



UL 756

STANDARD FOR SAFETY

Coin and Currency Changers and Actuators

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Coin and Currency Changers and Actuators, UL 756

Seventh Edition, Dated September 14, 2012

Summary Of Topics

This Seventh edition of UL 756 incorporates the following changes in requirements:

- 1. Relocation Of General Component Requirements To The Construction Section And Addition Of Glossary Terms**
- 2. Addition And Revision Of Requirements To Relocate Component Standard References From Appendix A Into The Body Of The Standard As Component Requirements**
- 3. Addition Of Definition Of Barriers, Clarification Of Requirements For Barriers, And Alignment Of The Barrier Requirements With Similar Requirements In Other UL Standards**
- 4. Revision And Addition Of Requirements For Gaskets Intended To Clarify Requirements And Allow An Option For Gaskets To Comply With The Standard For Gaskets And Seals, UL 157**
- 5. Reorganization And Clarification Of Supply Connection Requirements**
- 6. Addition And Revision Of Overcurrent Protection Requirements Intended To Clarify The Requirements**
- 7. Revisions To Clarify Software Class Requirements With Respect To Investigating Protective Electronic Circuits**
- 8. Revision And Addition Of Requirements For Switches And Controllers To Specify Component Requirements**
- 9. Revision To the Capacitor Requirements To Clarify The Requirements And To Allow An Option For Capacitors To Comply With The Standard For Capacitors, UL 810**
- 10. Addition Of Lighting-System Requirements Including Requirements For General Systems And Electric-Discharge Systems**
- 11. Revision To And Addition Of Strain-Relief Requirements To Clarify The Requirements And Specify The Means for Testing Strain-Relief**
- 12. Revision To The Definition Of An Enclosure And Addition Of A Definition Of A Cabinet And Proposed Revisions To Requirements That Refer To These Appliance Parts Intended To Clarify The Requirements**
- 13. Addition And Revision Of Requirements Specific To Polymeric Parts To Align With Requirements In The Standard For Polymeric Materials – Use In Electrical Equipment Evaluations, UL 746C**
- 14. Revisions To Dielectric-Voltage Withstand Test Requirements To Allow The Use Of A Direct-Current As The Test Potential**

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15. Editorial Revisions

The new and requirements are substantially in accordance with Proposal(s) on this subject dated May 25, 2012.

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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.

SEPTEMBER 14, 2012

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UL 756

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September 14, 2012

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 <http://csds.ul.com>.

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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, ANSI/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 Battery operated coin and currency changers and actuators are covered by these requirements.

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 **BARRIER** – A partition for isolating high-voltage electrical components, separating ignition sources from flammable materials, isolating moving parts and protection of wiring.

2.4 **CABINET** – The part of the equipment that provides physical protection to insulated wiring, enclosures, moving parts, motors, enclosed electrical parts, tubing or other parts that may cause injury to persons.

2.5 **CIRCUITS, ELECTRICAL** –

a) **High-Voltage (Class 1)** – A circuit involving a potential of not more than 600 volts and having circuit characteristics in excess of those of a low-voltage power-limited circuit.

b) **Low-Voltage** – A circuit involving a potential of not more than 30 volts AC rms, 42.4 volts DC or AC peak.

c) **Power-Limited** – A circuit whose output is limited as specified in Power-Limited Circuits, Section 60.

d) **Class 2** – A circuit in which the voltage and power limitations are in accordance with the requirements of Table 60.1 for AC circuits and Table 60.2 for DC circuits.

e) **Class 3** – A circuit in which the voltage and power limitations are in accordance with the requirements of Table 60.1 for AC circuits and Table 60.2 for DC circuits.

2.6 **COMPONENT** – A device or fabricated part of the appliance covered by the scope of a safety standard dedicated to that purpose. If incorporated in an appliance, a product that is otherwise typically field installed (e.g. luminaire) is considered to be a component. Unless otherwise specified, materials

that compose a device or fabricated part, such as aluminum or copper, are not considered components. Generally, components are incomplete in construction features or restricted in performance capabilities. Such components are intended for use only under specific, limited conditions, such as certain temperatures not exceeding specified limits.

