

Standard for Safety

UL 756

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● Coin and Currency Changers and Actuators



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Standard



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April 30, 1993

Standard for

Coin and Currency Changers and Actuators

UL 756, Fourth Edition

Accompanying this transmittal notice is a copy of the Fourth edition of UL 756.

THIS EDITION OF THE STANDARD IS NOW IN EFFECT.

As indicated on the title page, 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 ANSI/UL 756-1992.

Revised and/or additional pages may be issued from time to time.

APRIL 30, 1993



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FOURTH EDITION**APRIL 30, 1993**

Approval as an American National Standard (ANSI) covers the numbered paragraphs on pages dated April 30, 1993. These pages should not be discarded when revised or additional pages are issued if it is desired to retain the ANSI approved text.

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

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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 published set of revision pages.

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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 differing from those detailed in the requirements of this Standard may be examined and tested according to the intent of the requirements and, if found to be substantially equivalent, 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 self-contained coin, credit card, debit card, currency, and token changers and actuators rated not more than 600 volts for use in accordance with the National Electrical Code, NFPA 70.

1.2 These requirements cover open-type appliances intended to be factory or field installed in vending machines and other appliances.

1.3 These requirements cover open-type controls for use with coin, credit card, debit card, currency, and token-operated devices intended to be factory installed within vending machines and other appliances.

1.4 These requirements do not cover the effectiveness of antitheft protection features.

1.5 A product that contains features, characteristics, components, materials, or systems new or different from those in use when the standard was developed, and that involves a risk of fire, electric shock, or injury to persons shall be evaluated using the appropriate additional component and end-product requirements as determined necessary to maintain the level of safety for the user of the product as originally anticipated by the intent of this standard.

2 Glossary

2.1 For the purpose of this standard, the following definitions apply.

2.2 **APPLIANCE** – Denotes all coin, credit card, debit card, currency, and token changers and actuators included in the scope of this standard. A requirement that applies only to specific equipment is identified by a specific reference in that requirement to the equipment involved.

2.3 **ENCLOSURE** – The outer cabinet of a self-contained appliance or vending machine.

2.4 **OPEN-TYPE CONTROL** – Controls and devices that are incomplete in certain construction features and need to be installed within another appliance.

2.5 **OPERATOR OR USER SERVICING** – Any form of servicing that might be performed by personnel other than qualified service personnel. Some examples are:

- a) The attachment of accessories by means of attachment plugs and receptacles or by means of other separable connectors.
- b) Resetting or replacement of circuit breakers, tubes, fuses, and lamps that are accessible without the use of tools.
- c) Making routine operating adjustments necessary to adapt the appliance for its different intended functions.
- d) Routine cleaning, removal of coins, price changing, replenishing the product supply, making minor adjustments, and other services performed by the route man who regularly opens an appliance for such purposes.

2.6 **SELF-CONTAINED APPLIANCE** – Coin, credit card, debit card, currency, and token changers and actuators that are complete in their construction.

3 Components

3.1 Except as indicated in 3.2, 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 generally used in the products covered by this standard.

3.2 A component need not comply with a specific requirement that:

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

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

3.4 Specific components are recognized as being 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 for which they have been recognized.

4 Units Of Measurement

4.1 If a value for measurement is followed by a value in other units in parentheses, the second value may be only approximate. The first stated value is the requirement.

5 Undated References

5.1 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.

CONSTRUCTION

6 General

6.1 An appliance shall employ materials found by investigation to be acceptable for the use, and shall be made and finished with the degree of uniformity and grade of workmanship practicable in a well-equipped factory.

7 Frame And Enclosure

7.1 General

7.1.1 An appliance shall be formed and assembled so that it will have the strength and rigidity necessary to resist the abuses to which it may be subjected, without increasing the risk of fire, electric shock, or injury to persons due to total or partial collapse with resulting reduction of spacings, loosening or displacement of parts, or other serious defects.

7.1.2 Electrical parts of an appliance, other than a supply cord or low-voltage terminals — see 17.1 — shall be located or enclosed so that protection against unintentional contact with uninsulated live parts will be provided. See 11.1.

Exception: An enclosure is not required for an appliance designed for assembly as part of another appliance.

