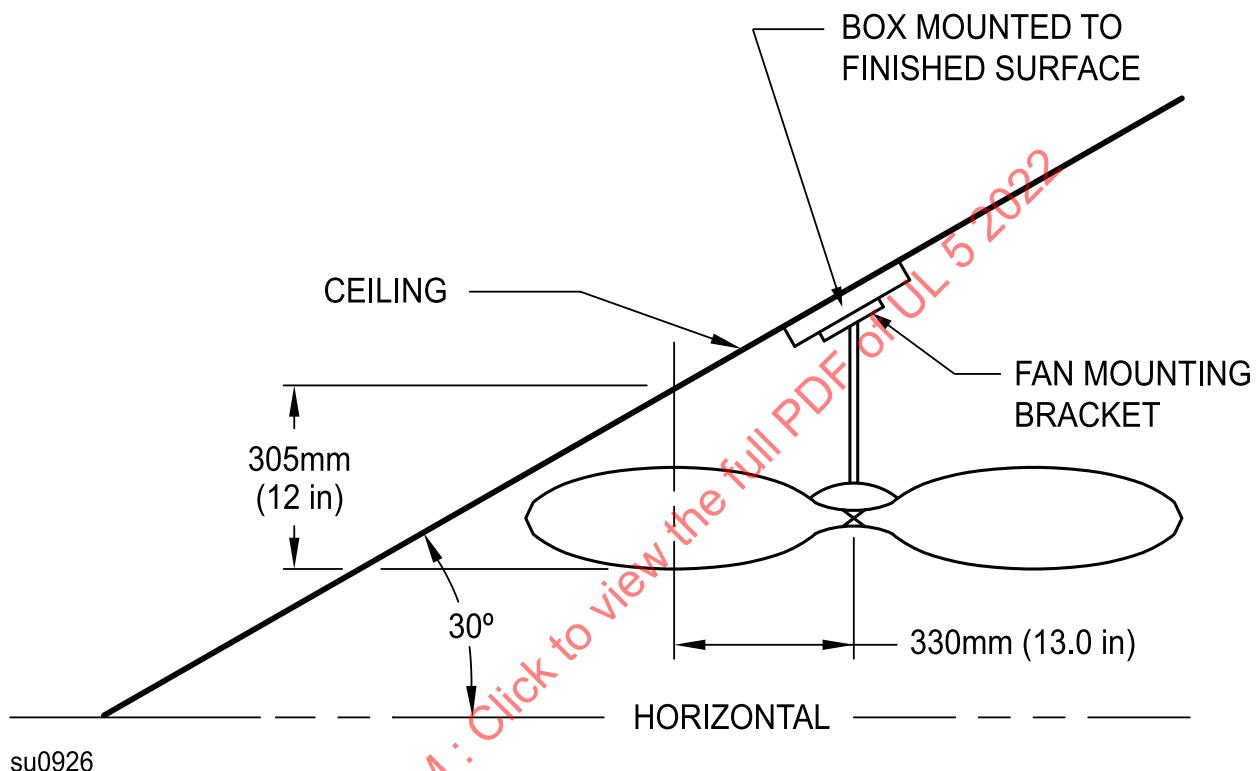
### 16 Ceiling-Suspended Fan Support

16.1 A box or fitting intended to support a ceiling-suspended fan (see Ceiling-Suspended Fan Support, Section [14](#)) shall comply with the Fixture Support Test, Section [15](#). As a result of the test specified in [16.2](#) – [16.6](#), there shall not be cracking, crazing, breaking, or visible damage to the box, mounting ears, or box or fitting supporting system (other than bending). Additionally, there shall not be stripping of threads in the fitting or box supporting system. The fitting or box supporting system shall not be pulled loose from the test structure. There shall not have any openings that exceed 1/16 inch (1.59 mm) in width between the box cover and base and between the box/raceway covers. One sample shall be tested in the horizontal position, and one additional sample shall be tested in the inclined position.