2.7 CONTROL, OPERATING – A device or assembly of devices, the operation of which starts or regulates the end product during normal operation. For example, a thermostat, the failure of which a thermal cutout/limiter or another layer of protection would mitigate the potential hazard, is considered an operating control. Operating controls are also referred to as "regulating controls".

2.8 CONTROL, PROTECTIVE – A device or assembly of devices, the operation of which is intended to reduce the risk of fire, electric shock, or injury to persons during normal and reasonably anticipated abnormal operation of the appliance. For example, a thermal cutout/limiter, or any other control/circuit relied upon for normal and abnormal conditions, is considered a protective control. Protective controls are also referred to as "limiting controls" or "safety controls" and are investigated under normal and single-fault conditions.

2.9 ENCLOSURE The part of the appliance that does one or more of the following:

- a) Isolates ignition sources;
- b) Renders inaccessible all or any part(s) of the equipment that may otherwise present a risk of electric shock;
- c) Retards propagation of flame initiated by electrical disturbances occurring within.

2.10 FUNCTIONAL PART – A part other than an enclosure or cabinet used to maintain the intended relative physical position of fixed or moving parts, or maintain the integrity of the structure.

2.11 IGNITION SOURCE – Any high-voltage electrical component not located within an enclosure.

2.12 MOTOR CONTROLLER – Any device normally used to start and stop a motor, such as a switch, thermostat, pressure limiting control, or the like.

2.13 MOTOR, DIRECTLY ACCESSIBLE – A motor that can be contacted without opening or removing any part, or that is located so as to be accessible to contact.

2.14 MOTOR, INDIRECTLY ACCESSIBLE – A motor that is accessible only by opening or removing a part of the cabinet, such as a guard or panel that can be opened or removed without using a tool, or that is located at such a height or is otherwise guarded or enclosed so that it is unlikely to be contacted.

2.15 NONFUNCTIONAL PART – A part of the equipment that does not perform a specific function.

2.16 NONFUNCTIONAL PART, SMALL – A nonfunctional part having an area of less than 1 ft² (0.093 m²) located so it cannot propagate flame from one area to another, and does not connect a possible source of ignition to the other ignitable parts.

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

2.18 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.

2.19 ROUTE PERSON – A person who regularly opens an appliance for such purposes as cleaning, removing coins, making minor adjustments and replenishing the product supply.

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

2.21 SERVICE PERSON – A person who may periodically open an appliance to repair or maintain electrical or mechanical components.

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.

CONSTRUCTION

5 General

5.1 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.

5.2 A component shall:

- a) Comply with the safety standard covering that component;
- b) Be used in accordance with its rating(s) established for the intended conditions of use;
- c) Be used within its established use limitations or conditions of acceptability; and
- d) Comply with the applicable requirements of this end product standard.

Exception: A component of a product covered by this standard is not required to comply with a specific component requirement that:

a) Involves a feature or characteristic not required in the application of the component in the product;

b) Is superseded by a requirement in this standard; or

c) Is separately investigated when forming part of another component, provided the component is used within its established ratings and limitations.

5.3 A component that is also required to perform other necessary functions, such as overcurrent protection, ground-fault circuit interruption, surge suppression, any other similar functions, or any combination thereof, shall comply additionally with the requirements of the applicable standard(s) covering products that provide those functions.

6 Barriers

6.1 A barrier shall be formed from one or more of the following:

- a) Metal, minimum 0.005 inch (0.13 mm) thick;
- b) Fiberglass, minimum 0.5 inch (12.7 mm) thick;
- c) A nonmetallic material rated 5 volt-ampere;
- d) A nonmetallic material evaluated to the 127 mm (5 inch) End Product Flame Test as described in Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C;
- e) Vulcanized fiber, varnished cloth, mica or phenolic composition, minimum 0.028 inch (0.71 mm) thick; or
- f) Any other material or construction determined to be equivalent to items (a) to (e).

6.2 A barrier shall be secured to the mounting surface such that tools are required for its removal.

6.3 Except as specified in 6.5 and 13.2, a nonmetallic barrier that isolates ignition source(s) shall comply with the enclosure requirements of Table 65.1.