7.1.3 The frame or chassis of an appliance shall not be relied upon to carry current during normal operation.

Exception: As provided in 13.5.

7.1.4 A part such as a dial or nameplate that is, in effect, a part of the enclosure shall comply with the requirements in 7.3.1, 7.4.1, or 7.6.1.

7.2 Doors and covers

7.2.1 An enclosure cover shall be hinged if it gives access to a fuse, thermal cutout, or any other overload-protective device, the intended functioning of which requires renewal, or if it is necessary to open the cover in connection with the normal operation of the device.

Exception: A hinged cover and the construction described in 7.2.2–7.2.4 are not required for an appliance in which the only fuses enclosed are (1) an extractor-type fuse with its own enclosure, or (2) fuses in low-voltage circuits – see 17.1.

7.2.2 A door or cover giving access to a fuse or thermal cutout in other than a low-voltage circuit – see 17.1 – shall shut closely against a 1/4-inch (6.3-mm) rabbet or the equivalent, or shall have either turned flanges for the full length of four edges or angle strips fastened to it. Flanges or angle strips shall fit closely with the outside of the walls of the box proper and shall overlap the edges of the box not less than 1/2 inch (12.7 mm). A construction that affords equivalent protection or a combination of flange and rabbet that has been investigated and found to be acceptable may be used.

7.2.3 Strips used to provide rabbets, or angle strips fastened to the edges of a door shall be secured at not less than two points, not more than 1-1/2 inches (38.1 mm) from each end of each strip and at points between these end fastenings not more than 6 inches (152 mm) apart.

7.2.4 A hinged cover shall be provided with a spring latch or catch.

Exception: For a hinged cover that is provided, although not required, a hasp, sliding latch, or other means for holding the cover closed may be employed.

7.2.5 An enclosure and a part of an enclosure such as a door, a cover, or a tank, shall be provided with means for firmly securing it in place.

7.2.6 Sheet-metal screws threading directly into metal shall not be used to attach a cover, a door, or other part that is removed to install field wiring or for operation of the equipment. Sheet-metal screws may thread into sheet-metal nuts that are permanently mounted and protected against corrosion, and machine screws and self-tapping machine screws may thread directly into sheet-metal walls. See 14.16.

7.2.7 Sheet-metal screws mounting internal components that are not removed for installation or operation may thread directly into metal.

7.3 Cast metal

7.3.1 Cast metal for an enclosure shall not be less than 1/8 inch (3.2 mm) thick at every point, of greater thickness at reinforcing ribs and door edges, and not less than 1/4 inch (6.3 mm) thick at tapped holes for conduit, except that, other than at plain or threaded conduit holes, die-cast metal shall not be less than 3/32 inch (2.4 mm) thick for an area greater than 24 square inches (155 cm²) or having any dimension greater than 6 inches (152 mm), and shall not be less than 1/16 inch (1.6 mm) thick for an area of 24 square inches or less and having no dimension greater than 6 inches. The area limitation for metal 1/16 inch thick may be obtained by the provision of reinforcing ribs subdividing a larger area.

Exception No. 1: Die-cast metal not less than 0.035 inch (0.89 mm) thick may be employed if the enclosure will not be used as a splice box and if the voltage rating of the complete appliance is such that the voltage between any two conductors is 250 volts or less and is limited to direct current or single-phase alternating current.

Exception No. 2: Die-cast metal not less than 0.028 inch (0.71 mm) thick may be employed for an enclosure housing only low-voltage circuits as defined in 17.1.

7.4 Sheet metal

7.4.1 Unless investigated and found acceptable for the application, the thickness of a sheet-metal enclosure shall not be less than that specified in Tables 7.1 and 7.2, except that uncoated steel shall not be less than 0.032 inch (0.81 mm) thick, zinc-coated steel shall not be less than 0.034 inch (0.86 mm) thick, and nonferrous metal shall not be less than 0.045 inch (1.14 mm) thick at points at which a wiring system is to be connected.

7.4.2 Tables 7.1 and 7.2 are based on a uniform deflection of the enclosure surface for any given load concentrated at the center of the surface regardless of metal thickness.