16.2 A box or fitting shall be mounted with one piece of raceway and secured in accordance with the manufacturer's installation instructions (see [24.8](#)) to a supporting test structure and tested while:

- a) In the horizontal position and
- b) Inclined 30 degrees from the horizontal with the mounting screws perpendicular to the ceiling and the fan blades parallel to the floor. See [Figure 16.1](#).

**Figure 16.1**  
**Fan support test**



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16.3 box or fitting shall be subjected to the tests specified in [16.4 – 16.6](#) using:

- a) A fan weighing 35 lb (15.9 kg) or 50 lb (23 kg) for a box marked in accordance with [25.6](#) or
- b) A fan weighing 35 lb (15.9 kg), 50 lb (23 kg), or 70 lb (32 kg) for a box marked in accordance with [25.6](#) and [25.7](#).

16.4 A  $52 \pm 1$  in (1320  $\pm$  25 mm) diameter test fan having four blades shall be used for the tests. A 1.4-oz (40-g) imbalance shall be placed 15-1/4 in (387.4 mm) from the center of the motor shaft. The fan shall be provided with a downrod of rigid metal pipe of a length to position the lower edge of the fan blades 12  $\pm$  1 in (305  $\pm$  25 mm) below the surface of the ceiling after mounting. The downrod shall be welded at the upper end to a 5/16-in (7.9-mm) thick fan-mounting bracket. The fan-mounting bracket shall be secured to the box in accordance with the box installation instructions. No. 8-32 screws or nuts shall be tightened to 20 lbf-in (2.26 N·m), and No. 10-32 screws or nuts shall be tightened to 35 lbf-in (3.96 N·m). A universal type joint mounting construction shall not be used for the test. The fan motor shall be an adjustable speed type.

16.5 The fan shall be connected to a variable voltage supply adjusted to maintain a tip speed of 4000 ft (1220 m) per minute (294 rpm). The blade pitch shall be reduced to a minimum. The fan shall be operated continuously at the prescribed speed for 24 h.

16.6 After testing as described in [16.2 – 16.5](#), one of the cover retaining or fan mounting screws or nuts shall be loosened two full turns, and the fan shall operate as specified for an additional 24 h for each mounting condition specified in [16.2](#). The screws or nuts shall not be loosened for a construction that employs cover-retaining or fan-mounting screws and locknuts with captive washers and an external star gripping pattern.

## 17 Chromic Acid Test for Thicknesses of Zinc Coating

17.1 Specimens prepared from finished zinc-coated raceway and fittings not covered by the Exception to [13.2.1](#) shall not exhibit thicknesses of zinc on any surface, excluding edges, less than indicated in [13.2.1](#) when tested by any applicable method. However, if the results of any measurement are in doubt, the results of measurements by means of the test described in [17.2 – 17.10](#) shall be taken as conclusive. (The method in [17.2 – 17.10](#) is essentially the same as the procedure described in Standard Guide for Measurement of Electrodeposited Metallic Coating Thicknesses by the Dropping Test, ANSI/ASTM B 555.)

17.2 The solution to be used for this test is to be made from distilled water and is to contain 200 grams mass per liter of the American Chemical Society (ACS) reagent grade of chromic acid ( $\text{CrO}_3$ ) and 50 grams mass per liter of the ACS reagent grade concentrated sulfuric acid ( $\text{H}_2\text{SO}_4$ ). The latter is equivalent to 27 milliliters per liter of the ACS reagent grade concentrated sulfuric acid, specific gravity 1.84, containing 96 percent of  $\text{H}_2\text{SO}_4$ .

17.3 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 approximately 0.025 inch (0.64 mm) and a length of 5.5 inches (140 mm). The lower end of the capillary tube is to be tapered to form a tip, the drops from which are about 0.025 ml each. To preserve an effectively constant level, a small glass tube is to be inserted in the top of the funnel through a rubber stopper and its position is to be adjusted so that, while the stopcock is open, the rate of drip is  $100 \pm 5$  drops per minute. It is not prohibited for an additional stopcock to be used in place of the glass tube to control the rate of drip.