6.4 A nonmetallic barrier providing mechanical protection shall comply with the cabinet requirements of Table 65.1.

6.5 If a barrier made of the materials specified 6.1(e) but less than 0.028 inch (0.71 mm) thick is used, the:

- a) Air spacing between the parts being insulated by the barrier shall be not less than one-half of the required through-air spacing; and
- b) Barrier shall be not less than 0.013 inch (0.3 mm) thick.

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 18.1 – 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 an extractor-type fuse with its own enclosure, or fuses in low-voltage circuits. See 18.1.

7.2.2 A door or cover giving access to a fuse or thermal cutout in other than a low-voltage circuit – see 18.1 – 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.

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 18.1.

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.

Exception: 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	
Maximum width, ^b inches (cm)	Maximum length, ^c inches (cm)	Maximum width, ^b inches (cm)	Maximum length, ^c inches (cm)	Uncoated, inch (mm)	Metal coated, inch (mm)
4.0 (10.2)	Not limited	6.25 (15.9)	Not limited		0.023 ^d (0.58)
4.75 (12.10)	5.75 (14.6)	6.75 (17.1)	8.25 (21.0)	0.020 ^d (0.51)	
6.0 (15.2)	Not limited	9.5 (24.1)	Not limited		0.029 ^d (0.74)
7.0 (17.8)	8.75 (22.2)	10.0 (25.4)	12.5 (31.8)	0.026 ^d (0.66)	
8.0 (20.3)	Not limited	12.0 (30.5)	Not limited		0.034 (0.86)
9.0 (22.9)	11.5 (29.2)	13.0 (33.0)	16.0 (40.6)	0.032 (0.81)	
12.5 (31.8)	Not limited	19.5 (49.5)	Not limited		0.045 (1.14)
14.0 (35.6)	18.0 (45.7)	21.0 (53.3)	25.0 (63.5)	0.042 (1.07)	
18.0 (45.7)	Not limited	27.0 (68.6)	Not limited		0.056 (1.42)
20.0 (50.8)	25.0 (63.5)	29.0 (73.7)	36.0 (91.4)	0.053 (1.35)	
22.0 (55.9)	Not limited	33.0 (83.8)	Not limited		0.063 (1.60)
25.0 (63.5)	31.0 (78.7)	35.0 (88.9)	43.0 (109.2)	0.060 (1.52)	
25.0 (63.5)	Not limited	39.0 (99.2)	Not limited		0.070 (1.78)
29.0 (73.7)	36.0 (91.4)	41.0 (104.1)	51.0 (129.5)	0.067 (1.70)	
33.0 (83.8)	Not limited	51.0 (129.5)	Not limited		0.084 (2.13)
38.0 (103.4)	47.0 (119.4)	54.0 (137.2)	66.0 (167.6)	0.080 (2.03)	
42.0 (106.7)	Not limited	64.0 (162.6)	Not limited		0.097 (2.46)
47.0 (119.4)	59.0 (149.9)	68.0 (172.7)	84.0 (213.4)	0.093 (2.36)	
52.0 (132.1)	Not limited	80.0 (203.2)	Not limited		0.111 (2.82)
60.0 (152.4)	74.0 (188.0)	84.0 (213.4)	103.0 (261.6)	0.108 (2.74)	
63.0 (160.0)	Not limited	97.0 (246.4)	Not limited		0.126 (3.20)
73.0 (185.4)	90.0 (228.6)	103.0 (261.6)	127.0 (322.6)	0.123 (3.12)	

^a See 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.

Table 7.1 Continued

Without supporting frame ^a		With supporting frame or equivalent reinforcing ^a		Minimum thickness	
Maximum width, ^b inches (cm)	Maximum length, ^c inches (cm)	Maximum width, ^b inches (cm)	Maximum length, ^c inches (cm)	Uncoated, inch (mm)	Metal coated, inch (mm)
^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 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	
Maximum width, ^b inches (cm)	Maximum length, ^c inches (cm)	Maximum width, ^b inches (cm)	Maximum length, ^c inches (cm)	inch	(mm)
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 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 Each gasket required to seal electrical enclosures against the entrance of rain and condensate shall be held in place by mechanical fasteners or adhesives, and shall:

- a) Be neoprene, rubber, thermoplastic or other materials with equivalent properties that comply with the requirements in 64.1 – 64.5; or
- b) Comply with the Standard for Gaskets and Seals, UL 157.