7.4.3 With reference to Tables 7.1 and 7.2, a supporting frame is a structure of angle or channel or a folded rigid section of sheet metal that is rigidly attached to and has essentially the same outside dimensions as the enclosure surface and that has the torsional rigidity to resist the bending moments that may be applied via the enclosure surface when it is deflected. Construction that is considered to have equivalent reinforcing may be accomplished by designs that will produce a structure that is as rigid as one built with a frame of angles or channels.

7.4.4 With reference to 7.4.3 and Tables 7.1 and 7.2, a construction is not considered to have a supporting frame if it is:

- a) A single sheet with single formed flanges – formed edges;
- b) A single sheet that is corrugated or ribbed;
- c) An enclosure formed or fabricated from sheet metal; or
- d) An enclosure surface loosely attached to a frame, for example, by spring clips.

Table 7.1
Thickness of sheet metal for enclosures,
carbon steel or stainless steel

Without supporting frame ^a		With supporting frame or equivalent reinforcing ^a		Minimum thickness, inch (mm)	
Maximum width ^b Inches (cm)	Maximum length ^c Inches (cm)	Maximum width ^b Inches (cm)	Maximum length ^c Inches (cm)	Uncoated	Metal coated
4.0 (10.2)	Not limited	6.25 (15.9)	Not limited	0.020 ^d (0.51)	0.023 ^d (0.58)
4.75 (12.1)	5.75 (14.6)	6.75 (17.1)	8.25 (21.0)		
6.0 (15.2)	Not limited	9.5 (24.1)	Not limited	0.026 ^d (0.66)	0.029 ^d (0.74)
7.0 (17.8)	8.75 (22.2)	10.0 (25.4)	12.5 (31.8)		
8.0 (20.3)	Not limited	12.0 (30.5)	Not limited	0.032 (0.81)	0.034 (0.86)
9.0 (22.9)	11.5 (29.2)	13.0 (33.0)	16.0 (40.6)		
12.5 (31.8)	Not limited	19.5 (49.5)	Not limited	0.042 (1.07)	0.045 (1.14)
14.0 (35.6)	18.0 (45.7)	21.0 (53.3)	25.0 (63.5)		
18.0 (45.7)	Not limited	27.0 (68.6)	Not limited	0.053 (1.35)	0.056 (1.42)
20.0 (50.8)	25.0 (63.5)	29.0 (73.7)	36.0 (91.4)		
22.0 (55.9)	Not limited	33.0 (83.8)	Not limited	0.060 (1.52)	0.063 (1.60)
25.0 (63.5)	31.0 (78.7)	35.0 (88.9)	43.0 (109.2)		
25.0 (63.5)	Not limited	39.0 (99.1)	Not limited	0.067 (1.70)	0.070 (1.78)
29.0 (73.7)	36.0 (91.4)	41.0 (104.1)	51.0 (129.5)		
33.0 (83.8)	Not limited	51.0 (129.5)	Not limited	0.080 (2.03)	0.084 (2.13)
38.0 (103.4)	47.0 (119.4)	54.0 (137.2)	66.0 (167.6)		
42.0 (106.7)	Not limited	64.0 (162.6)	Not limited	0.093 (2.36)	0.097 (2.46)
47.0 (119.4)	59.0 (149.9)	68.0 (172.7)	84.0 (213.4)		
52.0 (132.1)	Not limited	80.0 (203.2)	Not limited	0.108 (2.74)	0.111 (2.82)
60.0 (152.4)	74.0 (188.0)	84.0 (213.4)	103.0 (261.6)		
63.0 (160.0)	Not limited	97.0 (246.4)	Not limited	0.123 (3.12)	0.126 (3.20)
73.0 (185.4)	90.0 (228.6)	103.0 (261.6)	127.0 (322.6)		

^aSee paragraphs 7.4.3 and 7.4.4.

^bThe width is the smaller dimension of a rectangular sheet-metal piece that is part of an enclosure. Adjacent surfaces of an enclosure may have supports in common and be made of a single sheet.

^cFor panels that are not supported along one side; for example, side panels of boxes, the length of the unsupported side shall be limited to the dimensions specified.

^dSheet steel for an enclosure intended for outdoor use shall not be less than 0.034 inch (0.86 mm) thick if metal coated and not less than 0.032 inch (0.81 mm) thick if uncoated.

