UL 5

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Surface Metal Raceways and Fittings

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

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Summary of Topics

This new edition is a periodic re-issuance to ensure that UL's Standards remain up-to-date with regard to format and editorial issues such as renumbering, repaginating, correction of editorial errors, correction of cross-references and updating titles of referenced Standards. No changes in requirements are involved. This new edition is also being issued to update the title page to indicate the standard has been approved as an American National Standard.

UL Standards for Safety are developed and maintained in the Standard Generalized Markup Language (SGML). SGML -- an international standard (ISO 8879-1986) -- is a descriptive markup language that describes a document's structure and purpose, rather than its physical appearance on a page. Due to formatting differences resulting from the use of UL's new electronic publishing system, please note that additional pages (on which no requirements have been changed) may be included in revision pages due
to relocation of existing text and reformatting of the Standard.

The requirements are substantially in accordance with UL's Bulletin(s) on this subject dated April 11, 2003 and September 30, 2003. The bulletin(s) is now obsolete and may be discarded.

As indicated on the title page (page 1), this UL Standard for Safety is an American National Standard. Attention is directed to the note on the title page of this Standard outlining the procedures to be followed to retain the approved text of this ANSI/UL Standard.

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

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

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

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

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

Page	Date
1-22	February 26, 2004
A1-A2	February 26, 2004

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First Edition – February, 1920
Second Edition – April, 1921
Third Edition – September, 1925
Fourth Edition – December, 1940
Fifth Edition – March, 1969
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 26, 2004

The most recent designation of ANSI/UL 5 as an American National Standard (ANSI) occurred on December 3, 2003.

This ANSI/UL Standard for Safety, which consists of the Thirteenth Edition with revisions through February 26, 2004, is under continuous maintenance, whereby each revision is ANSI approved upon publication. Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Written comments are to be sent to UL-SC Standards Department, 1655 Scott Blvd, Santa Clara, CA 95050.

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

The Department of Defense (DoD) has adopted UL 5 on July 9, 1984. The publication of revised pages or a new edition of this Standard will not invalidate the DoD adoption.

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

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FOREWORD

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

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

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

D. A product employing materials or having forms of construction which conflict with specific requirements of the Standard cannot be judged to comply with the Standard. A product employing materials or having forms of construction not addressed by this Standard may be examined and tested according to the intent of the requirements and, if found to meet the intent of this Standard, may be judged to comply with the Standard.

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

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

INTRODUCTION

1 Scope

1.1 These requirements cover 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.

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

2 General

2.1 Components

2.1.1 Except as indicated in 2.1.2, 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.

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

a) Involves a feature or characteristic not required in the application of the component in the product covered by this standard, or

b) Is superseded by a requirement in this standard.

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

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

2.2 Units of measurement

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

2.3 Undated references

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

2.4 Installation

2.4.1 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.

2.4.2 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.

2.5 Nonmetallic parts

2.5.1 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.

3 Glossary

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

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

3.3 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.

3.4 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).

3.5 NONMETALLIC – A polymeric part.

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

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

3.8 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

4 General

4.1 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.

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

4.3 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.

4.4 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: 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.

4.5 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.

4.6 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).

4.7 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.

4.8 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 18.3.

4.9 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 4.6 – 4.8.

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.

4.10 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 4.12.

4.11 For raceways using conductors larger than No. 6 AWG (13.30 mm^2), the Short Circuit Test, Section 17, shall be performed on conductors in the raceway to determine whether the cover is secure.

4.12 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.

4.13 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.

5 Fittings

5.1 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 10. 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.

6 Wiring Devices

6.1 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 13.

6.2 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.

7 Grounding and Bonding

7.1 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 15.

7.2 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 16.

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

7.4 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.

7.5 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 No. 10 AWG (5.3 mm^2) conductor under the head of the screw. A sheet metal screw shall not be used as a grounding screw.

7.6 With regard to the requirements in 7.5, 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 No. 14 AWG (2.1 mm^2) or solid aluminum not smaller than No. 12 AWG (3.3 mm^2), and shall be a minimum of 6 inches (152 mm) long.

7.7 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 7.5.