7.5.2 In reference to 7.5.1, gaskets which are not held in place by mechanical fasteners or adhesives but are intended to be retained in the correct position by some other means shall be prevented from displacement either:

- a) Due to their location within the equipment; or
- b) By the placement of other components in the enclosure so that if the equipment cover is removed, the gasket will be reengaged in the intended manner when the cover is replaced.

7.5.3 An adhesive required to secure gaskets shall comply with the requirements in 64.7.

7.5.4 Sealing compounds required to seal enclosures shall comply with 64.6.

7.6 Nonmetallic Parts

7.6.1 All nonmetallic parts, except for small nonfunctional parts shall comply with Sections 7.7 – 7.9 and Table 65.1.

7.6.2 In addition to the requirement in 7.6.1, nonmetallic materials that serve as electrical insulation or that directly support live parts shall comply with the requirements for electric insulation in the Standard for Polymeric Materials – Use in Electrical Equipment Evaluations, UL 746C.

7.7 Nonmetallic Materials

7.7.1 Materials shall be classified with respect to flammability characteristics that are established by the tests specified in the Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances, UL 94.

7.7.2 Materials shall be assigned flammability ratings based on greatest to least resistance to flame and are identified as: 5VA, 5VB, V-0, V-1, V-2, HF-1, HF-2, HB, and HBF.

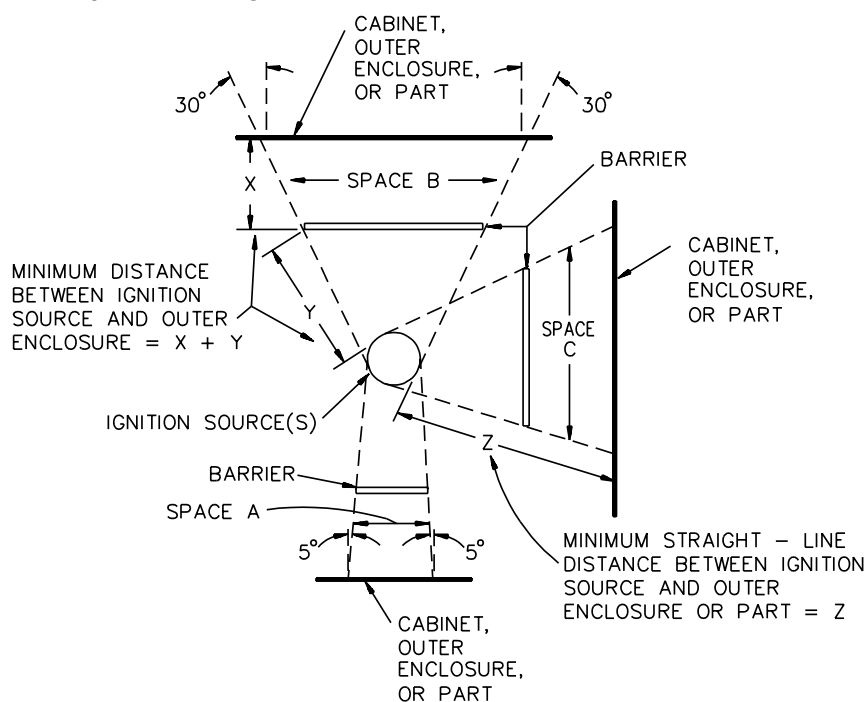
7.7.3 In reference to 7.7.2, the assigned flammability rating shall be appropriate for the material-use application in accordance with Section 7.8 and Table 65.1.

7.8 Nonmetallic Material Ignition Sources Separation

7.8.1 Parts formed from nonmetallic materials that are rated HB or HBF and positioned as shown in Figure 7.1 shall be separated from ignition sources by means of a barrier, extending at least to the boundary surface of the space if such parts are located:

- Below an ignition source and within Space A;
- Above an ignition source and within Space B; and
- In the vertical plane relative to an ignition source and within Space C.