Table 7.2
Thickness of sheet metal for enclosures,
aluminum, copper, or brass

Without supporting frame ^a		With supporting frame or equivalent reinforcing ^a		Minimum thickness, inches (mm)
Maximum width ^b inches (cm)	Maximum length ^c inches (cm)	Maximum width ^b inches (cm)	Maximum length ^c inches (cm)	
3.0 (7.6)	Not limited	7.0 (17.8)	Not limited	0.023 ^d (0.58)
3.5 (8.9)	4.0 (10.2)	8.5 (21.6)	9.5 (24.1)	
4.0 (10.2)	Not limited	10.0 (25.4)	Not limited	0.029 (0.74)
5.0 (12.7)	6.0 (15.2)	10.5 (26.7)	13.5 (34.3)	
6.0 (15.2)	Not limited	14.0 (35.6)	Not limited	0.036 (0.91)
6.5 (16.5)	8.0 (20.3)	15.0 (38.1)	18.0 (45.7)	
8.0 (20.3)	Not limited	19.0 (48.3)	Not limited	0.045 (1.14)
9.5 (24.1)	11.5 (29.2)	21.0 (53.3)	25.0 (63.5)	
12.0 (30.5)	Not limited	28.0 (71.1)	Not limited	0.058 (1.47)
14.0 (35.6)	16.0 (40.6)	30.0 (76.2)	37.0 (94.0)	
18.0 (45.7)	Not limited	42.0 (106.7)	Not limited	0.075 (1.91)
20.0 (50.8)	25.0 (63.4)	45.0 (114.3)	55.0 (139.7)	
25.0 (63.5)	Not limited	60.0 (152.4)	Not limited	0.095 (2.41)
29.0 (73.7)	36.0 (91.4)	64.0 (162.6)	78.0 (198.1)	
37.0 (94.0)	Not limited	87.0 (221.0)	Not limited	0.122 (3.10)
42.0 (106.7)	53.0 (134.6)	93.0 (236.2)	114.0 (289.6)	
52.0 (132.1)	Not limited	123.0 (312.4)	Not limited	0.153 (3.89)
60.0 (152.4)	74.0 (188.0)	130.0 (330.2)	160.0 (406.4)	
^a See paragraphs 7.4.3 and 7.4.4. ^b The width is the smaller dimension of a rectangular sheet-metal piece that is part of an enclosure. Adjacent surfaces of an enclosure may have supports in common and be made of a single sheet. ^c For panels that are not supported along one side; for example, side panels of boxes, the length of the unsupported side shall be limited to the dimensions specified. ^d Sheet copper, brass, or aluminum for an enclosure intended for outdoor use shall not be less than 0.029 inch (0.74 mm) thick.				

7.5 Gaskets and adhesives

7.5.1 Where a gasket is required to seal electrical enclosures against the entrance of rain and condensate, it shall be held in place by mechanical fasteners or adhesives, and shall comply with the requirements in 49.1–49.5.

Exception: A gasket that is prevented from displacement either by its location or placement of other components in the enclosure when the cover is removed, and that would be re-engaged in the intended manner when the cover is replaced, is not required to be held by mechanical fasteners or adhesives. When determining the acceptability of the gasket securement, consideration shall be given to the intended mounting of the gasket in the application.

7.5.2 A gasket shall be neoprene, rubber, or thermoplastic. Another material may be used if it has equivalent properties.

7.5.3 An adhesive required to secure gaskets shall comply with the requirements in 49.6.

7.6 Nonmetallic

7.6.1 A polymeric enclosure or polymeric part of an enclosure shall comply with the requirements in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

7.6.2 A nonmetallic part such as a reset knob, lever, or button protruding through a hole in the enclosure shall be made of a material classified as 94V-0, 94V-1, or 94V-2 in the Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94, if the hole is not larger than 0.6 square inches (3.9 cm²). Nonmetallic parts protruding through a hole larger than 0.6 square inches shall be made of materials that comply with the requirement in 7.6.1.