8 Specific Materials and Dimensional Limits

8.1 The base of a raceway or fitting shall be of metal that complies with Table 8.1, 8.2, 8.3, or 8.4; or be of metal that provides equivalent protection for the wiring. 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 8.1
Dimensions of raceway and fitting bases and covers for seven or fewer conductors not larger in cross-sectional area than No. 12 AWG (3.31 mm^2)

Material	Minimum thickness at knock-outs and other points of connection for a wiring system,		Minimum thickness elsewhere than in break-off areas and at points of connection for a wiring system,		Maximum width of raceway,	
	inch	(mm)	inch	(mm)	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 8.2
Thickness of raceway and fitting bases and covers for conductors not larger in cross-sectional area than No. 6 AWG (13.30 mm^2)

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

Table 8.3
Thickness of raceway and fitting bases and covers for conductors that are larger in cross-sectional area than No. 6 AWG (13.30 mm^2)

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 8.4
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

8.2 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.

8.3 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.

8.4 Other than as noted in 8.5, 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 8.5.

Table 8.5
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)	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

[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 remains after removal of a knockout.

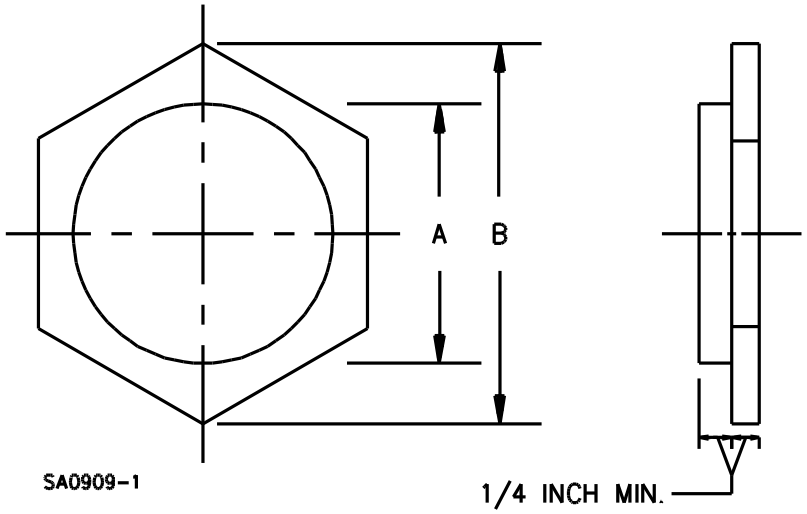
8.5 When the concentric flat surface required in 8.4 is not provided, the acceptability of the flat surface surrounding a knockout on both the inside and outside surfaces is able to be determined by application of a test gauge as illustrated in Figure 8.1 which has the dimensions specified in Table 8.6. 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 8.6
Dimensions of test gauges for flat surfaces surrounding knockouts

Trade size, inches	Nominal knockout diameter, inches	(mm)	Nominal diameter of conduit, inches	(mm)[a]	Maximum diameter of locknut, inches	(mm)[b]
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

[a] Nominal outside diameter of rigid conduit. Tolerances for test gauge: ±0.001 inch (0.03 mm).
[b] Maximum diameter of locknut. Tolerances for test gauge: plus 0.001 inch, minus 0.000 inch.

Figure 8.1
Dimensions of test gauges for flat surfaces



A – Nominal diameter of conduit

B – Maximum diameter of locknut

8.6 When evaluating a raceway for compliance with the requirement in 8.4, 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.

9 Corrosion Protection

9.1 General

9.1.1 Metal raceway and fittings shall be protected against corrosion on all inside and outside surfaces in accordance with 9.2 or 9.3 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 spot welds are made on metallic material the integrity of the coating shall be maintained.

9.2 Zinc coatings

9.2.1 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 11.1 – 11.10 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, 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^2 (152 g/m^2) specified in ASTM A653. 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.

9.2.2 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.

9.2.3 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 9.2.2), added protection shall cover the damaged area.

9.3 Nonmetallic coatings

9.3.1 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 12.

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

PERFORMANCE

10 Fixture Support Test

10.1 A fitting or box identified for fixture support shall withstand, without pulling apart, a direct pull force equal to four times the manufacturer's identified maximum load to be supported by the fitting or box, when tested in accordance with 10.2. The manufacturer's identified maximum load to be supported by the fitting or box shall not exceed 50 lbf (223 N).