Figure 7.1
Separation of ignition sources from nonmetallic materials



S2514C

7.8.2 The HB or HBF materials referenced by 7.8.1 shall be located such that the distance between:

- High-voltage wiring not employing VW-1 insulation and the HB or HBF materials shall be a minimum of 2 inches (51 mm); and
- Any other ignition source and the HB or HBF materials shall be a minimum of 4 inches (102 mm).

7.8.3 In reference to 7.8.2 and Figure 7.1, the minimum distance for HB or HBF materials located:

- a) Above the ignition source shall be as shown in Distance X + Y; and
- b) In the vertical plane relative to the ignition source shall be as shown in straight-line Distance Z.

7.9 Nonmetallic Material Application and Location

7.9.1 Nonmetallic materials shall comply with the applicable tests as described in Table 65.1.

7.9.2 Nonmetallic fasteners used as a part of the enclosure shall comply with the Fastener Strength Test, Section 66.

7.10 Glass-covered openings

7.10.1 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. 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 Safety Glazing Materials Used in Buildings – Safety Performance Specifications and Methods of Test, ANSI Z97.1; 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-gram) steel sphere without cracking or breaking to the extent that a piece is released or dropped from its normal position.

7.11 Wiring openings

7.11.1 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.

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

7.11.3 Clamps, fittings 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 Conduit, Tubing and Cable Fittings, UL 514B.

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

7.11.5 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.

7.11.6 A plate or plug for an unused conduit opening or other hole in the enclosure shall have a thickness not less than:

- a) 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
- b) 0.027-inch (0.69-mm) for steel or 0.032-inch (8.1-mm) for 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.

7.11.7 In measuring a spacing between an uninsulated live part and a bushing installed in a knockout as mentioned in 7.11.5, 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.

7.12 Enclosures for outdoor use

7.12.1 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 the Resistance to Moisture Test, Section 67.

7.12.2 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.

7.12.3 An enclosure of sheet steel shall be protected against corrosion as specified in Protection Against Corrosion, Section 10.

Table 7.3
Knockout or hole sizes and dimensions of bushings

Trade size of conduit, inches	Knockout or hole diameter, inches (mm)		Bushing dimensions			
			Overall diameter, inches (mm)		Height, 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 another 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 Stability, Section 49.

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 as defined in 2.18 by the route person. 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.*

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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 for 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 Ferrous metal parts shall be protected against corrosion by enameling, coating, 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.

10.2 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 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, 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 (Mass) of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings, ASTM A90/A90M-95a.
- 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 69. 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 69.
- 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 69, 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 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 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 (Mass) of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings, ASTM A90/A90M-95a.
- 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 69.

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 The requirements of 10.2.5 also apply 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 electric shock from an uninsulated live part or film-coated wire, or injury to persons from a moving part, an opening in an enclosure shall comply with either (a) or (b). This requirement applies to the cabinet with and without the parts specified in 11.8, 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.

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, inches ^b (mm) ^b		Minimum acceptable distance from opening to part, 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	d	30	(762)
^a See 11.6. ^b Between 3/4 inch (19.1 mm) and 2-1/8 inches (54.0 mm), interpolation is to be used to determine a value between values specified in the table. ^c Any dimension less than 1 inch applies to a motor only. ^d More than 2-1/8 inches, but not more than 6 inches (152 mm).			