17.4 The specimens and the test solution are to acquire the temperature of the test room, and the temperature is to be noted and recorded. The test is to be conducted at an ambient temperature of 70 – 90°F (21.1 – 32.2°C).

17.5 Each specimen is to be cleaned before testing. Any grease, lacquer, paint, or other nonmetallic material on the zinc is to be removed completely by means of organic solvents. The specimens are then to be rinsed in water and dried. The specimens are not to be touched by hands or anything else that can contaminate or damage the surfaces.

17.6 The specimen to be tested is to be supported 0.7 – 1.0 inch (17.8 – 25.4 mm) below the orifice, so that the drops of solution strike the point to be tested and run off quickly. The surface to be tested is to be inclined 45 degrees from the horizontal.

17.7 The stopcock is to be opened and the time in seconds is to be measured until the solution dissolves the zinc coating, exposing the underlying metal. The end point is the first appearance of the underlying metal, which is recognizable by the change in color at that point.

17.8 Each raceway or fitting part is to be subjected to test at three or more points, excluding all edges, on the inside surface and at an equal number of points on the outside surface, at places where the zinc is the thinnest. In the case of a part fabricated of steel sheet or coil that is coated with zinc before forming, the external corners that are subjected to the greatest deformation are likely to have the thinnest zinc coating on the outside surfaces of the corners. In the case of a cast part or a steel sheet or coil part to which the zinc is applied by any method after the part is cast or formed, it is not prohibited to make a preliminary test in many or all areas of an extra sample to determine where the zinc is thinnest.

17.9 The thickness of zinc is to be calculated for each test point by means of whichever of the following formulas is applicable:

$$T_{in} = 10^{-5} \times S \times F$$

$$T_{\mu m} = 0.254 \times S \times F$$

in which:

$T_{in}$  is the thickness of the zinc coating at the test point in inches,

$S$  is the time in seconds for the solution to expose the metal underlying the zinc at the test point,

$F$  is the factor from [Table 17.1](#) for the temperature at which the test was made, and

$T_{\mu m}$  is the thickness of the zinc coating at the test point in micrometers.

17.10 The zinc coating is to be considered not in compliance when:

- a) For any single test point on an interior surface, the calculation results in a thickness of zinc less than 0.0001 inch (0.0025 mm), or
- b) For any single test point on an exterior surface, the calculation results in a thickness of zinc less than 0.0004 inch (0.0102 mm), or
- c) The average of the thicknesses calculated for all of the test points on the interior surface results in a thickness less than 0.00015 inch (0.0038 mm), or
- d) The average of the thicknesses calculated for all of the test points on the exterior surface results in a thickness less than 0.0005 inch (0.013 mm).

**Table 17.1**  
**Temperature factor F for use in zinc-thickness calculation**

Temperature, °F	(°C)	Factor F
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

**Table 17.1 Continued on Next Page**

**Table 17.1 Continued**

Temperature, °F	(°C)	Factor F
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

## 18 Rust Resistance Test for Nonmetallic Coatings

18.1 A raceway or fitting part is acceptable when there is minute rusting less than 0.03 percent of surface rusted (Rust Grade 9) in accordance with the Standard Test Method for Evaluating Degree of Rusting on Painted Steel Surfaces, ASTM D610, at the conclusion of the test specified in [18.2](#).

18.2 The raceway or fitting parts are to be subjected to a salt spray (fog) using the test method in Standard Practice for Operating Salt Spray (Fog) Apparatus, ASTM B117, and employing a 5 percent, by weight, salt solution for 24 hours. At the end of the test the specimens are to be removed from the chamber, washed in clean running water [not warmer than 100°F (37.8°C)] to remove salt deposits from the surface, and dried immediately. Corrosion products are to be removed by light brushing when required to observe corrosion of the underlying surface.

## 19 Receptacle Secureness Test

19.1 A receptacle that is secured in place by a snap-fit or any means other than screws, rivets, or equivalent positive securement means, shall be tested as described in [19.2](#) – [19.3](#). The receptacle or fitting shall remain fully secured to the raceway.