7.7 Glass covered openings

7.7.1 Glass covering an opening shall be secured in place so that it cannot be readily displaced in service, and shall provide mechanical protection for the enclosed parts. Glass for an opening not more than 4 inches (102 mm) in any dimension shall not be less than 1/16 inch (1.6 mm) thick, and glass for a larger opening, but not more than 144 square inches (929 cm²) in area and having no dimension greater than 12 inches (305 mm), shall not be less than 1/8 inch (3.2 mm) thick. Glass used to cover a larger area shall not be less than 1/8 inch thick and:

- a) Shall be of a nonshattering or tempered type that, when broken, complies with the performance specifications in the Performance Specifications and Methods of Test for Safety Glazing Material Used in Buildings, ANSI Z97.1-1975; or
- b) Shall withstand a 2-1/2 foot-pound (3.38 joules) impact from a 2 inch (50.8 mm) diameter, 1.18 pound (535 grams) steel sphere without cracking or breaking to the extent that a piece is released or dropped from its normal position.

7.8 Wiring openings

7.8.1 If threads for the connection of conduit are tapped all the way through a hole in an enclosure wall, or if an equivalent construction is employed, there shall not be less than three nor more than five threads in the metal, and the construction of the device shall be such that a conduit bushing can be properly attached. If threads for the connection of conduit are not tapped all the way through a hole in an enclosure wall, conduit hub, or the like, there shall not be less than 3-1/2 threads in the metal and there shall be a smooth, rounded inlet hole for the conductors that shall afford protection to the conductors equivalent to that provided by a standard conduit bushing and that shall have an internal diameter approximately the same as that of the corresponding trade size of rigid conduit.

7.8.2 An enclosure threaded for support by rigid conduit shall provide at least five full threads for engaging the conduit.

7.8.3 Clamps and fasteners for the attachment of conduit, electrical metallic tubing, armored cable, nonmetallic flexible tubing, nonmetallic-sheathed cable, service cable, and the like, that are supplied as a part of an enclosure shall comply with the Standard for Fittings for Conduit and Outlet Boxes, UL 514B.

7.8.4 A knockout in a sheet-metal enclosure shall be reliably secured but shall be capable of being removed without undue deformation of the enclosure.

7.8.5 A knockout shall be provided with a flat surrounding surface adequate for proper seating of a conduit bushing or locknut and shall be located so that installation of a bushing or locknut at any knockout likely to be used during installation will not result in spacing between uninsulated live parts and the bushing or locknut of less than the requirements in this standard.

7.8.6 A plate or plug for an unused conduit opening or other hole in the enclosure shall have a thickness not less than (1) 0.014 inch (0.36 mm) for steel or 0.019 inch (0.48 mm) for nonferrous metal for a hole having a 1/4-inch (6.4-mm) maximum dimension and (2) 0.027-inch (0.69-mm) steel or 0.032-inch (8.1-mm) nonferrous metal for a hole having a 1-3/8-inch (34.9-mm) maximum dimension. A closure for a larger hole shall have a thickness equal to that required for the enclosure of the device or a standard knockout seal shall be used. Such plates or plugs shall be securely mounted.

7.8.7 In measuring a spacing between an uninsulated live part and a bushing installed in a knockout as mentioned in 7.8.5, it is to be assumed that a bushing having the dimensions specified in Table 7.3 is in place, in conjunction with a single locknut installed on the outside of the enclosure.

7.9 Enclosures for outdoor use

7.9.1 An enclosure shall be constructed so as to reduce the risk of wetting of live parts, and protect the appliance against a risk of electric shock due to exposure to weather as determined by the tests specified in Section 50.

7.9.2 A hole for conduit shall be threaded unless it is located wholly below the lowest terminal lug or other live part within the enclosure, and there shall be provision for drainage of the enclosure if knockouts or unthreaded holes are provided.