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

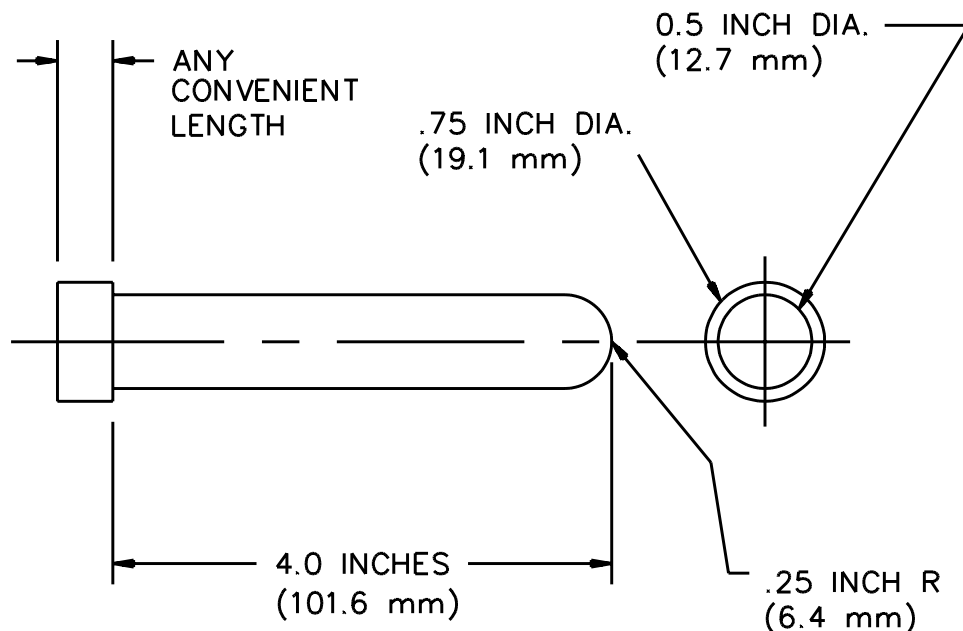
a) An opening that has a minor dimension (see 11.6) less than 3/4 inch (19.1 mm) is acceptable if:

- 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, an uninsulated live part cannot be contacted by the probe illustrated in Figure 11.4; and
- 4) In an indirectly accessible motor, an uninsulated live part cannot be contacted by the probe illustrated in Figure 11.3.

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 (a)(2) and (b) applies before and after opening a locked door or doors.

Figure 11.1
Probe for film-coated wire



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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.

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.

11.5 The probes specified in 11.4 and 11.6 are to be used as measuring instruments to judge the accessibility provided by an opening, and not as instruments to judge the strength of a material; they are to be applied with the minimum force necessary to determine accessibility.

11.6 With reference to the requirements in 11.1 and 11.2, the minor dimension of an opening is the diameter of the largest cylindrical probe having a hemispherical tip that can be inserted through the opening.

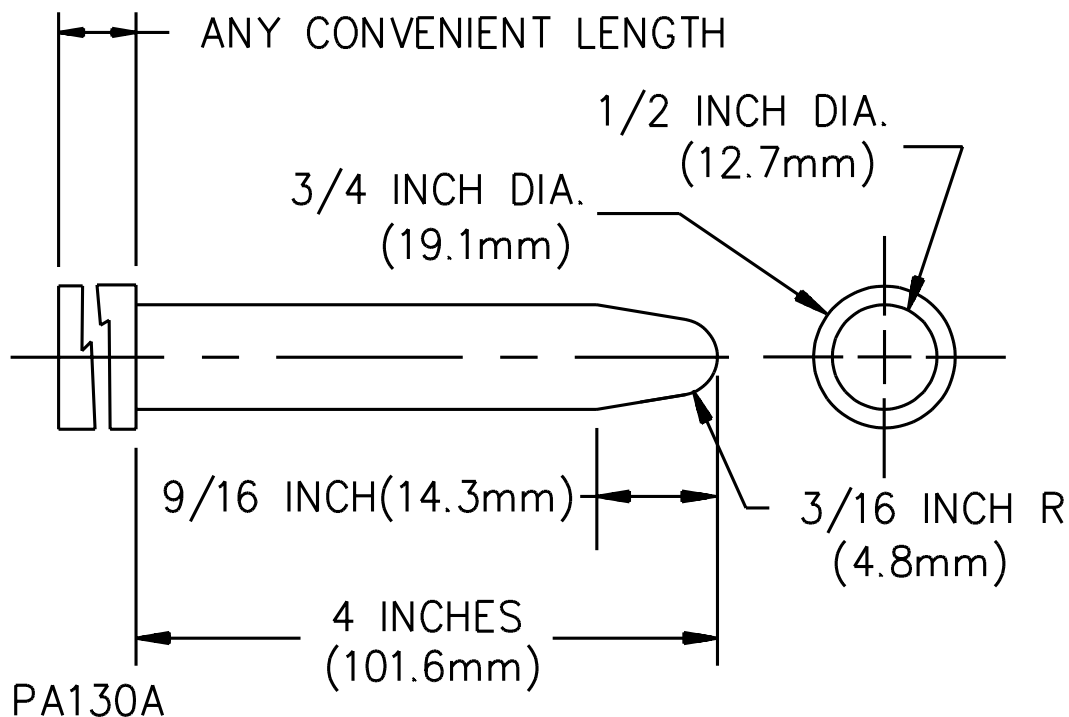
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Figure 11.3
Probe for moving parts and uninsulated live parts