10.2 The fitting or box is to be mounted as intended for service, and 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.

11 Chromic Acid Test for Thicknesses of Zinc Coating

11.1 Specimens prepared from finished zinc-coated raceway and fittings not covered by the Exception to 9.2.1 shall not exhibit thicknesses of zinc on any surface, excluding edges, less than indicated in 9.2.1 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 11.2 – 11.10 shall be taken as conclusive. (The method in 11.2 – 11.10 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.)

11.2 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 (CrO_3) and 50 grams mass per liter of the ACS reagent grade concentrated sulfuric acid (H_2SO_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 H_2SO_4.

11.3 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 ±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.

11.4 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).

11.5 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.

11.6 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.

11.7 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.

11.8 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.

11.9 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 11.1 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.

11.10 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 11.1
Temperature factor F for use in zinc-thickness calculation

Temperature,		Factor F
°F	(°C)	
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 11.1 Continued on Next Page

Table 11.1 Continued

Temperature,		Factor F
°F	(°C)	
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

12 Rust Resistance Test for Nonmetallic Coatings

12.1 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 12.2.

12.2 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.

13 Receptacle Secureness Test

13.1 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 13.2 – 13.3. The receptacle or fitting shall remain fully secured to the raceway.

13.2 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.

13.3 The test in 13.2 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.

14 Security of Knockout and Break-Away Tab Test

14.1 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.

14.2 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.

14.3 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 14.2.

15 Electrical Resistance Test

15.1 Measured on individual pieces

15.1.1 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 15.1.

Table 15.1
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,		Ohms per foot	(Ohms per meter)
	inches	(mm)		
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	0.000086

15.2 Measured across joints

15.2.1 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.

15.2.2 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.

16 Fault Current Test

16.1 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 16.2 after being subjected to the conditioning and test specified in 16.3 – 16.6. 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 16.3.

16.2 After application of the test current, the equipment-ground path provided by the metal raceway system shall not open and there shall not be any openings that exceed 1/16-inch (1.59-mm) in width on surfaces that are accessible. The electrical resistance across the joint shall not exceed 0.005 ohm when measured in accordance with the Electrical Resistance Test, Section 15.

16.3 Each assembled specimen, in turn, is to be hung freely by one end while a load of 15 lb (6.8 kg) is suspended from the other end such that the load is in the direction opposite to the direction of the force used to make the joint. The load is to be applied until movement at the joint ceases. The load shall not be applied for less than 1 min. The joint shall remain secure after the test and the electrical resistance across the joint shall not exceed 0.005 ohm during the test, when measured in accordance with the Electrical Resistance Test, Section 15.

16.4 The raceway system shall carry the current specified in Table 16.1 for the time specified in that table for the largest size of wire for which the system is intended.

Table 16.1
Short-time test currents

Maximum conductor size, AWG	Maximum conductor size, (mm^2)	Time, seconds	Test current, amperes (ac)
14	2.1	4	300
12	3.3	4	470
10	5.3	4	750
8	8.4	4	1180
6	13.3	6	1530
4	21.2	6	2450
3	26.7	6	3100
2	33.6	6	3900
1	42.4	6	4900
1/0	53.5	9	5050
2/0	67.4	9	6400
3/0	85.0	9	8030
4/0	107.0	9	10,100
250 MCM	127.0	9	12,000

16.5 A solid copper bus bar is to be connected to each end of each test specimen. The end of each of the bus bars not connected to the raceway is to be connected to two 36 inch (914 mm) lengths of No. 3/0 AWG copper conductors in parallel. The ends of the copper bus bars at which the connection to the raceway is to be made are to be connected together. The free ends of each pair of copper conductors are
to be connected together and then each of the two parallel pairs is to be connected to each side of a supply circuit. This supply is to be adjusted to deliver the test current. Without disturbing this adjustment the supply is to be turned off and the bus bars are to be separated.

16.6 The bus bars are then to be attached to the test specimen. The specimen is to be mounted on a surface as intended by the manufacturer. After mounting the supply is to be energized and the test current is to be passed through the specimen.