7.9.3 An enclosure of sheet steel shall be protected against corrosion as specified in Section 10.

7.9.4 A nonmetallic enclosure shall be judged on the basis of the effect of exposure to ultraviolet light and water.

Table 7.3
Knockout or hole sizes and dimensions of bushings

Trade size of conduit	Knockout or hole diameter		Bushing dimensions			
			Overall diameter		Height	
	Inches	mm	Inches	mm	Inches	mm
1/2	7/8	22.2	1	25.4	3/8	9.5
3/4	1-3/32	27.8	1-15/64	31.4	27/64	10.7
1	1-23/64	34.5	1-19/32	40.5	33/64	13.1
1-1/4	1-23/32	43.7	1-15/16	49.2	9/16	14.3
1-1/2	1-31/32	50.0	2-13/64	56.0	19/32	15.1
2	2-15/32	62.7	2-45/64	68.7	5/8	15.9
2-1/2	3	76.2	3-7/32	81.8	3/4	19.1
3	3-5/8	92.1	3-7/8	98.4	13/16	20.6
3-1/2	4-1/8	104.8	4-7/16	112.7	15/16	23.8
4	4-5/8	117.5	4-31/32	126.2	1	25.4
4-1/2	5-1/8	130.2	5-35/64	140.9	1-1/16	27.0
5	5-5/8	142.9	6-7/32	158.0	1-3/16	30.2
6	6-3/4	171.5	7-7/32	183.4	1-1/4	31.8

8 Mounting

8.1 Provision shall be made for securely mounting an appliance in position. A bolt, a screw, or an other part used for mounting an appliance shall be independent of those used for securing a component to the frame, base, or panel. Provision for drilling a mounting hole by the installer is acceptable provided that the area for locating the mounting hole is specified by a marking on the appliance or in the installation instructions. See Section 35.

Exception: A freestanding appliance need not be provided with means for being securely mounted in position.

9 Mechanical Assembly

9.1 The assembly of an appliance shall provide for easy and safe servicing by the route man as defined in 2.5. The servicing performed shall not result in damage to wiring, electrical components, or refrigerant-containing parts.

9.2 An appliance shall be assembled so that it will not be adversely affected by the vibration of normal operation.

9.3 A switch, a fuseholder, a lampholder, an attachment-plug receptacle, a motor-attachment plug, or other component that is handled by the user shall be mounted or assembled securely, and shall be prevented from turning or shifting in its mounting panel.

Exception: The requirement that a switch be prevented from turning or shifting may be waived provided all four of the following conditions are met:

- a) *The switch is a plunger, slide, or other type that does not tend to rotate when operated. A toggle switch is considered to be subject to forces that tend to turn the switch during normal operation of the switch.*
- b) *Means for mounting the switch make it unlikely that operation of the switch will loosen the switch.*
- c) *Spacings are not reduced below the minimum acceptable values if the switch rotates.*
- d) *Normal operation of the switch is by mechanical means rather than by direct contact by persons.*

9.4 With reference to the requirements in 9.3, friction between surfaces is not acceptable as the sole means to prevent shifting or turning of live parts or a device having a single-hole mounting means but a properly applied lock washer is acceptable.

10 Protection Against Corrosion

10.1 General

10.1.1 Iron and steel parts shall be protected against corrosion by enameling, galvanizing, sherardizing, plating, or other equivalent means.

Exception: Bearings, thermal elements, and the like where such protection is impracticable.

10.1.2 Metals used in combination shall be galvanically compatible.

10.1.3 Hinges and other attachments shall be resistant to corrosion.

10.1.4 These requirements do not contemplate corrosion that might be caused by exposure to the earth or other corrosive agents.

10.1.5 A nonmetallic enclosure is to be judged on the basis of the effect of exposure to ultraviolet light and water.

10.2 Outdoor use

10.2.1 A metallic enclosure shall be protected against corrosion as specified in 10.2.2–10.2.9.

Exception No. 1: A motor enclosure if the motor is contained within the appliance enclosure.

Exception No. 2: A decorative grill that does not form a required part of an enclosure.

10.2.2 Copper, bronze, brass containing not less than 80 percent copper, or stainless steel may be used without additional protection against corrosion. Aluminum – sheet, extrusion, or casting, die-cast zinc, or another metal shall be of a grade or alloy known to be resistant to atmospheric corrosion, or shall be subjected to appropriate tests, or shall be additionally protected against corrosion.

10.2.3 An enclosure of cast iron or malleable iron at least 1/8 inch (3.2 mm) thick shall be protected against corrosion by:

- a) A 0.00015-inch (0.004 mm) thick coating of zinc, cadmium, or the equivalent on the outside surface and a visible coating of such metal on the inside surface, or
- b) One coat of an organic finish of the epoxy or alkyd-resin type or other outdoor paint on each surface. Unless suitability of the paint can be determined by consideration of its composition, corrosion tests are required.