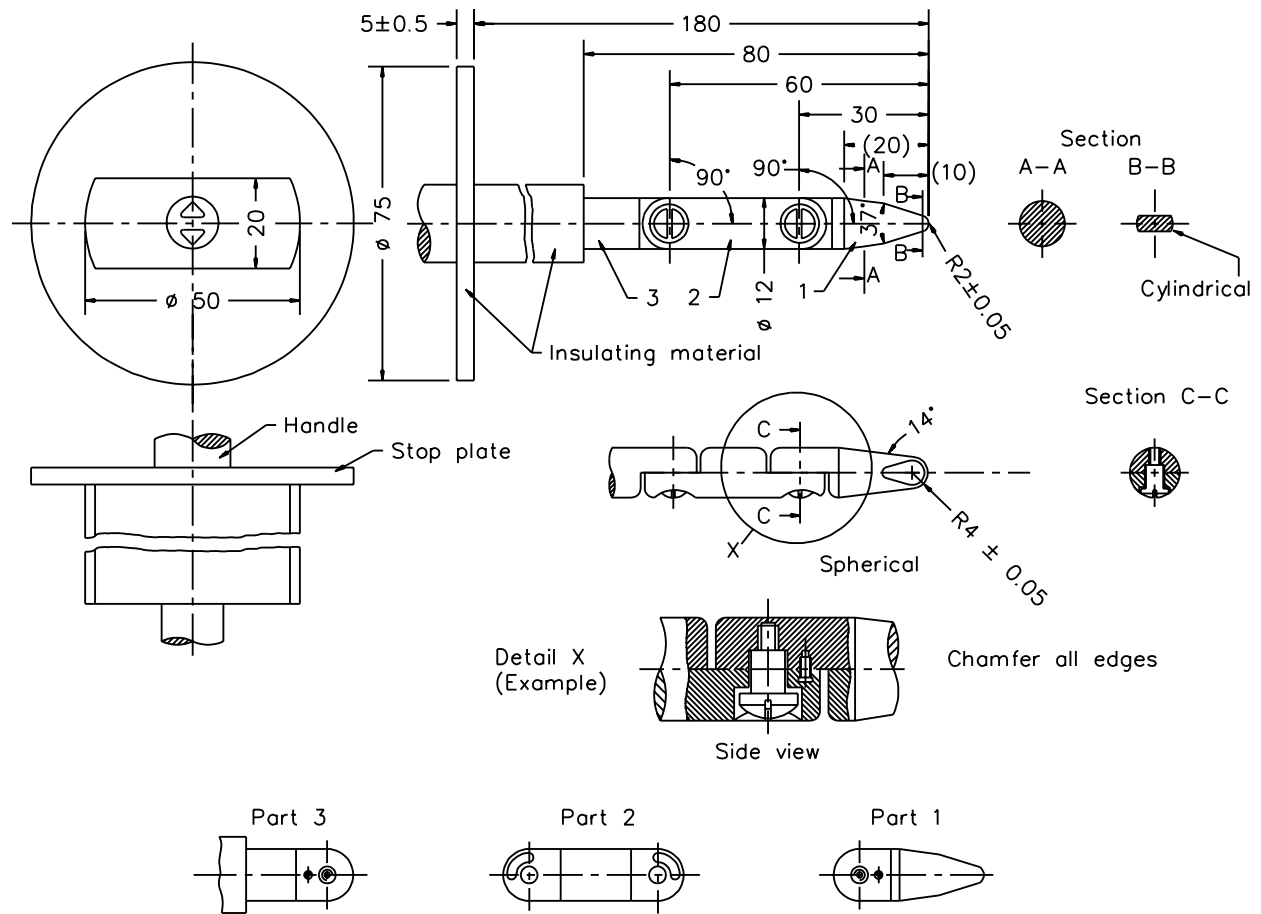
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Figure 11.4
Articulate probe



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