17 Short Circuit Test

17.1 The cover of a metal raceway system that is intended for use with conductors larger than No. 6 AWG (13.3 mm^2) shall not loosen from the raceway base after the system is subjected to the test specified in 17.2. There shall not be any openings that exceed 1/16 inch (1.59 mm) in width on accessible surfaces.

17.2 Two of the maximum size conductors with which the raceway system is intended to be used are to be connected in series with a fuse or circuit breaker and placed in a 20-foot (6.1-m) section of the raceway. The fuse or circuit breaker is to be of the appropriate rating for the conductor size and is to have
a minimum 10,000-A interrupting rating. The raceway is to be mounted in accordance with the manufacturer's installation instructions and the conductors are to be connected to a circuit capable of delivering 10,000 amperes at 600 Vac. The short circuit current is then to be passed through the conductors until the fuse or breaker opens.

Exception: The circuit is to be capable of delivering 10,000 A at 300 VAC when the raceway cover is marked in accordance with 19.5.

INSTALLATION INSTRUCTIONS

18 Details

18.1 The smallest unit shipping container for raceways and raceway fittings (including fixture boxes, device boxes, and transition fittings that are to be added to the raceway system independent of the raceway installation itself) shall be provided with instructions so that intended installation of the raceway and/or fitting can be accomplished.

Exception: Installation instructions for elbows, tees, inside and outside corners, and other fittings that are included in the initial installation of the raceway system are not required to be provided with these products when they are provided as part of the installation instructions for the overall raceway system.

18.2 The instructions shall clearly indicate the method(s) of mounting the raceway or raceway fittings and securing them to other fittings and raceway sections.

18.3 The instructions shall reference the appropriate type of hardware such as screws, bolts, or other means for securing the raceway or fitting to the mounting surface, when the hardware is not packaged with the raceway or fitting.

18.4 The instructions shall indicate that an adhesive strip, when provided on the raceway, shall serve only as a positioning aid during the installation process and that the raceway shall be secured by mechanical fastening means.

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 only with Class 2 circuits, as defined in Article 725 of the National Electrical Code, NFPA 70.

18.5 The instructions shall identify raceway fittings that effectively reduce the raceway system wire fill capacity. The instructions shall provide required special installation recommendations for those fittings.

18.6 The instructions for a raceway provided with mechanical wire retainers shall indicate their recommended installation interval.

MARKINGS

19 Details

19.1 Each length of raceway and each fitting intended for use with the raceway shall be marked with the name or trade name, or both, or any other distinctive marking that has been evaluated and determined to be suitable, by means of which the organization responsible for the raceway and fittings can readily be identified and with the catalog number or its equivalent. Identification of a private labeler is not prohibited.

Exception: It is not prohibited that the catalog number be marked on the smallest unit shipping carton.

19.2 The raceway or fitting shall be durably and legibly marked, on its base or cover (whichever is not interchangeable with a raceway or fitting of another catalog number) or on the package or on the installation instruction sheet, with the number, type, and size of insulated conductors for which it is intended.

19.3 A fitting or box identified for fixture support that has been evaluated for compliance with the Fixture Support Test, Section 10, shall be permanently marked with the following or the equivalent: ″Suitable for a fixture not exceeding ____lbs. ″ The specified fixture weight shall not exceed 50 lbs (22.7 kg). The marking is to be readily visible after the fitting or box has been mounted.

19.4 Each length of raceway intended for use only with Class 2 circuits, as defined in Article 725 of the National Electrical Code, NFPA 70, shall be marked with the following or the equivalent: ″For Class 2
Circuits Only. ″ The marking shall be visible following mounting as intended.

19.5 The cover of each length of raceway provided with a metal cover less than 0.040 inch (1.02 mm) nominal thick shall be marked ″300 V maximum ″ or the equivalent. The marking shall be visible following mounting as intended.

APPENDIX A

Standards for Components

Standards under which components of the products covered by this standard are evaluated include the following:

Title of Standard − UL Standard Designation

Plugs and Receptacles, Attachment – UL 498
Raceways and Fittings, Nonmetallic Surface – UL 5A
Switches, General-Use Snap – UL 20

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