10.2.4 An enclosure of sheet steel having a thickness less than 0.126 inch (3.20 mm) zinc-coated or 0.123 inch (3.12 mm) thick if uncoated shall be protected against corrosion by one of the following means or by other metallic or nonmetallic coatings that have been found to provide equivalent protection as described in 10.2.7:

- a) Hot-dipped mill-galvanized sheet steel conforming with the coating Designation G90 in Table I of ASTM Designation A525-80a, with not less than 40 percent of the zinc on any side, based on the minimum single-spot test requirement in this ASTM designation. The weight of zinc coating may be determined by any suitable method; however, in case of question, the weight of coating shall be established in accordance with the Standard Test Method for Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles, ASTM Designation A90-69(1978).
- b) A zinc coating, other than that provided on hot-dipped mill-galvanized sheet steel, uniformly applied to an average thickness of not less than 0.00061 inch (0.015 mm) on each surface with a minimum thickness of 0.00054 inch (0.014 mm). The thickness of the coating shall be established by the Metallic Coating Thickness Test, Section 52. An annealed coating shall also comply with 10.2.9.
- c) A zinc coating conforming with 10.2.5 (a) and (b) with one coat of an organic finish of the epoxy or alkyd-resin type or other outdoor paint applied after forming on each surface. The suitability of the paint may be determined by consideration of its composition or by corrosion tests.
- d) A cadmium coating not less than 0.001 inch (0.025 mm) thick on both surfaces. The thickness of coating shall be established in accordance with the Metallic Coating Thickness Test, Section 52.
- e) A cadmium coating not less than 0.00075 inch (0.019 mm) thick on both surfaces with one coat of outdoor paint on both surfaces, or not less than 0.00051 inch (0.013 mm) thick on both surfaces with two coats of outdoor paint on both surfaces. The thickness of the cadmium coating shall be established in accordance with the Metallic Coating Thickness Test, Section 52, and the paint shall be as specified in (c).

10.2.5 An enclosure of sheet steel 0.126 inch (3.20 mm) thick if zinc-coated or 0.123 inch (3.12 mm) thick if uncoated or heavier shall be protected against corrosion by one of the following means or by other metallic or nonmetallic coatings that have been shown to give equivalent protection as described in 10.2.7:

- a) Hot-dipped mill-galvanized sheet steel conforming with the coating Designation G60 or A60 in Table I of the Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot Dip Process General Requirements, ASTM A525-80a with not less than 40 percent of the zinc on any side, based on the minimum single-spot test requirement in this ASTM designation. The weight of zinc coating may be determined by any suitable method; however, in case of question, the weight of coating shall be established in accordance with the Standard Method for Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles, ASTM A90-69(1978).

b) A zinc coating, other than that provided on hot-dipped mill-galvanized sheet steel, uniformly applied to an average thickness of not less than 0.00041 inch (0.010 mm) on each surface with a minimum thickness of 0.00034 inch (0.009 mm). The thickness of the coating shall be established by the Metallic Coating Thickness Test, Section 52.

c) Two coats of an organic finish of the epoxy or alkyd resin type or other outdoor paint on each surface. The suitability of the paint is to be determined by consideration of its composition or by corrosion tests.

d) Any one of the means specified in 10.2.4.

10.2.6 10.2.5 also applies to sheet steel 0.056 inch (1.42 mm) thick if zinc-coated or 0.053 inch (1.35 mm) thick if uncoated or heavier for an enclosure to be mounted within and protected from direct exposure to weather by the enclosure of other equipment. Such an enclosure shall not be marked rainproof or raintight.

10.2.7 With reference to 10.2.4 – 10.2.6, other finishes, including paints, metallic finishes, and combinations of the two may be accepted when comparative tests with galvanized sheet steel – without annealing, wiping, or other surface treatment – conforming with 10.2.4 (a) or 10.2.5 (a), as applicable, indicate they provide equivalent protection. Among the factors that are taken into consideration when judging the suitability of such coating systems are exposure to salt spray, moist carbon dioxide-sulphur dioxide-air mixtures, moist hydrogen sulphide-air mixtures, ultraviolet light, and water.