19.2 The attachment plug of a power-supply cord is to be inserted into the receptacle and made mechanically secure. A weight exerting 25 lbf (111 N) is to be attached to the opposite end of the power-supply cord. The receptacle is to be attached in the intended manner to a length of raceway. With the raceway in the horizontal position (receptacle face directed towards the ground) and the weight initially resting on a horizontal surface, the raceway is to be gradually raised vertically until the weight is supported by the receptacle. The weight is to be supported for 60 seconds.

19.3 The test in [19.2](#) is then to be repeated with the raceway tilted so that a line perpendicular to the face of the receptacle makes an angle of 30 degrees with the vertical cord. The direction of the tilt relative to the receptacle is to be the direction most certain to cause separation.

## 20 Security of Knockout and Break-Away Tab Test

20.1 A force of 10 lbf (44.5 N) is to be applied to a knockout or a break-away tab for 60 seconds by means of a 1/4-inch (6.4-mm) diameter mandrel with a flat end. The force is to be applied with the mandrel's flat end perpendicular to the plane of the knockout or break-away tab and at the point most certain to cause movement. The knockout or break-away tab shall remain in place and the clearance between the knockout or break-away tab and the opening shall not be more than 0.030 inch (0.76 mm) when measured 60 minutes after the force has been removed.

20.2 A knockout or break-away tab shall be capable of being removed without leaving sharp edges and without damage to the part from which the knockout or tab was removed.

20.3 For multiple-stage knockouts or break-away tabs, there shall not be any displacement of a larger stage when any smaller stage is removed as described in [20.2](#).

## 21 Electrical Resistance Test

### 21.1 Measured on individual pieces

21.1.1 The electrical resistance per unit length of a complete (cover in place) individual section of metal raceway and of each complete (cover in place) metal coupling or other fitting shall not be greater than indicated in [Table 21.1](#).

**Table 21.1**  
**Maximum resistance of individual sections and fittings**

Material	Thickness of metal base and metal cover (when provided) elsewhere than in break-off areas and at points of connection for a wiring system, inches (mm)	Ohms per foot (Ohms per meter)
Steel	at least 0.025 and less than 0.036 (at least 0.63 and less than 0.91)	0.0083 (0.0272)
	at least 0.036 (at least 0.91)	0.0035 (0.0115)
Aluminum	at least 0.035 and less than 0.050 (at least 0.89 and less than 1.27)	0.0012 (0.0039)
	at least 0.050 (at least 1.27)	0.00060 (0.0020)

### 21.2 Measured across joints

21.2.1 The electrical resistance of the connection between adjacent sections of metal raceway, the connection between a raceway or fitting cover and base, and the connection between a raceway section and any metal fitting, internal or external to the raceway, shall not exceed 0.005 ohm.

21.2.2 The raceway and fittings are to be installed in the intended manner and a direct current of 30 A is to be passed between adjacent sections of raceway, between the raceway or fitting base and cover, and between raceway and fittings. The resulting voltage drop is to be measured between points (file marks) on two adjacent raceway sections 1/16 inch (2 mm) from the connection or between similar points on the connection of a raceway section and an end fitting. In the case of a fitting of the feed-through type, the resulting voltage drop is to be measured between points on the two adjacent raceway sections 1/16 inch (2 mm) from the connection. The resistance in any case is to be calculated by dividing the measured voltage drop by the current passing through the raceway.

## 22 Fault Current Test

22.1 A metal raceway system that relies upon a means of securement other than a supplemental set screw or other acceptable positive means to provide electrical continuity between adjacent raceway sections or between raceway sections and fittings shall comply with [22.2](#) after being subjected to the conditioning and test specified in [22.3 – 22.6](#). Three 6-inch (150-mm) specimens of the raceway assembly (cover and base) and a fitting or the part of the fitting that forms the joint being evaluated are to be tested. The test specimens are to be assembled in accordance with the manufacturer's installation instructions. The test specimens are not to be mounted while being tested in accordance with [22.3](#).