10.2.8 Test specimens of a finish as described in 10.2.3, or 10.2.4 (c), or 10.2.5 (c), if the paint is tested, are to be consistent with the finish that is to be used in production with respect to the base metal, cleaning or pretreatment method, application method, number of coats, curing method, thickness, and the like.

10.2.9 A hot-dipped mill-galvanized A60 (alloyed) coating or an annealed zinc coating that is bent or similarly formed after annealing and that is not otherwise required to be painted shall be painted in the bent or formed area if the bending or forming process damages the zinc coating, except that such areas on the inside surface of an enclosure that water does not enter during the rain test need not be painted. The zinc coating is considered to be damaged if flaking or cracking of the zinc coating at the outside radius of the bent or formed section is visible at 25 power magnification. Simple sheared or cut edges and punched holes are not considered to be formed.

11 Accessibility Of Uninsulated Live Parts, Film-Coated Wire, And Moving Parts

11.1 To reduce the likelihood of unintentional contact that may involve a risk of (1) electric shock from an uninsulated live part or film-coated wire or (2) injury to persons from a moving part, an opening in an enclosure shall comply with either (a) or (b). This requirement applies to the outer enclosure with and without the parts specified in 11.9, and also applies to parts located behind a locked door.

a) For an opening that has a minor dimension (see 11.6) less than 1 inch (25.4 mm), such a part or wire shall not be contacted by the probe illustrated in Figure 11.2.

b) For an opening that has a minor dimension of 1 inch or more, such a part or wire shall be spaced from the opening as specified in Table 11.1.

Exception No. 1: A motor need not comply with these requirements if it complies with the requirements in 11.2.

Exception No. 2: A moving part capable of causing injury to persons on an appliance that is provided with an on-off control that is readily accessible from the normal operating position need not comply with this requirement if complete guarding of the part would defeat the utility of the appliance.

11.2 In an integral enclosure of a motor as specified in Exception No. 1 to 11.1:

- a) An opening that has a minor dimension (see 11.3) less than 3/4 inch (19.1 mm) is acceptable if:
 - 1) A moving part cannot be contacted by the probe illustrated in Figure 11.3;
 - 2) Film-coated wire cannot be contacted by the probe illustrated in Figure 11.1;
 - 3) In a directly accessible motor (see 11.7), an uninsulated live part cannot be contacted by the probe illustrated in Figure 11.4; and
 - 4) In an indirectly accessible motor (see 11.7), an uninsulated live part cannot be contacted by the probe illustrated in Figure 10.3.
- b) An opening that has a minor dimension of 3/4 inch or more is acceptable if a part or wire is spaced from the opening as specified in Table 11.1.

The requirement in subitem 2 of (a) and (b) applies before and after opening a locked door or doors.

11.3 An uninsulated live part or film-coated wire is not considered to involve a risk of electric shock if the voltage is 42.4 volts peak or less or if the available current measured through a 1500-ohm noninductive resistor is 0.5 milliamperes or less.

Table 11.1
Distance from an opening to a part that
may involve a risk of electric shock or injury to persons

Minor Dimension ^a of Opening		Minimum Acceptable Distance from Opening to Part	
Inches ^b	(mm) ^b	Inches ^b	(mm) ^b
3/4 ^c	(19.1)	4-1/2	(114)
1	(25.4)	6-1/2	(165)
1-1/4	(31.8)	7-1/2	(190)
1-1/2	(38.1)	12-1/2	(318)
1-7/8	(47.6)	15-1/2	(394)
2-1/8	(54.0)	17-1/2	(444)
d		30	(762)

^aSee Paragraph 11.6.
^bBetween 3/4 inch and 2-1/8 inches, interpolation is to be used to determine a value between values specified in the table.
^cAny dimension less than 1 inch applies to a motor only.
^dMore than 2-1/8 inches, but not more than 6 inches (152 mm).

11.4 The probes specified in 11.1 and 11.2 and illustrated in Figures 11.1 – 11.4 are to be applied to any depth that the opening will permit; and are to be rotated or angled before, during, and after insertion through the opening to any position that is necessary to examine the enclosure. The probes illustrated in Figures 11.2 and 11.4 are to be applied in any possible configuration; and, if necessary, the configuration is to be changed after insertion through the opening.

Figure 11.1
Probe for film-coated wire



